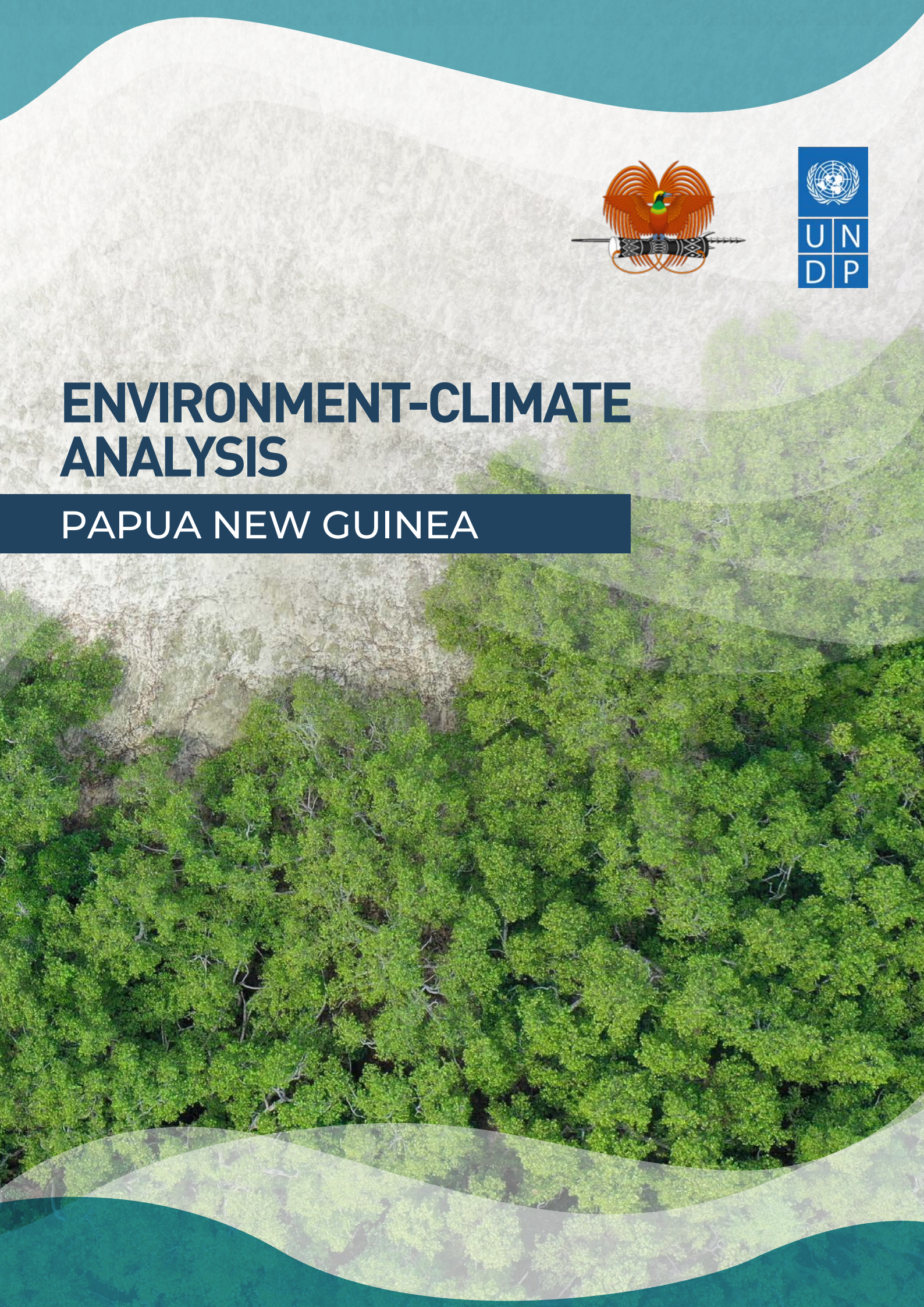
ENVIRONMENT-CLIMATE ANALYSIS

PAPUA NEW GUINEA



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ABBREVIATIONS AND ACRONYMS

ABS	Access and benefit sharing
ACIAR	Australian Centre for International Agricultural Research
ACSC	Australian Centre for Sustainable Catchments, University of Southern Queensland (USQ)
ADB	Asian Development Bank
AROB	Autonomous Region of Bougainville
BRC	Binatang Research Centre
CA	Conservation Area
CBD	Convention on Biological Diversity
CBO	Community-based Organisation
CCA	Common Country Analysis
CC-A	Community Conservation Area
CCDA	Climate Change Development Authority
CCSI	Columbia Centre on Sustainable Investment
CELCOR	Centre for Environmental Law and Community Rights
CEPA	Conservation and Environment Protection Authority
CEPF	Critical Ecosystem Partnership Fund
CI	Conservation International
CICI	Conflict Islands Conservation Initiative
CITES	Convention on International Trade in Endangered Species of Wild Fauna and Flora
CLRC	Constitutional and Law Reform Commission
CO2 eq	Carbon Dioxide Equivalents
CR	Critically Endangered
CROP	Council of Regional Organizations in the Pacific
CSIRO	Australian Commonwealth Scientific and Industrial Research Organisation
CTI	Coral Triangle Initiative
CTI-CFF	Coral Triangle Initiative on Coral Reefs, Fisheries and Food Security
DFAT	Australian Department of Foreign Affairs and Trade
DHS	Demographic and Health Survey
DLPP	Department of Lands and Physical Planning
DMT	Disaster Management Team
DNPandM	Department of National Planning and Monitoring
DPE	Department of Petroleum and Energy
DRM	Disaster Risk Management
e-waste	Electronic Waste
EEZ	Exclusive Economic Zone
EIA	Environmental Impact Assessment
EITI	Extractive Industries Transparency Initiative
EN	Endangered
ENSO	El Niño-Southern Oscillation
EPA	(EU) Economic Partnership Agreement
EU	European Union
EUR	Euro
EWS	Early Warning System
FAD	Fish Aggregating Device
FAO	Food and Agriculture Organisation
FCA	Forest Clearance Authority
FCPA	Forest Carbon Partnership Facility
FFA	Forum Fisheries Agency
FMA	Forest Management Agreement
FREAGER	Facilitating Renewable Energy and Energy Efficiency Applications for Greenhouse Gas Emission Reduction
FREL	Forest Reference Emission Level
FRI	Forest Research Institute
FRL	Forest Reference Level
GDP	Gross Domestic Product
GEF	Global Environment Facility
GFDRR	Global Facility for Disaster Reduction and Recovery
Gg	Gigagrams
GHG	Greenhouse Gas
GIZ	(Deutsche) Gesellschaft für Internationale Zusammenarbeit
GoPNG	Government of PNG
ha	Hectare
HDI	Human Development Index
HFC	Hydrofluorocarbon
IATTC	Inter-American Tropical Tuna Commission
ICAC	Independent Commission against Corruption
ICESCR	International Convention on Economic, Social and Cultural Rights
ICMM	International Council on Mining and Metals
IHO	International Hydrographic Organisation
IMO	International Maritime Organization

IOC	Intergovernmental Oceanographic Commission
IOM	International Organization for Migration
IPCC	Intergovernmental Panel on Climate Change
IPPU	Industrial Process and other Product Use
ISA	International Seabed Authority
ISO	International Organisation for Standardisation
ITT	International Tropical Timber
IUCN	International Union for the Conservation of Nature
IWASE	Integrated Water and Sustainable Energy project
J-PRISM	Japanese (Technical Cooperation Project for) Promotion of Regional Initiative on Solid Waste Management (in Pacific Island Countries)
JICA	Japan International Cooperation Agency
K	Kina
KBA	Key Biodiversity Area
kg	Kilogram
km	Kilometre
km2	Square kilometres
km3	Cubic kilometres
LFA	Local Forest Area
LMMA	Locally Managed Marine Area
LNG	Liquified Natural Gas
LULUC	Land use; land-use change
m3	Cubic metres
MARPOL	International Convention for the Prevention of Pollution from Ships
MEA	Multilateral Environment Agreement
METT	Management Effectiveness Tracking Tool
MHRA	Multi-Hazard Risk Assessment
MIS	Management Information System
ML	Mining Lease
MMWD	Marine Mine Waste Disposal
MoA	Memorandum of Agreement
MRA	Mineral Resources Authority
MSWG	Marine Sector Working Group
MW	Megawatt
NAQIA	National Agriculture Quarantine Inspection Authority
NARI	National Agriculture Research Institute
NBIS	National Biodiversity Information System
NBPOL	New Britain Palm Oil Ltd
NCDC	National Capital Development Commission
NDC	National Disaster Centre
NDC	Nationally Determined Contribution
NDRRF	National Disaster Risk Reduction Framework
NEC	National Executive Council
NFDP	National Forest Development Program
NFI	National Forest Institute
NFMS	National Forest Monitoring System
NFP	National Forest Plan
NGO	Non-Government Organisation
NMSA	National Maritime Safety Authority
NRS	National REDD+ Strategy
NRM	Natural Resource Management
NSLUP	National Sustainable Land Use Policy
NSO	National Statistical Office
NT	Near Threatened
OCCD	Office of Climate Change and Development
OCHA	(United Nations) Office for the Coordination of Humanitarian Affairs
OECM	Other Effective Conservation Means
OPOC	Office of the Pacific Ocean Commissioner
PACAM	Pacific American Climate Fund
PCCSP	Pacific Climate Change Science Program
PES	Payment for Ecosystem Services
PEUMP	Pacific-European Union Marine Partnership Programme
PIPAP	Pacific Islands Protected Areas Portal
PMAC	Provincial Management Advisory Committee
PNG	Papua New Guinea
PNG CLMA	Papua New Guinea Centre for Locally Managed Marine Areas
PNG-NDO	Papua New Guinea National Disaster Office
PNG-NFA	Papua New Guinea Fisheries Authority
PNG-NSO	Papua New Guinea National Statistics Office
PNGFA	Papua New Guinea Forest Authority
PNGRIS	Papua New Guinea Resource Information System
PRIF	Pacific Region Infrastructure Facility
RAMSAR	Ramsar Convention on Wetlands of International Importance
RAPPAM	Rapid Assessment and Prioritisation of Protected Area Management
RCF	Research and Conservation Foundation
REDD++	Reducing Emissions from Deforestation and Forest Degradation (and the role of conservation, sustainable management of forests and enhancement of forest carbon stocks in developing countries)
RESPAC	Disaster Resilience for Pacific Small Island Developing States
RFMO	Regional Fisheries Management Organization
RIMES	Regional Integrated Multi-Hazard Early Warning System
RMWD	Riverine Mine Waste Disposal
RRRC	Reef and Rainforest Research Centre
SABL	Special Agricultural Business Lease
SDG	Sustainable Development Goal
SEA	Strategic Environmental Assessment
SML	Special Mining Lease
SoE	State of Environment
SOE	State-Owned Enterprises
SPC	Secretariat for the Pacific Community

SPREP	Secretariat of the Pacific Regional Environment Programme
SPRFMO	South Pacific Regional Fisheries Management Organization
StaRS	Strategy for Responsible Sustainable Development
SWMI	Sepik Wetlands Management Initiative
TCA	Tenkili Conservation Alliance
TKCP	Tree Kangaroo Conservation Program
TNC	The Nature Conservancy
TRP	Timber Rights Purchase
UN	United Nations
UNCCD	United Nations Convention on Combatting Desertification
UNCLOS	United Nations Convention on the Law of the Sea
UNCTAD	United Nations Conference on Trade and Development
UNDAF	United Nations Development Assistance Framework
UNDP	United Nation Development Programme
UNDRR	United Nations Office for Disaster Risk Reduction
UNEP	United Nations Environment Programme
UNESCO	United Nations Educational, Scientific and Cultural Organization
UNFCCC	United Nations Framework Convention on Climate Change
USAID	United States Agency for International Development
US$	United States Dollars
USQ	University of Southern Queensland
VU	Vulnerable
WaSH	Water, Sanitation and Hygiene
WCPA	World Commission on Protected Areas
WCPFC	Western and Central Pacific Fisheries Commission
WCS	Wildlife Conservation Society
WDPA	World Database on Protected Areas
WHA	World Heritage Area
WMA	Wildlife Management Area
WTO	World Trade Organisation
WWF	World Wildlife Fund

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EXECUTIVE SUMMARY

INTRODUCTION

Papua New Guinea (PNG) has outstanding natural wealth, an exceptional diversity of wildlife and a growing population, most of whom live subsistence lifestyles and depend directly on the environment to provide their daily needs. However, PNG's natural resources are being depleted rapidly, with impacts on both biodiversity and people's well-being.

This environmental analysis collects and analyses information, examines progress, programmes and gaps, and makes recommendations about diverse environmental topics, vulnerability to disaster, and the environmental factors relating to the people left behind.

ENVIRONMENT OF PAPUA NEW GUINEA

PNG lies in the southwestern Pacific Ocean and comprises the eastern half of the island of New Guinea, the Bismarck Archipelago (New Britain, New Ireland, the Admiralty Islands, and several others), Bougainville Island (part of the Solomon Islands chain), and small offshore islands and atolls. PNG is one of the most disaster-prone countries in the world, due to geophysical conditions. Prevalent hazards include earthquakes, cyclones, storms, volcanic eruptions, riverine and coastal flooding, coastal erosion, epidemics, and droughts (UNDRR, 2019a).

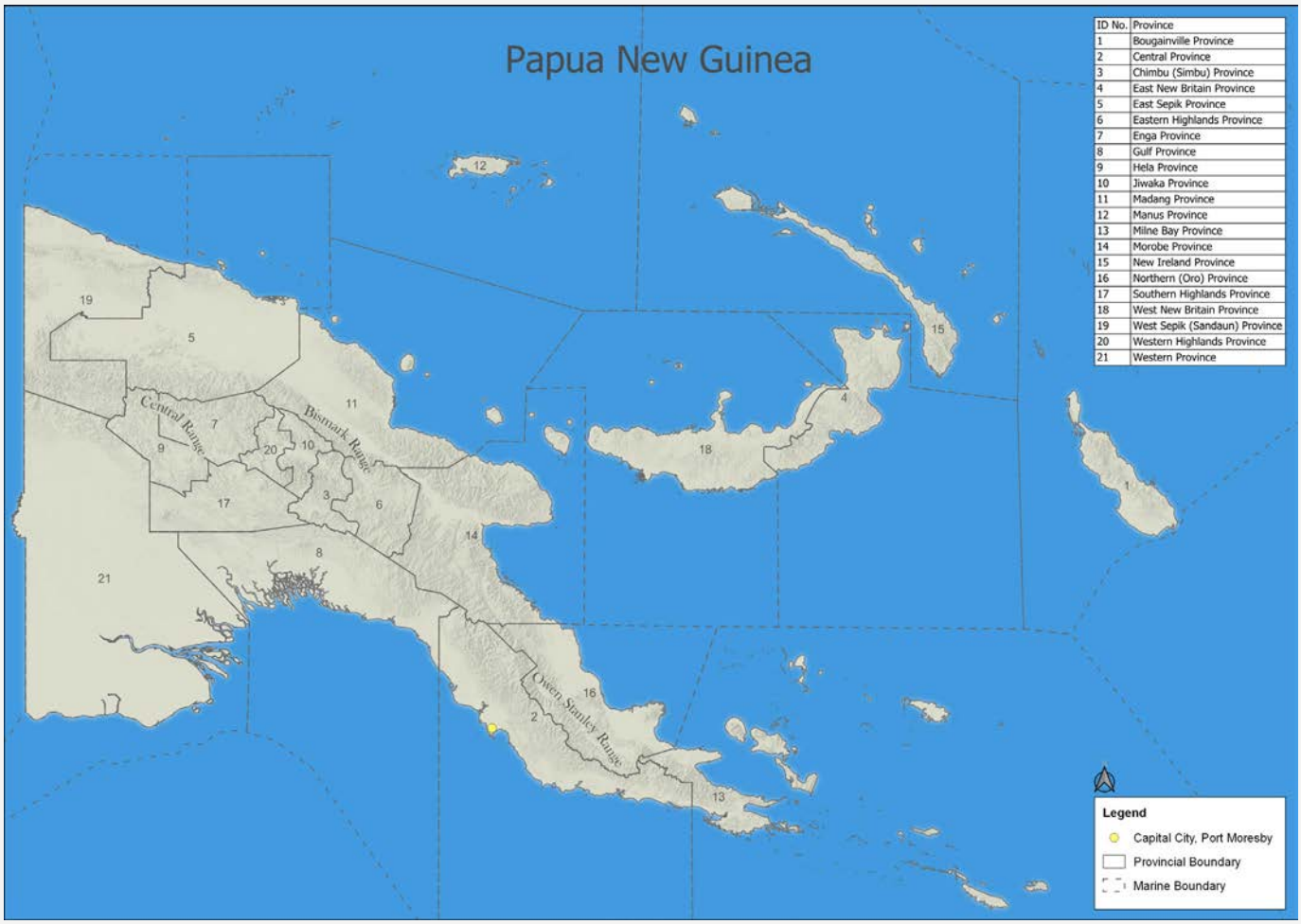

Figure 1: Papua New Guinea's provinces and mountain ranges

PNG's geography is defined by a high central cordillera (over 1,500m), with several subsidiary coastal ranges comprising montane landscapes. Many of PNG's islands are active or recently active volcanoes. The high equatorial ranges and warm tropical seas generate high rainfall, which feed thousands of streams and rivers that have broken the landscape into many isolated and hard-to-reach plains, plateaux and valleys. PNG's coastline is over 17,000 km long. The implications of its remote geography include:

- Evolution of very diverse flora and fauna, including many endemic species (those found nowhere else in the world);
- Development of diverse cultures, with over 850 recognized languages;
- Poor accessibility, lack of infrastructure and services and high transport costs in many areas;
- Some extremely wet areas with high disease potential and low productivity; and,
- Very high vulnerability to volcanic eruptions, earthquakes and other natural disasters.

LEGISLATION, POLICIES, AGREEMENTS AND TOOLS

Both PNG's Constitution and its strategic Vision 2050 include, as major pillars, the conservation of the environment and culture for the benefit of future generations. The country is a signatory to many international agreements that commit it to conserving the environment, respecting human rights, and taking action on climate change. These include the Convention on Biological Diversity (CBD); the United Nations Framework Convention on Climate Change (UNFCCC); the Paris Agreement, and a commitment to UN Sustainable Development Goals (SDGs).

Some components of PNG's environment legislation and policy are substantial, including the National Oceans Policy, Policy on Protected Areas, National Strategy for Responsible Sustainable Development (STARS), and Climate-compatible Development Policy, but the implementation of these has been lacking. However, much legislation is old and requires review and updating (e.g., biodiversity and wildlife conservation, forestry management, sustainable land use, chemical and waste disposal, and mining).

PNG's environmental governance remains weak. It scores poorly on the international Environmental Performance Index, where it is ranked 146 out of 180 countries (Yale Center for Environmental Law and Policy, 2020). While legislation appears to protect the rights of landowners and the community, in practice the laws and agreements are not always enforced, and this frequently leads to dissatisfaction and sometimes conflict.

Weak law enforcement and systemic corruption problems are recognized by GoPNG and the United Nations as significant barriers to development in the country: the government has committed to action on these issues under the auspices of the United Nations Convention Against Corruption and the PNG Anti-Corruption Project funded by the European Union and implemented by the United Nations Office on Drugs and Crime and the United Nations Development Programme PNG.

PNG carried out its first Money Laundering and Financing of Terrorism National Risk Assessment (NRA) in 2017 which identified strong indicators of large-scale corruption and illegal logging in the country's forest sector. In line with the findings of the NRA, the 2017-2022 National Anti-Money Laundering and Counter Terrorist Financing Strategic Plan requires the Papua New Guinea Forest Authority (PNGFA) to conduct a sectoral risk assessment. The NRA identified that environment crime covers a wide range of offences and does not limit it to mining related crimes and waste trafficking. The NRA also found that there is illegal mining such as alluvial gold mining and failures to comply with various conditions relating to mining and production activities which are designed to protect PNG's environment and breaches of environmental conditions with waste dumping (FATF Report 2021).

The impact of extractives without proper management has reportedly led to such consequences as environmental damage; health issues for the surrounding communities; issues of physical safety, freedom of movement, and access to services; lack of access to clean water; flooding and destruction of agricultural land and sacred sites; landslides; and food insecurity, among others.

Broadly, a lack of availability of high-quality and disaggregated data hinders progress towards sound environmental decision-making across PNG. Whilst data often exist at the project level, no comprehensive database or system exists with which to store, manage, and share and use this data over the long-term.

To assist community-level engagement in environmental management and conservation, several tools and mechanisms have been developed by the UN and development partners. These include the free, open-source Lukim Gather mobile data collection application (www.lukimgather.org) to assist protected area communities in mapping and monitoring their environment; the PNGBiodiversity (www.pngbiodiversity.org) library of resources for establishing and monitoring protected areas; the National Forest Monitoring System (http://png-nfms.org/portal/) for REDD+ and Forest Monitoring projects; and the Biodiversity and Climate Fund (www.pngbcf.org) which will assist communities, NGOs and community-based organizations in funding projects related to the preservation of environmental resources across PNG.

BIODIVERSITY CONSERVATION

PNG has outstanding biodiversity values. It is located on the most floristically diverse island in the world, with a high degree of endemism and many undescribed species (Cámara-Leret et al., 2020). The diversity of vertebrate animals is among the highest on the planet, with at least 1,786 species of amphibians, reptiles, birds and mammals, between five and nine percent of the world's total. The number of species is likely to increase as research continues to find new and undescribed plants and

Table 1: Numbers of threatened and endemic species in Papua New Guinea (August 2022)
Source: Red List IUCN (2020); data from the Red List (IUCN, 2022)

	Frogs	Reptiles	Birds	Mammals	Bony fish	Sharks, rays	Insects	Anthozoa (hard corals)	Plants
Critically Endangered	8	1	2	10	18	10	1	n/a	153
Endangered	5	4	4	18	22	21	2	6	283
Vulnerable	15	8	35	26	36	32	10	151	187
Threatened species total	28	13	41	54	76	63	13	157	623
% of assessed PNG spp	8%	3.75%	5.53%	18.37%	3.23%	56.25%	3.40%	28%	20.85%
Near Threatened	8	7	61	15	21	19	6	151	124
Least Concern	302	265	671	193	2118	24	220		1791
Data Deficient	52	62	9	32	141	6	162	214	450
Species total assessed	362	347	741	294	2356	112	402	38	2988
Endemic assessed	292	120	114	85	102	10	174	not assessed	1340
% endemic	81%	35%	15%	29%	4%	9%	43%		45%

animals. PNG is among the world's top ten countries where conservation of its natural environment can contribute to saving biodiversity (Dinerstein et al., 2020). Despite this, PNG's biodiversity loss continues to accelerate and there is a risk of losing species before they are identified and catalogued.

There has been little recent work at the national level on policy or programmes for wildlife and biodiversity conservation. In PNG, two-thirds of animal species and a fifth of plant species are listed as decreasing, with the population trend of most of the rest unknown (IUCN, 2022). One in five of PNG's mammals is threatened.

Threats to wildlife and biodiversity include wildlife trade, unsustainable hunting and resource use, invasive species, clearing and habitat loss (e.g., rough extractive industries including agriculture, logging, mining, oil and gas extraction), invasive species, loss of biocultural knowledge, climate change, and pollution and sedimentation. Sustainable use of wildlife is a pillar of survival for many rural people in PNG, as a source of food, medicine, firewood, and building materials. Wildlife is also an integral part of the cultural and traditional life. Sustainability has become more difficult to ensure due to increasing human populations placing pressure on habitats for wildlife populations. Often, the loss and destruction of biodiversity results in few long-term benefits for local landholders, or the PNG community. The people who suffer most from biodiversity decline are the poorest, who are reliant on hunting and fishing for survival, and women and children.

PNG has outstanding diversity of varieties in its common food crops, and is the centre of diversity for crops including bananas and sweet potatoes. PNG is currently considering the ratification of the Nagoya Protocol on Access and Benefit Sharing (ABS). In the past, PNG's genetic resources have been exploited without any benefit for landowners or the country or protection of landowners' intellectual property. The PNG government is concerned about community and national rights to genetic material.

The UN and development partners support a number of programmes to improve biodiversity outcomes through strengthening management effectiveness, establishment of a network for community collaboration and partnerships, advocacy initiatives to create a forum for conservation stakeholder, piloting demonstration initiatives and sustainable financing. The Secretariat of the Pacific Regional Environment Programme (SPREP) also provides a useful mechanism for South-South cooperation.

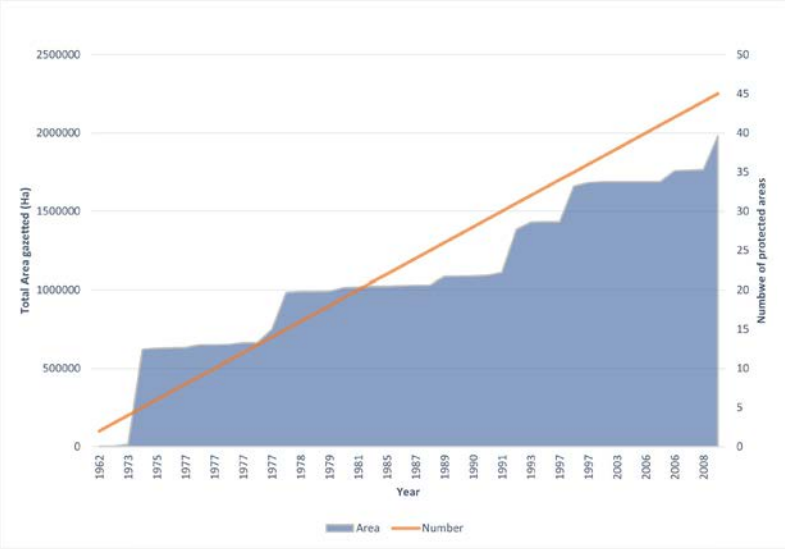

Figure 2: Papua New Guinea's protected area network, 1962-2022
Source: Drawn from the protected area database, provided by CEPA, Government of PNG

PROTECTED AREAS

Protected areas in PNG are managed under several pieces of legislation that will be aligned when the Protected Areas Bill is finalised and enacted. The Policy on Protected Areas was approved in 2015.

In 2022, there were 61 formally gazetted protected areas in PNG totalling just over 2.2 million ha (4.8 percent of the land area), well below the agreed 17 percent for terrestrial protected areas as stated in the CBD Aichi targets and the PNG Policy on Protected Areas. Since 2010, four protected areas have been gazetted, and one has been substantially expanded. Representation of ecosystems and species falls well short of the agreed targets. Priority areas for future reservation have been identified (Adams et al., 2017), but the time required to create new protected areas is significant. Free, prior and informed consent of landowners is essential for any proposals to be progressed.

The management effectiveness of most protected areas is very low, with more than 90 percent having no or minimal funding or staffing (Leverington et al., 2017), resulting in limited active management and monitoring of biodiversity outcomes. The exceptions are protected areas with consistent external support, usually coupling biodiversity conservation with community development. Recent projects supported by the Global Environment Facility (GEF) and UNDP have assisted in increasing capacity, especially at the national level, and developing preliminary management plans for most protected areas. However, the staffing and funding of protected areas across the board is inadequate, especially considering the vital importance of biodiversity in PNG. As most protected areas will be managed at the provincial level, partnerships with provincial administrations and capacity building at local-level government and community levels are critical.

Protected and conserved areas offer opportunities for PNG communities, as they can be a focus for funding that integrates conservation objectives with social and economic progress and the continuance of diverse cultures. A long-term, sustained effort needs to continue at many levels – national, provincial and local across the country, including in remote locations. The current GEF-funded project on sustainable financing of protected areas aims to reduce the funding gap for protected areas and improve their management effectiveness and the livelihoods of customary landowners. With the support of UNDP, it aims to establish a national Biodiversity and Climate Fund as a legally independent institution. This fund will aim to support financial sustainability of protected area management in the country, as well as support the coordination of fund-raising efforts on behalf of protected areas.

FORESTS

In PNG, 78 percent of the land is classified as forest (PNG Forest Authority, 2019). In terms of ecosystem structure and function, carbon storage, and biodiversity, these forests are globally significant. Most forest land is owned by customary landowners who rely on forest resources for subsistence and income. About 76 percent of forests have had no significant human disturbance. Nearly 11 percent are logged, and around 13 percent are disturbed by other activities -- namely subsistence gardening, fire and small-scale logging, such as *wokabaut* (mobile) sawmills. Logging activities mainly occur in low altitude (<500m) forest on plains, fans, and uplands (PNG Forest Authority, 2019).

Changes to forest cover are distinguished between forest degradation (e.g. as a result of commercial logging), and forest deforestation where a forest is replaced by other land cover types (e.g. cropping, urban expansion) (Babon and Gowae, 2013). Between 2000 and 2019, just over 350,000 ha of forest was cleared and converted to other uses (PNG Forest Authority, 2019). The average annual area of deforestation between 2011 and 2015 (30,700

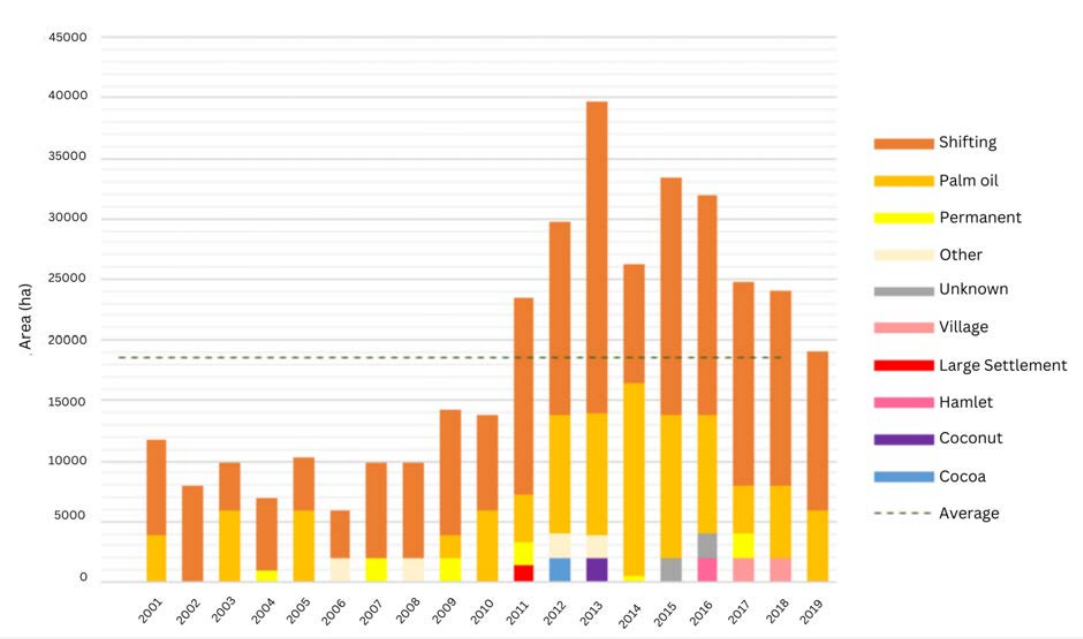

Figure 3: Estimated annual rates of deforestation in PNG, 2001-2019
Source: Global Green Growth Institute and CCDA, 2021, from draft LULUCF Assessment 2016-2019

ha), was significantly more than between 2001 and 2005 (PNG Forest Authority, 2019). This annual rate slowed to under 20,000 ha by 2019), due to government policies and cancellation of some Special Agricultural Business Leases (SABLs) (Global Green Growth Institute and CCDA, 2021) (Figure 3). Almost all deforestation (99 percent) was due to land use conversion from forest land to cropland. Subsistence agriculture is reported to be the most significant driver of deforestation (responsible for over about two thirds), followed by oil palm plantation development (30 percent) (PNG Forest Authority, 2019).

Nearly 3 million ha of forest was mapped as becoming "degraded" between 2000 and 2019 (Global Green Growth Institute and CCDA, 2021). This represents about 10 percent of the country's forests and is mostly due to logging. The annual area of forest degradation more than doubled from 2001 (87,600 ha) to its peak in 2011 (200,050 ha). Since its peak, the rate slowed to 100,000 ha in 2019 (Figure 4) (Global Green Growth Institute and CCDA, 2021).

Key areas of concern related to forestry include the impact of timber harvesting activities, including sustainable logging cycles and illegal logging; third parties' rights; transport and trade; and poor governance, as well as lack of suitable engagement with customary landowners.

PNG is the largest exporter of tropical round logs in the world, exporting 84 percent of these logs to China (PNGi, 2022). The government has committed to phasing this out by 2025, with two supporting policies: an end to new timber permits and permit renewals, and an end to new log export licenses for foreign owned logging companies. Given that round log-exports are still at a high level (Figure 5) and that many agreements and licences are not due to expire for many years, this phasing out will require a concerted action (Act Now! for a better PNG, 2022).

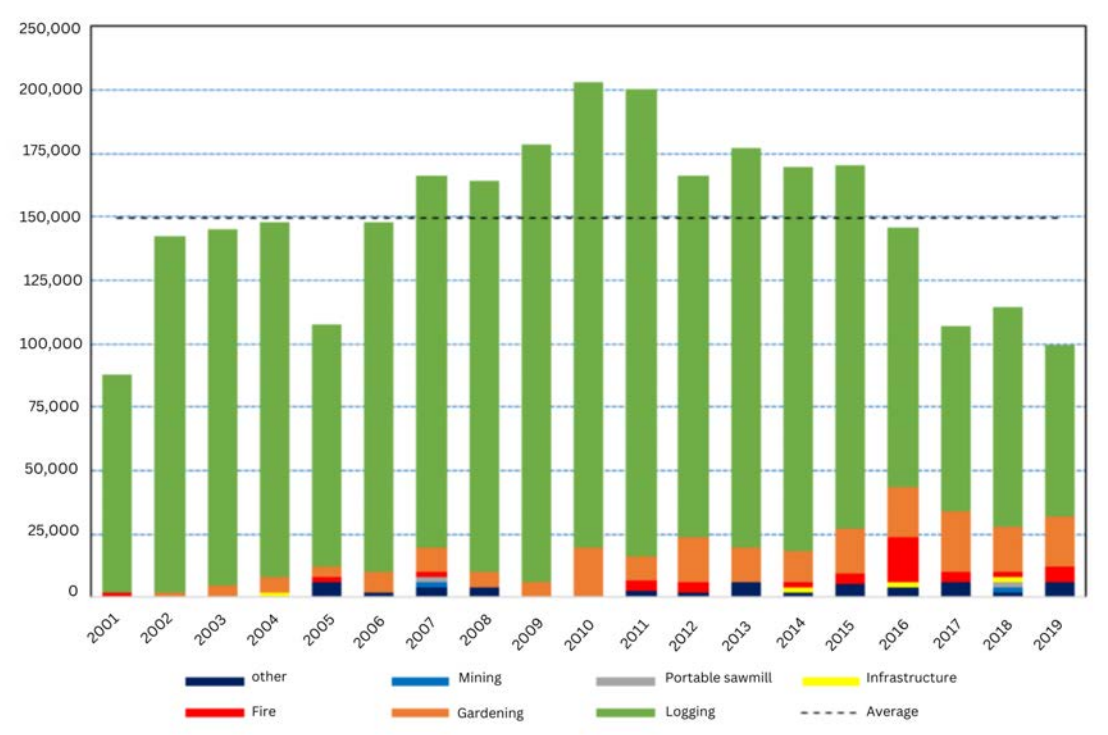

Figure 4: Annual rate of forest degradation 2001-2019 (area in ha)
Source: Global Green Growth Institute and CCDA, 2021

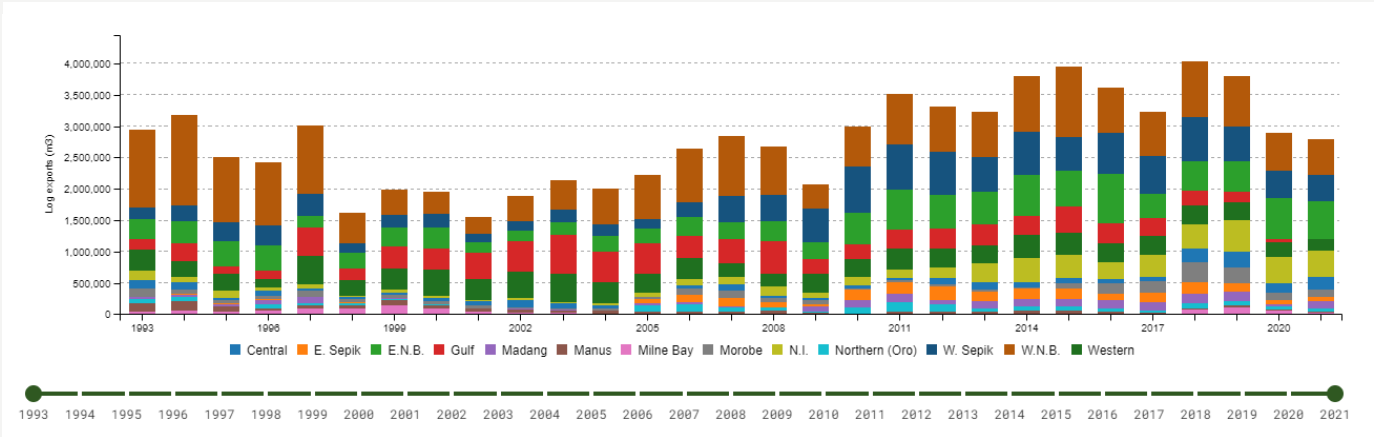

Figure 5: Exports of round logs from PNG, 1993 to 2021
Source: PNGi 2022

There have been allegations of inadequate monitoring and poor enforcement within the forestry sector for a number of years (Davidson, 2021; Gabriel and Wood, 2015; Laurance et al., 2012; Lawson, 2014; Mousseau, 2017). These mainly applied to logging within Special Agricultural Business Leases, and allegations were confirmed by a government inquiry (Numapo, 2013), which led to the cancellation of some of the licenses. As well as environmental impacts, social impacts can include greater violence and hardship for women (Cannon, 2020), and issues of use of force by uniformed forces.

Reducing Emissions from Deforestation and Forest Degradation (REDD+) aims to support countries to reduce or stop deforestation, primarily as a climate change mitigation measure. Development of the National REDD+ Strategy has been supported by legal, policy and technical advances including the National Forest Monitoring System, to achieve a consistent and repeatable approach to monitor changes in forest cover. GoPNG has committed to ending forest loss by 2030.

MARINE CONSERVATION

PNG's marine environment is vast and diverse, globally significant in terms of its ecosystem structure, function and biodiversity, and locally significant for the many thousands of PNG residents who rely on its resources for subsistence and income. Most of PNG's threatened and highly biodiverse marine and coastal ecosystems and species are not well protected, leaving them potentially vulnerable to conflicting resource use and over-exploitation.

In about 4,000 rural coastal communities throughout 14 maritime provinces, most people survive on artisanal fishing, hunting and gardening, with few opportunities to earn money for essential services. Coastal populations are expanding rapidly, placing pressure on coastal and marine resources. Pressures on marine and coastal areas include:

1. Changing and intensifying weather patterns and other effects of climate change;
2. Impacts from land-based activities including a loss of foraging and breeding grounds for many species of fish;
3. Invasive marine and coastal species;
4. Subsistence and artisanal over-fishing, and destructive fishing practices in some areas;
5. Illegal, unreported and unregulated fishing; pollution and sedimentation impacts from forest clearing, agriculture, mining, oil spills and industrial activities.

Locally managed marine areas (LMMAs) are an important mechanism for sustainable management of in-shore areas, and will be more formally recognized in the protected area legislation when passed. In addition, there is a commitment to create larger off-shore marine sanctuaries. Any plans to effectively manage marine resources must include viable pathways for the health and wellbeing of coastal communities, including alternative incomes and employment such as through tourism, and improved access to basic human services.

Additional conservation areas are required to meet SDG 14 and Aichi Target 11, including a need to protect and manage deep water habitats and reefs, and to adequately protect commercial fish stock spawning aggregations, marine turtles, seabirds and cetaceans.

The expansion of marine protected areas in PNG presents opportunities for strengthened management and pursuit of economic activities that positively contribute to biodiversity. The endorsement of the PNG's Ocean Policy has highlighted the importance and potential for the blue economy. Early initiatives include the UN joint programme to establish a Blue Economy Incubation Facility to provide early stage financial and technical support to women-led blue businesses, funded through the Global Fund for Coral Reefs and Joint SDG Fund.

MANAGING WATER, WASTE, AND POLLUTION

Management of waste of all kinds in PNG is limited. The report from the February 2020 meeting of the Pacific Waste programme (PACWASTE) (SPREP, 2020) recorded that PNG had:

- Outdated legislation governing waste and chemical management;
- Limited sustainable financing mechanisms;
- Limited institutional and human resource capacity at national/municipality levels;
- A lack of national policies or strategies on waste management.

Wastewater and sewage are primarily released with stormwater drainage, even in larger cities where sewerage treatment plants may exist. Wastewater from commercial premises have high concentrations of pollutants.

Rapid population growth is outpacing investment in water, sanitation and hygiene (WaSH) and waste infrastructure and services in urban, peri-urban and rural areas. Improvements are required to reduce the exposure of vulnerable populations to health risks from poor quality water, sanitation and hygiene, and impacts on the environment from unmanaged or poorly managed waste disposal. There is significant multilateral (World Bank, EU, ADB) and bilateral (Japan, Australia) investment in improving WaSH and waste management in PNG. These investments are guided by multi-lateral, national and institutional frameworks and strategies, and are accompanied by technical guidance, project monitoring and evaluation, and capacity building. PNG has embraced eco-industrial development where the goal is to create a node of industrial sustainability (Government of Papua New Guinea, 2018), and is currently developing its first National Waste and Chemical Management Policy (Department of National Planning and Monitoring, 2020).

MANAGING MINING AND GAS PRODUCTION

PNG is highly prospective for minerals including gold, copper, silver, nickel and cobalt, as well as hydrocarbon resources in the form of oil and gas. Foreign investment in large mines, oil and gas extraction is encouraged in PNG, and the sector dominates the economy. There is also small-scale alluvial gold mining (a 'reserved activity' for Papua New Guineans only), sand mining and limestone mining. Pressure for deep-sea mining is growing in line with rising demand for rare minerals to support the expanding technology sector.

Mining, oil and gas extraction in PNG has had weak environmental regulation, environmental degradation, adverse social impacts and limited community gains. Environmental and social impacts of mining, oil and gas extraction include: gendered inequality and inequity; fraudulent consent; displacement; social breakdown; land alienation; pollution (from tailings runoff, including increases in heavy metals, sedimentation, and lowered water quality); biodiversity loss and changes; greenhouse gas emissions (e.g., gas flaring); poor health; and social conflict (Mudd et al., 2020; Roche et al., 2019). An important issue is the disposal of mine tailings, which constitute up to 99 percent of the volume of material mined. Tailing dams are prone to failure in areas of high seismic activity and extreme rainfall events. Three mines in PNG and one in Indonesia are the only places in the world where mine tailings are licensed to be discharged into rivers (Kwong et al., 2019), and this has had serious consequences for places such as the Fly River (Busilacchi et al., 2020). In March 2020 the National Executive Council (NEC) recommended a ban on all riverine tailings' disposal for all future mines. The ban is not retrospective and changes to legislation have yet to be introduced. Deep-sea disposal is an alternative practiced in 16 mines in six countries. It is now banned in most parts of the world due to its environmental impacts, but it may be a viable alternative in a few countries including parts of PNG where deep water is in close proximity to the shore, provided strict conditions are followed (GESAMP, 2016; Kwong et al., 2019).

The Mining Project Rehabilitation and Closure Guidelines (Mineral Resources Authority of PNG et al., 2019) recognize that mine closure and reclamation need to be planned for, early in the mining process to maximise the beneficial outcomes following mine closure. Due to the uneven distribution of benefits from this sector and the breakdown of traditional culture associated with mining, many mine, oil and gas sites are witnessing opposition from associated landowning communities.

Given that the PNG economy is heavily reliant on the extractive resource industry, interventions need to address how to improve the industry's economic, environmental and social performance.

CLIMATE CHANGE AND GREEN ENERGY

The impacts of global climate change are driving vulnerabilities associated with more extreme weather events, sea level rise, and potential changes to biodiversity, including loss of livelihoods. Over 80 percent of the country's population is susceptible to climatic extremes due to their direct dependence on natural resources and subsistence agriculture, and their limited capacity to adapt (Butler et al., 2014), and over half a million people live in coastal villages exposed to sea-level rise, coastal degradation and storm surges (UNDRR, 2019b). These diverse risks have implications for human rights as the negative impact on lives and livelihoods may fuel social unrest and increase vulnerability for marginalized populations.

Global climate model projections indicate that for PNG in the coming century (Australian Bureau of Meteorology and CSIRO, 2014):

- El Niño and La Niña events will continue to occur in the future (very high confidence), but there is little consensus on whether these events will change in intensity or frequency;
- Annual mean temperatures and extremely high daily temperatures will continue to rise (very high confidence);
- Average rainfall is projected to increase in most areas (medium confidence), along with more extreme rain events (high confidence), and droughts are projected to decline in frequency (medium confidence);
- Ocean acidification is expected to continue (very high confidence);
- The risk of coral bleaching will increase (very high confidence); and
- Sea level will continue to rise (very high confidence).

PNG has been a world leader in pressing for action against climate change. In 2015, PNG adopted the Paris Agreement and in 2021 supported the Glasgow Climate Pact as well as the Glasgow Leaders' Declaration on Forests and Land Use, which commits to halting and reversing forest loss by 2030. The vast natural forests of PNG play an important role in regulating climate, and PNG was traditionally a carbon sink. However, by 2015, PNG had become a net source of carbon, as a result of accelerated land clearing and land use change and increases in emissions from the energy sector. Net emissions returned to below zero in 2017 as the rate of forest clearing and logging decreased, but emissions from energy sources have continued to increase (Figure 6) (Government of Papua New Guinea, 2022).

Mitigation efforts have centred on the REDD+ initiatives (see Forestry section) and the transition to renewable energy. PNG has a high potential for renewable energy from hydropower, solar, wind,

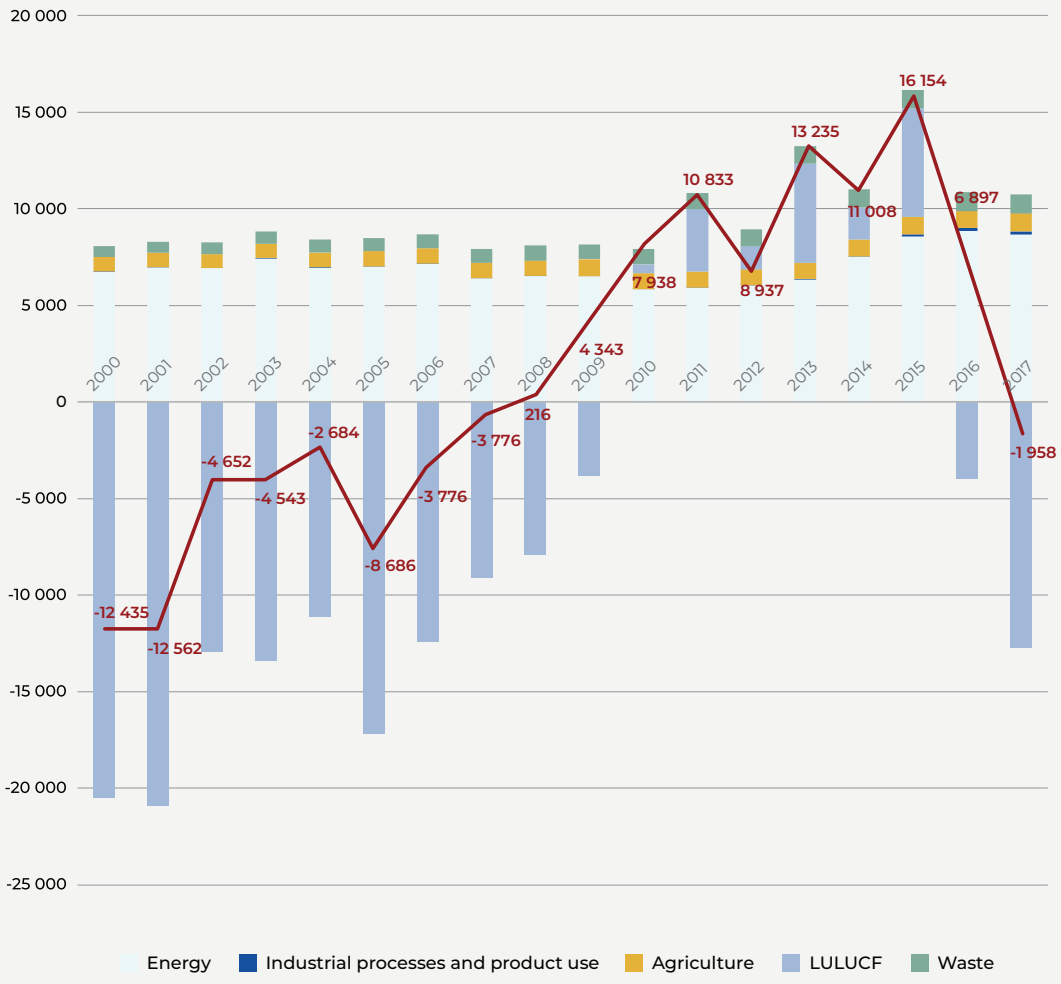

Figure 6: Total estimated emissions of greenhouse gases, 2001-2017
Source: Government of Papua New Guinea, 2022

biomass, and geothermal sources, but barriers need to be overcome to enable the widespread adoption of renewable energy (Global Green Growth Institute, 2019) such as: lack of an enabling policy environment (e.g. a fixed national electricity tariff which is subsidised and does not cover the full cost of generation and distribution); lack of readiness for the private sector and financial services in relation to renewable energy; lack of reliable data about demand (and supply); and, vandalism and theft of infrastructure.

Adaptation and building resilience are also a focus for the government, as impacts from climate change increase. A national adaptation plan is being prepared (UNDP, 2020) and sectoral plans are also being prepared, as well as adaptation plans for provinces. UNDP has been supporting the implementation of an Asian Development Bank-funded project to strengthen climate resilience in 21 islands and atolls in five provinces in PNG. The replication of this approach would be a valuable avenue to address community resilience.

PNG has clear targets and policies for managing climate change. A key challenge is resourcing implementation. Financial resources, expert and technical advice, government systems and community capacity are all needed. Development partners have contributed to at least 26 projects supporting PNG's climate change initiatives, and there are clearly defined needs for future support (Government of Papua New Guinea, 2022).

VULNERABILITY TO NATURAL AND ENVIRONMENTAL DISASTERS

PNG is among the most disaster-prone countries in the world. Prevalent hazards include earthquakes, cyclones, storms, volcanic eruptions, riverine and coastal flooding, coastal erosion, tsunamis, epidemics, and droughts (UNDRR, 2019b). Climate-related hazards are expected to become increasingly severe as a result of climate change (e.g., droughts, sea level rise). The INFORM Risk Index (2022) ranked PNG as the 22nd most vulnerable of 189 countries in relation to hazard and exposure, vulnerability, and lack of coping capacity.

Vulnerability is increased by the distribution and socio-economic circumstances of the population, and the lack of capability for governments and communities at all levels to plan and respond for events. Rural people who are dependent on natural resources are often left without shelter or any form

of income, and are highly exposed to disease and hunger.

The health, livelihoods and food security of PNG's rural population (constituting 80 percent of the population) are particularly vulnerable to the impact of disasters (UNDRR, 2019a). Natural and environmental disasters particularly affect the most vulnerable in the community, including children, women, the elderly, people living with disability and the rural poor. Gender-based violence after disasters is a major issue.

Floods, volcanic eruptions, landslides, earthquakes, and storms are the top five most frequent natural hazards in PNG, based on the EMDAT International Database data from 1990 to 2014. Many of these hazards require adaptive measures (Table 2).

Investment in disaster planning, response and recovery is largely funded from external development assistance. UNDP and other development partners continue to fund activities that aim to strengthen disaster prevention, response and recovery including expanding early warning systems, and local area

Table 2: Hazards which require adaptive measures
Source: Dartmouth Flooding Database; EM-DAT; Reliefweb.int; press clippings; academic journals; Reefbase; WHO; PNAS; Worldbank; FAO; IMF; WRI; TEEB; ANU; Internet research; interviews; Adaptation technical working group

Hazard	Risk Exposure
Coastal Flooding 	• Climate change will exacerbate the issue due to rising sea levels and occurence of coastal storms • Damages infrastructure • Affects ~6,000 and displaces ~400, several deaths on an annual basis
Inland Flooding 	• Occurs multiple times per year • Damages buildings and infrastructure • Affects ~26,000 annually, including the displacement of ~8,000 people and several deaths.
Land Slides 	• Affects 500-600 and kills several people in remote, mountainous areas • Damages infrastructure, particularly roads, causing transport issues
Malaria 	• Already affects half of the population, with climate change impacting ~200k more in the Highlands as conditions become more tolerable for the disease • Highlands cases are becoming more severe
Agricultural yield loss 	• 3 million people depend on climate-sensitive crops • Climate change may reduce yields: adaptation measures are needed
Coral reef decay 	• 70,000 people earn a living from reefs • Bleaching events and decay will reduce the livelihood and subsistence opportunities

preparedness, response and recovery. The investment is coordinated through the National Disaster Centre, which itself requires additional capacity and capability building. The key issue is the lack of capacity for sustained implementation at the national, provincial and local levels and greater status and authority across government.

Priorities identified include:

- Expanding early warning systems;
- Systematic data collection, analysis, and management, required for risk analyses, situational assessments, projection of future scenarios and planning for effective disaster risk reduction and response measures;
- Further localization to increase the capacity of local actors and operators in disaster preparedness, and to effectively respond and recover in the aftermath of disasters;
- Improving the ability of local communities to effectively manage response and recovery through resilience and capacity building, including community-led resilience building; and,
- Improving and reinforcing disaster finance including investment in increasing community resilience, poverty reduction and environmental protection, responding to mechanisms for alleviating loss of livelihoods, and addressing shelter and access to safe water/sanitation in the aftermath of disaster events.

The existing frameworks focus on preventing and mitigating the socio-economic impacts of disasters, and only tangentially touch on environmental impacts.

SUSTAINABLE LAND USE PLANNING

In PNG, up to 97 percent of land is in customary ownership. Land is central to an individual and group's sense of social identity and belonging and this knowledge is passed on verbally from one generation to the next. The PNG Constitution recognizes customary land tenure and hence exclusive individual landownership and inheritance of land are limited.

Progress in land use planning (LUP) in PNG has been slow and disjointed. The National Strategy for Land Use Planning is awaiting government approval. There is no widespread spatial planning across the country or within provinces or LLG; limited capacity and systems to deliver the required outcomes for biodiversity and communities; and a lack of integrated sectoral responses to land use.

The focus on land formalization and registration of land titles has the possibility of leaving customary landowners behind, especially if this process diminishes or eradicates the rights that are attached to their land. This impacts significantly on women, who have limited ownership of land and unequal access to resources and decision-making concerning land.

At the national level, priority zones of nationally important biodiversity should be identified as areas of constraint to broadscale land clearing. Biodiversity matters should be mainstreamed into all land use planning and marine planning and local land use plans are needed to identify what communities value, which areas are constrained and what areas offer potential for a range of land uses (e.g. agriculture, settlement, conservation, industry). This is an important way to minimise land use conflicts, protect people's rights (including women), ensure good management of resources, and preserve cultural values. This planning effort needs to be coupled with effective dispute resolution processes. The GEF-funded UNDP project (2021-27) aims to establish systems for sustainable integrated land use planning across New Britain, including the scaling up of land use planning processes from community to national level. Similarly, the UNDP project to strengthen integrated sustainable landscape management in Enga Province (2021-26) aims to integrate approaches from local to provincial level and will include mapping of conservation areas, monitoring of target areas and developing base maps and spatial information for effective LUP.

Future approaches in LUP need to focus on respect of the customary landowners' rights by recognizing the 'bundle of rights' that is attached to land; build on and accommodate informal and semi-formal arrangements for land reform (e.g., by identifying all existing tenure rights and rights holders and include all these people in consultation processes); strengthen women's land rights (e.g., equitable engagement of women in law making in relation to inheritance, land titling and registration, equitable benefit sharing, and better sex-disaggregate data); developing 'fit for purpose' systems of land registration, administration of land tenure and LUP; addressing corruption in land dealings; addressing informal land and the need for expanded settlement areas (due to increasing population growth, in-migration and displacement); updating legislation, policy and plans; improving data storage and usage systems; and enhancing capacity at all levels.

THOSE LEFT BEHIND

About 87 percent of PNG's population live in peri-urban, rural and remote settlements, and 80 percent rely on artisanal fishing, hunting, gathering and gardening (Bourke, 2020). There is little cash flow and limited access to health care, education, sanitation and clean water (Department of National Planning and Monitoring, 2020). Forty percent of these residents live below the international poverty line (World Bank Group, 2020).

PNG's rural and remote communities are vulnerable to shocks resulting from extractive industries (including mining, oil, gas, commercial fishing and logging) especially where people are largely dependent on the local environment for their livelihoods. Environmental shocks include: land clearing, loss of farmlands and forests; pollution of rivers, streams and marine areas, and land and soils; entry of toxins including heavy metals into the environment and food chain, causing health impacts;

decline in fish catch and loss of marine food sources; siltation with resultant loss of farmlands and healthy aquatic systems, blocking of waterways and changes in water flows; and flow-on effects relating from increased mobility and migration where people are displaced and have to venture further afield to seek livelihoods.

The remoteness of many of PNG's rural communities can create immense challenges for responding to disasters effectively, and lack of local infrastructure and health services can have long-lasting impacts on communities following catastrophic events (UNDRR, 2019). Climate change is already affecting the most disadvantaged and will result in many more people being 'left behind' unless actions are taken. Women and children suffer most adversely, and it was reported that "women...(are) often most vocal about dimensions of vulnerability (e.g., population growth) and their links to social issues (e.g., alcoholism, domestic violence and petty crime) that they viewed as likely to be heightened through ecosystem decline" (McKenna et al., 2019).

MULTIDIMENSIONAL RISKS

The primary identified risks to biodiversity and the environment (Table 3) all have additional impacts on people and communities. Women and other 'left behind' groups in PNG tend to suffer most from environmental disasters and decline.

Table 3: Primary direct threats to biodiversity and the environment, with impacted SDGs

Threat and risk	Areas affected	Impacted SDGs
Clearing and habitat loss	• Biodiversity • Climate change (loss of carbon sink) • Clean water (loss of protected catchments, sedimentation) • Food security (soil erosion, loss of forest resources, fish catch) • Disasters (increased likelihood of landslides, floods, famine, fires) • Increased conflict and women most affected	
Unsustainable extractive industries	All above plus pollution Greater inequality due to loss of land and basic sustenance	
Unsustainable resource use and wildlife trade	• Biodiversity • Food security (decline in available hunting and fish catch)	
Invasive species	• Biodiversity (competition, predation) • Food security (loss of crops and native fish)	
Loss of biocultural knowledge	• Biodiversity (loss of knowledge and traditional sustainability measures) • Loss of cultural identity and language	
Pollution from mining, waste disposal, plantations and industry	• Loss of clean water (loss of protected catchments, sedimentation) • Climate change (emissions) • Food security (loss of farming lands and fish catch)	

Threat and risk	Areas affected	Impacted SDGs
Climate change	• Biodiversity • Climate change • Food security (loss of cultivable land, fish catch) • Disasters (increased likelihood of landslides, floods, famine, fires) • Displacement • Increased conflict and women most affected	

RECOMMENDATIONS

Recommendations for improving environmental management and governance can be grouped into seven headings: good environmental governance; stronger environmental regulation of industry, and enforcement of conditions; wise allocation of land and water; real capacity where it is needed; compensation, incentives and innovation for conservation; responsive and thoughtful actions; partnerships, awareness and cooperation. Most of the proposed recommendations require government agencies to take the lead. UN agencies can support and assist, where relevant, and can further promote policies and actions toward achieving the SDGs.

Good environmental governance

- Review and replace the Fauna (Protection and Control) Act 1966
- Finalise and implement the National Biodiversity Strategy and Action Plan
- Formalise participation in the Nagoya protocol, and finalise legislation and policies addressing genetic property rights and access benefit sharing agreements
- Include biodiversity values in national and subnational accounting to reduce the perverse incentives currently applying to development
- Finalise and implement the Protected Areas Bill
- Finalise the review of the Forestry Act 1992 to harmonize with the National REDD+ Strategy 2017-2027
- Improve governance of the forestry industry to strengthen forest legality and effective participation of stakeholders. Ensure the register of critical activities is maintained and available for public review
- Integrate and support provincial and local level government planning and implementation for WaSH and waste management
- Integrate local disaster resilience planning with climate change adaptation and other well-being programmes
- Ensure all mining company annual environmental reports are made publicly available, in a format that allows them to be readily assessed. Regulatory agencies or independent bodies should oversee regulation, enforcement and accountability rather than industry self-regulation
- Complete and apply the National Adaptation Plan for climate change adaptation
- Finalise and implement the draft biodiversity offsets policy, with emphasis on avoidance and mitigation of damage wherever possible, followed by appropriate offsets

Stronger environmental regulation of industry, and enforcement of conditions

- Require the mineral, oil and gas industry to reduce and/or offset their greenhouse gas emissions including fugitive emissions
- Require tailings and other mining waste to be contained and managed rather than dispersed to the environment for all new mines and extensions of existing mines
- Monitor and enforce environmental conditions in existing mining approvals
- Develop and apply (including retrospectively) a system for mine closure and site remediation including setting standards and calculating costs for setting bonds
- Require industry to take responsibility for future settlements (including new developments) for people attracted to or displaced by their activities
- Support implementation of the ban on exports of unprocessed 'round log' timber, including an exit strategy for existing permits and agreements

- Improve monitoring and surveillance of logging practices
- Implement mitigation action for the transport sector identified in the National Climate Compatible Development Management Policy
- Reduce emissions from the agriculture sector through improved agricultural practices, and protecting valuable agricultural land from conversion for urban and suburban use
- Create a node of industrial sustainability that minimises waste, reduces emissions in the industrial process, product use, and waste sectors; and enhance inter-industry cooperation, more effectively utilising local resources
- Reduce emissions from LULUCF sector by effectively implementing the national REDD+ Strategy 2017-2027 and reducing the impacts of commercial logging, subsistence agriculture and oil palm plantations
- Secure funding to transition to 78 percent power generation from renewable sources by 2030
- Accelerate implementation of reliable and safe energy efficiency initiatives, including off-grid mechanisms
- Ensure those left behind are not subject to further environmental harm through any development activity

Wise allocation of land and water

- Complete and implement the National Sustainable Land Use Policy
- Allocate areas where development is not permitted due to high biodiversity or cultural values or climate vulnerability
- Require better environmental impact studies for all developments. Apply avoid/mitigate/offset hierarchy
- Expand the protected area network according to the Policy on Protected Areas. Provide regular updates of maps and statistics including ecological representation
- Establish and manage marine protected areas including locally managed marine areas
- Plan for new urban areas and semi-rural settlements to cater for internal migrants
- Implement local planning frameworks to balance forest production with other uses
- Protect priority forests through appropriate conservation measures
- Support local-level ownership dispute resolution and land use planning

Real capacity where it is needed

- Employ and support environment staff at national and provincial levels. Ensure high degree of transparency, accountability and anti-corruption measures for jobs related to aspects such as environmental approvals, forest operations and wildlife trade
- Support environmental research especially PNG-based organizations and researchers, including a formal system to mentor and support environmental scientists
- Resource CEPA and provincial governments to enhance protected area management
- Support PNG's national NGOs/CBOs working for environmental and social benefits
- Build capacity for on-ground (and water) management through local management committees
- Develop a network of community and protected area rangers to undertake a range of tasks in rural areas: enforcement of protected area and biodiversity laws; invasive species control; maintenance of community and tourist facilities; environmental education and monitoring, and maintaining clean water and waste systems
- Fund and provide on-going capacity to support the National Forest Monitoring System and National Forest Inventory
- Build capacity in waste management and recycling
- Ensure CEPA undertakes monitoring and compliance activities independent of mining companies
- Consider a third party 'assessor' which is empowered to report on the environmental activities of mining companies and government, and to follow through on commitments to communities and customary landowners
- Assist communities to have a full understanding of the implications of development proposals and their likely expansion in order to provide or deny informed consent. Ensure women and vulnerable groups are equally represented in the process
- Strengthen PNG's greenhouse measurement, reporting and verification system, including the capacity to more regularly report on emissions and land clearing rates
- Develop teams of capable responders at a local level

Compensation, incentives and innovation for environmental management

- Implement benefit sharing agreements and livelihood support for conservation-related initiatives including payment for ecosystem services (PES), incorporation of ecosystem services into national and subnational accounting, livelihood projects, ecotourism and research payments and benefit-sharing agreements.
- Explore and support blue carbon options and the sustainable blue economy.
- Support marine and coastal tourism.
- Find new models for providing partially or fully subsidized clean water and waste services.
- Enforce compensation payments, with fair distribution to those affected.
- Plan for future migration and increased mobility into rural and urban areas, likely to result from mining, oil and gas exploration and extraction, forest operations, other industry, natural disasters and climate-change related issues such as sea level rise.
- Strengthen, resource and expand programmes that address both 'those left behind' and environmental matters.

Responsive and thoughtful actions

- Address invasive species in PNG, including environmental pests.
- Manage species sustainably, and develop species management plans where needed.
- Reduce emissions from LULUCF sector by effectively implementing the national REDD+ Strategy 2017-2027 and reducing the impacts of commercial logging, subsistence agriculture and oil palm plantations.
- Continue to support and expand programmes that contribute to both environmental protection and well-being.

Partnerships, awareness and cooperation

- Support tradition, tambu systems and local practices for sustainable management.
- Increase wildlife conservation awareness programmes.
- Improve partnerships in protected area management.
- Develop partnerships to support sustainable fisheries.

Chapter 1.

Papua New Guinea and its environment


UN
DP

1.1 Rich natural resources

Papua New Guinea (PNG) has outstanding natural resources. Its lands and waters are home to an exceptional diversity of wildlife and support its growing population, most of whom live subsistence lifestyles and depend directly on the environment to provide their daily needs. PNG is one of the world's top ten countries where conservation of its natural environment can contribute to saving global biodiversity (Dinerstein et al., 2020).

PNG's natural resources are being depleted and degraded at an alarming rate, partly through extractive industries. Though PNG's gross domestic product (GDP) has benefitted from development activities, many of the country's people are among 'those left behind'. PNG is the lowest-rated Pacific country in the Human Development Index, where it ranks 155th of 189 countries. PNG has not yet overcome the dilemma of the 'resource curse': where countries without stable governance and with abundant natural resources are at risk of their resources being exploited, with environmental consequences but without accompanying socio-economic progress (Laurance et al., 2012). This dilemma has led to numerous conflicts – partly because people perceive development benefits are not fairly distributed and because there is inequitable treatment of women, disputed land rights, and environmental impacts (McKenna, 2016). In the worst cases, displacement, poor health and extreme poverty among PNG's communities have resulted from extractive industry impacts (Busilacchi, Curth-Bibb, et al., 2020).

The Government of PNG has committed to conservation principles in its Constitution and its Vision 2050 (Chapter 2). In recent years, the Government has formally expressed concern about unsustainable exploitation of natural resources, and the effects of this exploitation on the environment and people of PNG. For example, the National Strategy for Responsible Sustainable Development champions 'green growth', states that: *Long-term sustainability requires that more attention be paid to the responsible management and use of our natural resources... Excessive extraction of these resources led by foreign companies leads to their exhaustion leaving nothing for our future generations. Similarly, our renewable resources, such as, forest, fishery and coral reefs also need to be used responsibly without exploiting them beyond their critical biological re-generational limits for their sustainability*" (Department of National Planning and Monitoring, 2015a, p. 15).

Despite constitutional, legislative and national policy settings aimed at protection of customary livelihoods and the environment, the large, intensive export industries of forestry, commercial plantation agriculture and mining and gas production have created environmental degradation, and continue to fuel societal division. Regulatory and compliance systems are insufficient and unable to effectively influence environmental outcomes.

In PNG there may be some difficult trade-offs between environment and progress, and it will be critical to use best practices in planning, design of infrastructure, and impact minimization. For example, establishing the transport corridors and agricultural expansion needed to improve health and education is likely to lead to environmental and social impacts (Alamgir et al., 2019). In 2019, the United Nations (UN) in PNG wrote: "Efforts to pursue increased economic growth continue to raise the importance of strengthened legislative frameworks and appropriate policy settings that promote better governance of PNG's unique natural resources and biodiversity; as well as how best to address the social, economic and environmental impacts of climate change. Much needed land and forestry reform continue to remain amongst PNG's most sensitive issues" (United Nations in PNG, 2019).

1.2 Scope of this report

This report is an input into the United Nations Common Country Analysis (CCA) for PNG. The CCA is:

> *"the UN system's independent, impartial and collective assessment (i.e., a description of a country situation) and analysis (i.e., a description of causes and implications) of a country's situation for its internal use in developing the Cooperation Framework. It examines progress, gaps, opportunities and bottlenecks vis-à-vis a country's commitment to achieving the 2030 Agenda, UN norms and standards and the principles of the UN Charter, as reflected in the Cooperation Framework Guiding Principles".*

1.3 The environment of Papua New Guinea

1.3.1 World context

PNG lies in the southwestern Pacific Ocean and is comprised of the eastern half of the island of New Guinea as well as the Bismarck Archipelago (New Britain, New Ireland, the Admiralty Islands, and several others); Bougainville and Buka (part of the Solomon Islands chain); and small offshore islands and atolls (Figure 7). In the south, the Torres Strait adjoining the Gulf of Papua separates the island of New Guinea from Australia (Beehler, 2020). The western half of the New Guinea island consists of Papua and West Papua (Papua Barat), both provinces of Indonesia, and much of the border between the two countries runs through rugged and inaccessible terrain.[1]

[1] Note that any reference in this report to 'New Guinea Island' means the entire island.

PNG stretches from just below the equator (i.e., Mussau Island, the northern-most point is at 1°23' S) to just north of Australia (i.e., the southernmost point is Sudest Island in Milne Bay 11°39' S). The environment of the Torres Strait between PNG and Australia depends on management by both countries. People from the Torres Strait Islands have close family ties with people in Australia, and this is recognized in the Torres Strait Treaty.

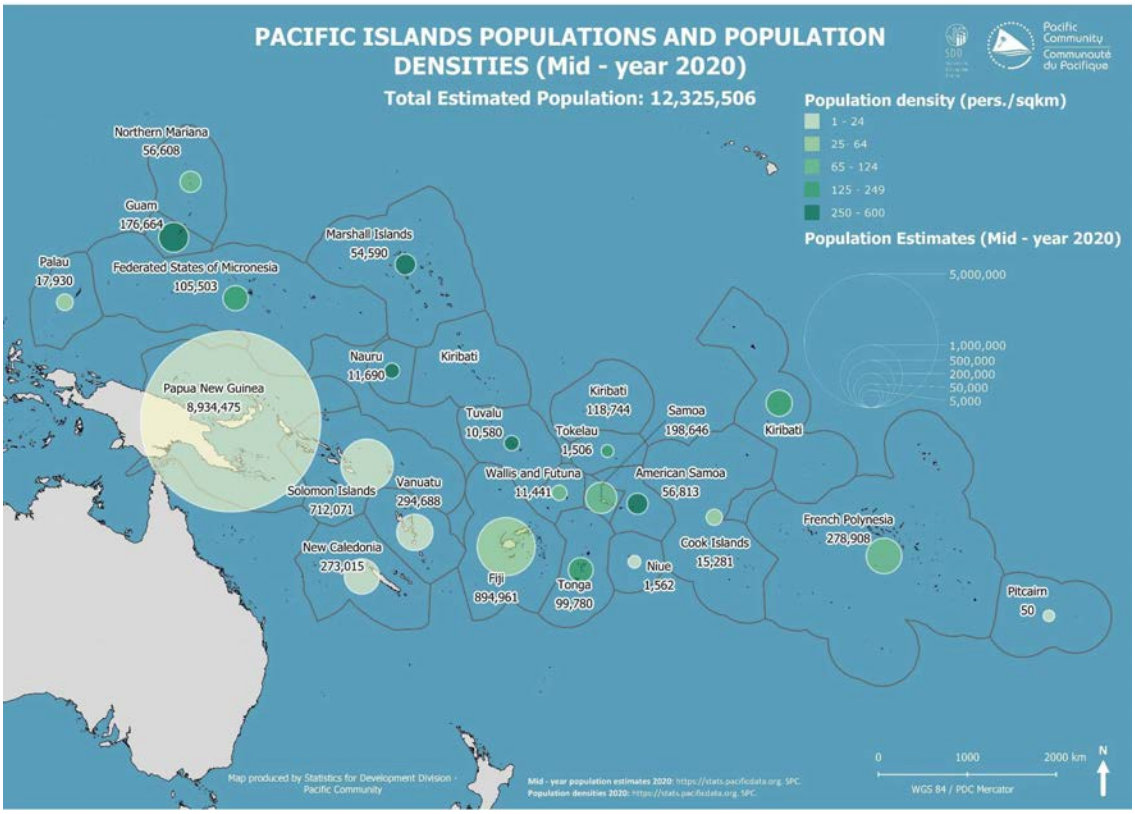

Figure 7: PNG is part of the Pacific Islands community, but its size and its population are many times that of the islands in the group.
Source: SPREP, 2020d[2]

1.3.2 Geology and geography[3]

The island of New Guinea's geography is partly due to tectonic activity which occurred when the northward-moving Australian Plate collided with the westward-moving Pacific Plate, creating a land of extremely folded and faulted mountains covering more than half of the island. Located at the northern edge of the Australian plate and in the active Pacific Ring of Fire, PNG is among the most disaster-prone countries in the world. Prevalent hazards include earthquakes, cyclones, storms, volcanic eruptions, riverine and coastal flooding, coastal erosion, epidemics, and droughts (UNDRR, 2019a). Implications of geography for disaster management are discussed in Chapter 12, and for 'Those Left Behind' in Chapter 13.

Key facts and figures 2022

Land area: 462,840sq km
Population estimate (2022): between 9.4 and 10.2 million
Population growth between 2.7% (1980-2000) and 3.1% (2000-2011)
Human development index: 0.55 (ranked 155 in the world)
Inequality-adjusted HDI: 0.39
Life expectancy: 64 years
Infant mortality: 38 (per 1000 live births)
Adult literacy: 61.6%
Average years of schooling: 4.7
Child malnutrition (stunting under 5 years): 49.5%
Population living in severe multi-dimensional poverty: 25.8%
People living in rural areas: 87%
People living in urban areas: 13%
Human population living within 100 km of coast: 61%
Claimed Exclusive Economic Zone (EEZ): 3.12 million km2 (National Oceans Policy)

Source: UNDP (2020, 2022)

https://hdr.undp.org/data-center/human-development-index#/indices/HDI
https://hdr.undp.org/sites/default/files/Country-Profiles/PNG.pdf

[2] Obtained from Pacific Community (refer to https://sdd.spc.int/topic/population-estimates-and-projections).

[3] General information in this section is referenced to Beehler (2020) except where otherwise indicated. This book provides a useful overview of the geography and biodiversity of PNG.

Mountain ranges

PNG's geography is defined by a high central cordillera (over 1,500 m), which stretches from West Papua across PNG to the South East Peninsula. Highest points in PNG on this range include Mt Wilhelm (4,508 m) and Mt Giluwe (4,376 m). There are also many 'subsidiary' coastal ranges – younger and not quite as high – that include very significant mountainous areas. The highest are a series of high ranges on the Huon Peninsula in the north of PNG, including the Finisterre Range (4,094 m) and the Saruwaged Range (4,120 m). Other mountain ranges on the northern coast include the Torricelli Mountains (1,650 m) and the Adelbert Mountains (1,600 m), and there are also steep ranges on the South East Peninsula, including the Hertzog, Kuper and Owen Stanley Ranges. Many of PNG's islands are active or recently active volcanoes and have some extremely steep slopes.

Rivers and lakes

These high equatorial ranges, not far from warm tropical seas, generate high rainfall which feeds thousands of streams and rivers. The most significant rivers include the Sepik, Markham and Ramu, which flow north, and the Kikori and Fly Rivers which flow south. The combination of mountains and waterways has partitioned PNG into many isolated plains, plateaux and valleys, which are difficult to reach. There are over 5,000 freshwater lakes in PNG, most of which are small in area and relatively shallow. Significant lakes include Lake Murray (about 65,000 ha, the largest freshwater lake in PNG), and the upland Lake Kutubu (4,924 ha), and volcanic crater lakes, including Wisdom Lake (8,670 ha), Long Island.

Interior valleys

Upland interior valleys are found where the central cordillera branches into parallel ranges in the central west of the country. The extensive Waghi Valley is in the Western Highlands where agriculture has been practised continually for over 8,000 years, whilst the Markham and Ramu Valleys bisect mountain ranges in the lowlands. The mild climates and fertile soils have long supported quite high populations of subsistence farmers, with diverse languages and culture.

Lowland basins and platforms

Two large lowland basins are found in PNG: one drains the Sepik and Ramu Rivers in the north; the other, the Fly River.

Coastlines

An estimated 850,000 people live within one km of PNG's 17,000 km coastline. Apart from the mangrove-lined river estuaries, the north coast is mostly hilly, descending into sandy beaches, while the coralline islands have white sandy beaches. With climate change, many beaches are receding, some exposing pebble or rock beaches. The southwestern coast has mangroves and silty beaches.

Islands

PNG contains about 600 offshore islands. Along PNG's north-eastern coast lies the Bismark Archipelago which comprises of a number of islands formed by active volcanoes (e.g., New Britain). The island of Bougainville is a part of the Solomon Islands chain. Other important island groups include archipelagos with atolls, corallines and mountains to 2,500m that extend from the east of New Guinea (e.g., D'Entrecasteaux Islands and Louisiade Archipelago). There are also the small islands of the Torres Strait.

The geology and geography of PNG have resulted in a richness of natural heritage and cultures, but also present many challenges, including remoteness and vulnerability to natural disasters. Implications of PNG's geography include:

- A very diverse flora and fauna has evolved, including many endemic species;
- People have lived in relative isolation and developed many diverse cultures, with over 800 recognized languages;
- Many areas are difficult to service and infrastructure is very limited, due to rugged topography, fast-flowing streams and vast wetland areas;
- Transport is very expensive, with many areas accessible only by air;
- Some extremely wet areas have high disease potential and low productivity;
- Many islands are remote and the communities have few services or facilities; and
- There is a very high potential for volcanic eruptions and earthquakes.

"Literally thousands of rivers and streams break up the geography...They initially rush through deep, rocky mountain gorges and then wind sinuously through planar swamplands. During the height of local rainy seasons, the gorges become thundering torrents and the plains become expansive floodscapes."
Beehler (2020, p.25)

1.3.3 Bioregions and ecosystems

Terrestrial ecoregions of PNG (Table 4), and marine ecoregions (Table 5) support PNG's largely subsistence population.

Table 4: Terrestrial ecoregions of PNG

	Ecoregions	Size (Ha)	% of land	Source WWF Ecoregion
1	Manus Island	208,505	0.5	132. Admiralty Islands
2	North-eastern Islands	4,699,775	10.2	111. New Britain/New Ireland Lowlands 112. New Britain/New Ireland Uplands
3	Bougainville Island	939,137	2.0	119. Bougainville Island
4	Northern New Guinea	9,482,056	20.5	107. Huon Range 115. North New Guinea Lowlands 116. North New Guinea Uplands
5	Central Range	11,821,294	25.5	105. Central Range
6	Southeast Peninsula	7,457,004	16.1	120. Southeast Peninsula
7	Trobriand Island	432,689	0.9	125. Trobriand Islands
8	Louisiade (Southeastern Island)	181,395	0.4	110. Louisiade Archipelago
9	Southern New Guinea	11,053,974	23.9	121. Southern Wetlands 122. Southern Plains 708. Trans-fly
	Total	46,275,829	100%	

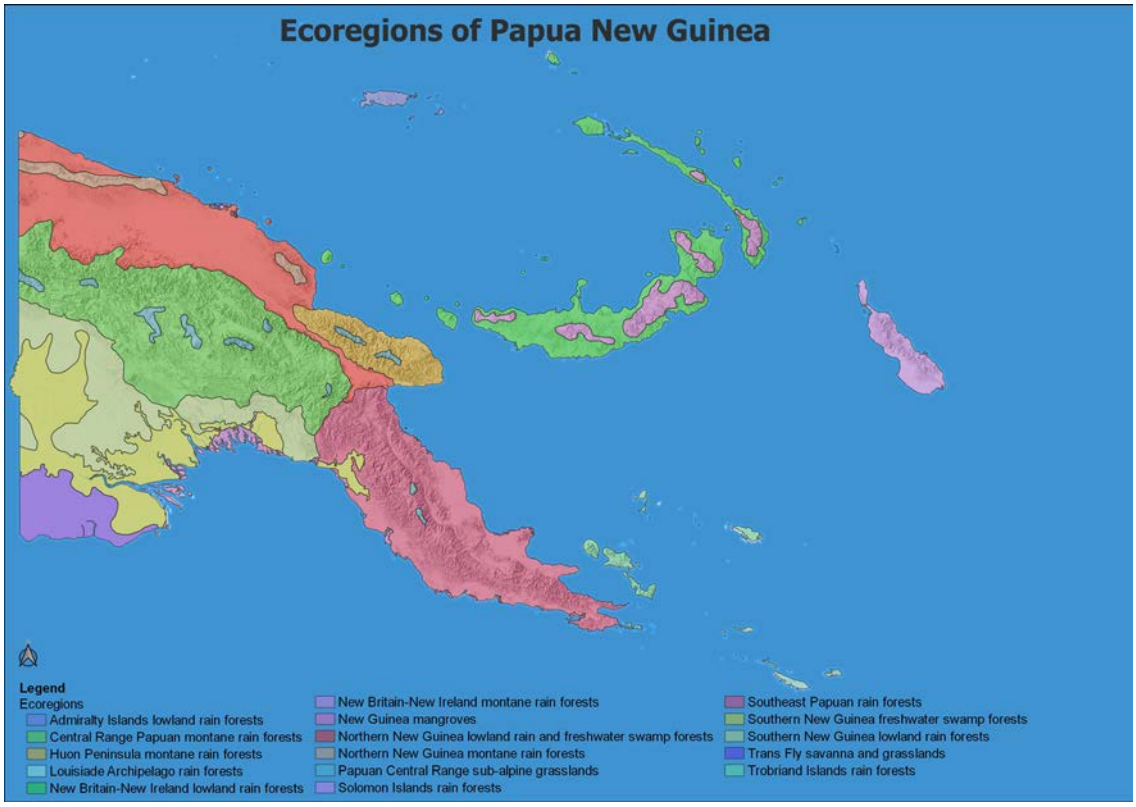

Figure 8: Ecoregions of Papua New Guinea
Source: SP Source: Terrestrial Ecoregions of the World. WWF (2012)

Table 5: Marine bioregions of the PNG

	Marine bioregion	Description
1	Bismarck Sea	Includes the island of Manus, New Britain, New Ireland and north coast of the Momase region.
2	Milne Bay Area	Includes the areas Lae to Milne Bay Province excluding the southeast of the province.
3.	Southeast PNG	Including the southeast coastline from Port Moresby and further east to Louisiade Archipelago that divides the Solomon and Coral Seas in the Milne Bay Province.
4	Bougainville Island	In the Solomon Sea.
5	Southwest PNG	Far west of Port Moresby, including the Gulf of Papua and the Torres Strait area.

Land cover and land use are shown in Figure 9.

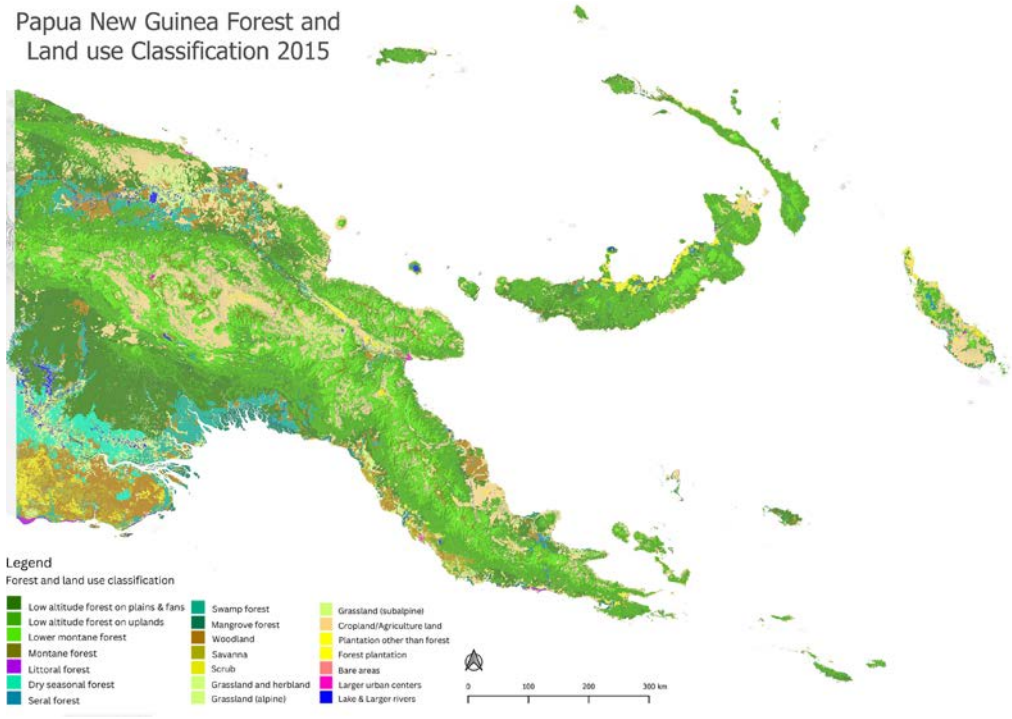

Figure 9: Vegetation cover in Papua New Guinea
Source: USAID report (US Department of the Interior International Technical Assistance Program, 2017). Data adapted from Forest Inventory Mapping (FMI) System.

1.3.4 Biodiversity

The island of New Guinea has outstanding biodiversity values. It has a comparatively high proportion of remaining natural vegetation and is the most floristically diverse island in the world, with a high degree of endemism and many undescribed species (Cámara-Leret et al., 2020)[4]. The diversity of vertebrate animals in PNG is amongst the highest on the planet, with at least 1,786 species of amphibians, reptiles, birds and mammals – a little over five percent of the world's total (Allison & Tallowin, 2015).

The island of New Guinea supports an estimated five to nine percent of the world's terrestrial biodiversity in less than one percent of the land area (R. A. Mittermeier et al., 1998). PNG's high number of species and endemism qualify it as one of the world's 17 mega-diverse countries, which between them have two-thirds of all non-fish vertebrate species and three-quarters of all higher plant species (R. Mittermeier et al., 1997). In addition, the islands of New Guinea (provinces of Manus, New Ireland, East New Britain and West New Britain plus the Autonomous Region of Bougainville) are part of an international biodiversity hotspot known as ''East Melanesian Islands", which also includes Vanuatu and the Solomon Islands. The hotspot is one of the most geographically complex areas on Earth, with a diverse range of islands of varying age and development. It also has a great diversity of culture and languages.

PNG's natural habitats are diverse, ranging from alpine grasslands and forest to lowland rainforests,

[4] Both PNG and the Indonesian part of New Guinea Island each have a high degree of endemism. Many species are shared between them and are found nowhere else in the world: others are found only on one side of the border or the other. This report takes care to distinguish whether a reference refers to the island as a whole or to PNG, which also includes its smaller islands.

Table 6: Estimated number of species in PNG in some key groups

Group	Number	% of world total (approx.)	Reference
Butterflies	924	5.3%	Novotny and Toko (2015)
Freshwater fish	355	2.2%	Froese and Pauly (2019a); IUCN Freshwater Fish Specialist Group (2021)
Marine fish	2604	17%	Froese and Pauly (2019c)
Frogs	390	6.1%	IUCN (2022)
Reptiles	351	3.4%	IUCN (2022)
Birds	782	6.7%	IUCN (2022)
Mammals	297	4.4%	IUCN (2022)
Vascular plants	10,973	19%	Cámara-Leret et al. (2020), Christenhusz and Byng(2016)

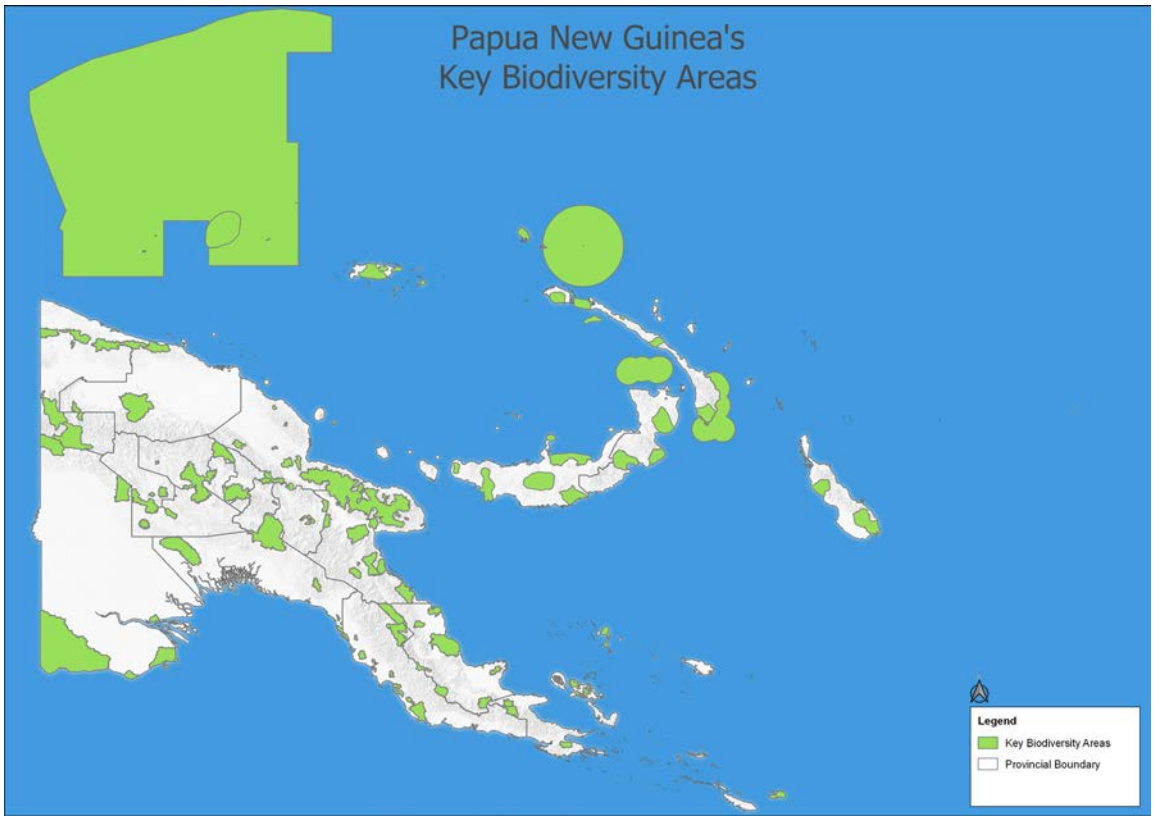

Figure 10: Key Biodiversity Areas in Papua New Guinea
Source: BirdLife International (2020)

wetlands and coral cays. There remain examples of continual gradation of natural forests from lowland to mountains, creating rare opportunities for science and conservation efforts (Novotny and Toko, 2015). In the south, there are three significant woodland areas known as the New Guinea savannas, with strong affinities to northern Australia (Joseph et al., 2019). Due to the variety of habitats and its long isolation from other landmasses, plant diversity is very high. PNG supports 10,973 described species, 1,654 genera and 260 families of vascular plants (Cámara-Leret et al., 2020). The island of New Guinea is one of only five places in the world where plant diversity exceeds 5,000 species per 10,000 km (Gideon, 2015).

PNG has a total coastline of approximately 17,110 km, and its coral reefs are among the most diverse in the world. Its marine environment is large, complex and highly biodiverse, with inshore lagoons, fringing and barrier reef systems, shallow banks, shelf and associated submarine canyons, sea mounds and very deep offshore areas with the trench off western Bougainville to a depth greater than 8,000 m. An estimated 3.2 million km^2 lies in PNG's exclusive economic zone (EEZ) (Department of Justice & Attorney General, 2020), with 46,000 km of coastal habitats and 6,000 km of estuaries. Extensive mangrove forests, as well as a wide variety of productive deltaic and coastal wetlands, are also well represented. PNG also forms part of the 'Coral Triangle' – a centre of diversity for corals and other marine life (Coral Triangle Initiative on Coral Reefs Fisheries and Food Security (CTI-CFF), 2013).

On a local scale, people depend heavily on PNG's natural resources for sustenance. Wildlife plays an important part in traditional diets, constituting the primary source of protein and fats in many highland and isolated areas of the country. In coastal communities, people eat a wide variety of seafood, including fish, molluscs, and turtles. Currently, coral reef ecosystems in PNG are being exploited mostly by small-scale artisanal and subsistence fishers, who use a range of techniques to harvest reef and reef-associated fish.

Key Biodiversity Areas are sites contributing significantly to the global persistence of biodiversity, in terrestrial, freshwater and marine ecosystems: 132 of these areas have been mapped and described for PNG (BirdLife International, Figure 10).

PNG also has a very high level of cultural diversity, and over 840 languages are still spoken. Culture and tradition are closely woven with nature and wildlife: the two cannot be thought of separately in PNG.

PNG has extremely valuable biodiversity at the genetic level, including many food crops. It is the centre of origin for banana, sugar cane, sago and pipit; it is the centre of diversity for yams, taro and sweet potato among others (Conservation and Environment Protection Authority, 2019).

For information about species numbers, including threatened species, see Chapter 4.

1.3.5 Papua New Guinea's ecological footprint

Ecological footprint accounting is a measure of how a country is using its natural assets (Global Footprint Network, 2019)[5]. The footprint calculated for PNG (2018 - the latest available data) shows the country is in 'credit' on the ecological footprint index, but the biocapacity is steadily declining and the credit is becoming smaller (Global Footprint Network, 2022).

1.3.6 Social, cultural and economic environment[6]

To analyse environmental issues, it is essential to understand the people and the challenges they face. Life for many is difficult and often short, and conditions are more extreme in remote areas. There is a weak health system, very high rates of maternal and infant mortality, and an ageing and critically inadequate health workforce. Fewer than half of the households in PNG have access to improved drinking water, and only a third have access to sanitation facilities (Chapter 10). PNG ranks 31 out of 190 countries for epidemic risk, and first among countries in South-East Asia and Pacific regions. Educational provision is sparse and expensive, with the mean years of schooling being 4.7 years. Only 12.5 percent of the people over 25 years of age have some secondary education.[7]

The health system was a major problem even before Covid-19, with outbreaks of measles, drug-resistant tuberculosis, and polio. According to UNICEF (2022), an estimated 15,400 children (one in 13 children) die each year in PNG, mostly from preventable diseases. Immunization rates remain low at 60 percent. The life-time risk of maternal death is 215 per 100,000 live births: eight times higher in PNG than for the East Asia and Pacific region average. The rate of maternal and infant deaths is considered a national emergency: most of the deaths are preventable, but the number of skilled birth attendants remains critically low, and most clinics are poorly equipped.

PNG has an extremely rich and diverse culture. Attitudes and customs related to many aspects of life (including the role of women, treatment of children, expectations of reciprocity, attitudes

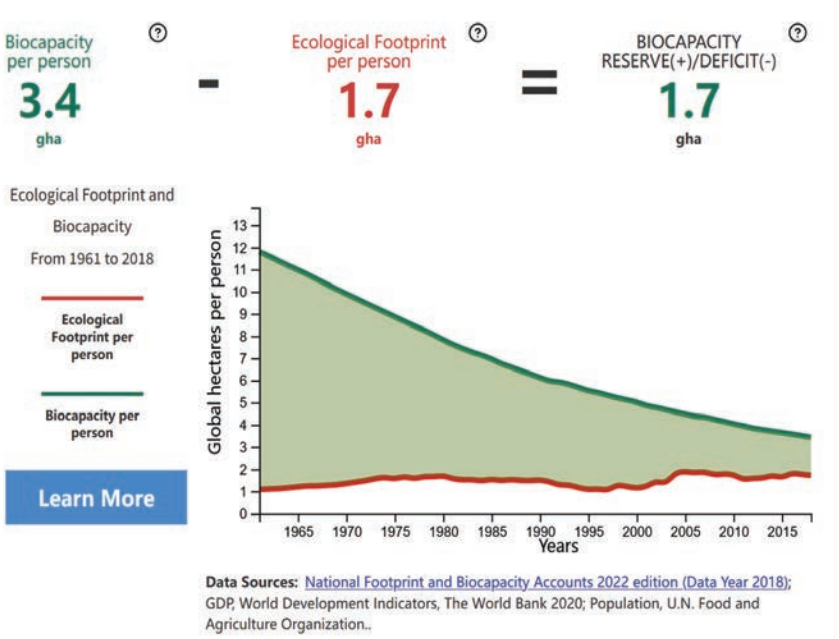

Figure 11: Papua New Guinea's ecological footprint, 1963-2018

[5] It measures "the ecological assets that are used to produce the natural resources a country consumes (including plant-based food and fibre products, livestock and fish products, timber and other forest products, space for urban infrastructure) and to absorb its waste, especially carbon emissions. On the supply side, a city, state or nation's biocapacity represents the productivity of its ecological assets (including cropland, grazing land, forest land, fishing grounds, and built-up land). These areas, especially if left unharvested, can also absorb much of the waste we generate, especially carbon emissions" (Global Footprint Network, 2022).

[6] See also CCA reports on social exclusion, financial landscape, governance and humanitarian and peace-building.

[7] Statistics from UNDP database 2022 https://hdr.undp.org/en/countries/profiles/PNG.

towards foreigners) vary across the country and are strongly rooted in culture and tradition. For these reasons any successful natural resource management programme needs to understand the local cultural and social environment and work with the community. Programmes need a holistic approach that includes consideration of improving livelihoods, health and education, enhancing awareness, improving competences, reducing inequity, sharing benefits and building long-term relationships with communities.

More than 87 percent of PNG's people live in rural areas, and 80 percent rely mostly on food they grow or catch themselves (Bourke, 2020). Most farming or gardening is for subsistence and small-scale marketing, with most commonly produced crops being sweet potato, banana, yam, cassava, taro, coconuts and sago. Cash crops include rubber, tea, vanilla, cocoa and coffee, and people also sell pigs and chickens, betel nut, fish, tobacco and firewood (Bourke, 2020).

High crime rates are prevalent across PNG, including a high rate of violence against women and children. Family violence affects more than two-thirds of women, and sorcery-related violence continues to endanger the lives of women and girls (Human Rights Watch, 2019). PNG's Demographic and Health Survey (DHS) 2016-2018 found that 56 percent of women aged 15-49 years have experienced physical violence, and 28 percent have experienced sexual violence (National Statistical Office - NSO & ICF, 2019). A parliamentary enquiry held in 2021 reported that rates of gender-related violence appear to be rising in the country, and that the restrictions resulting from the Covid-19 pandemic made the situation even worse. Again, these facts make working in environmental and natural resource management programmes extremely challenging.

1.3.7 Land and sea tenure

Land is central to life in PNG. It is at the core of economic life as it is the basis for providing a sustainable livelihood. Customary landowners hunt, fish, maintain gardens, cut trees for timber and firewood, gather plants for traditional and medicinal purposes, and collect shellfish and other marine species. Land underpins cultural and spiritual beliefs. People have an intimate knowledge of their land and seas and related species, ecosystems and features in the landscape and use their Tok ples (local languages) to describe key elements of this landscape. Some areas have spiritual value, being identified as ples masalai and are important in traditional ceremonies . Land also provides a sense of social identity and belonging for individuals and groups, and knowledge about land and related practices is passed on through the generations (Sillitoe, 1999, cited in Koczberski et al., 2017).

Customary land tenure is the basis for the land system and land use planning in PNG and is recognised in the Constitution and the Organic Law on Provincial Government and Local-Level Government (Organic Law). The tenure system operates on unwritten laws, customs and practices whereby kinship groups own lands and seas and recognise and enforce a system of ownership and rights, including access to natural resources. Exclusive individual landownership and inheritance are limited and this impacts on the way that land use planning operates and the way that land is opened for development.

In modern times, several factors impinge on the traditional land and sea tenure arrangements, including large-scale resource development (mining, commercial plantations), smallholder production of cash crops (e.g., cocoa, coffee), population growth, internal migration, rapid urbanization and the growth of informal settlements, growing individualism and changing aspirations (Koczberski et al., 2017). Land reform has proven difficult in PNG. While customary land tenure is recognized in PNG's Constitution, Vision 2050 acknowledges land as an enabler of wealth creation and the PNG Development Strategic Plan 2010-2030 and the Medium-Term Development Plan III 2018-2022 set targets for the mobilization of customary land for development purposes. Land reform is based on the view, by some, that secure individual property rights through land titling and tenure conversion are needed to foster investment and economic development.

At independence in 1975, about 97 percent of land in PNG was in customary ownership, and about three percent was alienated with titles belonging to the government (about 2.5 percent, with some granted as long term, 99-year leases) or freehold (about 0.5 percent) (Fletcher & Mousseau, 2019; Manning & Highes, 2008). Recorded land titles are rare and PNG law does not allow for the permanent alienation of customary land. However, two mechanisms have been used to reduce customary landownership to less than 85 percent of the country (Hennings, 2021). These are Incorporated Land Groups (ILGs), which allow customary owners to create a corporate body to 'hold, manage and deal with their customary land' and Special Agricultural Business Leases (SABLs), which allow landowner groups to lease customary land for agricultural purposes (refer Chapter 9 Sustainable Land Use Planning).

1.4 Reading the Environment-Climate Analysis

In the next chapter, a discussion of the environmental governance factors of PNG, including listing environmental legislation, policies, and international agreements are presented. In Chapter 3, a brief outline is given of the threats to biodiversity and to sustainable management of PNG's natural resource management.

Chapters 4 to 11 discuss some of the most important themes in environmental management: wildlife and biodiversity; protected and conserved areas; forests and forestry; climate change and green energy; marine conservation; land use planning; managing water, waste and pollution; managing mining and gas extraction; Chapter 12 explores PNG's vulnerability to disasters, while Chapter 13 discusses how geography and vulnerability to disasters contribute to issues for those most left behind. In Chapter 14, the risks and recommendations from all these chapters and reports are synthesised, and some brief conclusions from the analysis are drawn.

Chapter 2.

Environmental governance and commitments


UN
DP

2.1 High-level obligations for environmental protection

2.1.1 Conservation applied to the Papua New Guinea context

At the highest level in the country, the fourth goal of the PNG Constitution ('Natural resources and environment') makes a commitment for:

- Wise use to be made of the natural resources and the environment in and on the land or seabed, in the sea, under the land, and in the air, in the interests of our development and in trust for future generations;
- The conservation and replenishment, for the benefit of ourselves and posterity, of the environment and its sacred, scenic, and historical qualities; and
- All necessary steps to be taken to give adequate protection to our valued birds, animals, fish, insects, plants and trees.

And to achieve this through the fifth goal of Papua New Guinean ways:

- To achieve development primarily through the use of Papua New Guinean forms of social, political and economic organization.

This commitment is cemented in the national plan, Vision 2050 (National Strategic Plan Taskforce, 2011), where one of seven pillars relates to the environment: "Conserve and wisely use our natural resources and environment, language and cultural diversity for the collective benefit of the present and future generations".

Commitments include:

- Conserve biodiversity at the current five to seven percent of the world's biodiversity
- Establish a total of 20 national reserves, wilderness areas and national parks
- Establish at least one million hectares of marine protected areas
- Conserve and preserve cultural diversity.

Any approach to conservation, land management and environmental issues in PNG must take into consideration the complex nature of government and tenure systems (see Section 1.3.7).

At many levels of policy direction, from the National Constitution to the Strategy for Responsible Sustainable Development, PNG has made policy commitments to conserving its environment. Further commitments in medium-term development plans, legislation and policies are outlined in Section 2.3. In addition, PNG is a signatory to many bilateral and multilateral environmental conventions and agreements, discussed in the following sections.

2.1.2 Human rights and the environment

PNG has ratified the International Covenant on Economic, Social and Cultural Rights (ICESCR), which recognizes in Article 12 the enjoyment of the highest attainable standard of physical and mental health and the improvement of all aspects of environmental and industrial hygiene. In 2011, the UN adopted the Guiding Principles on Business and Human Rights, which articulates the State's obligation to promote and protect human rights in business activities, including environmental protection. The UN promotes these guidelines and supports the PNG Government in the implementation of this important framework, which – among others – focuses on the State's obligation to enhance regulatory frameworks.

2.1.3 United Nations Framework Convention on Climate Change (UNFCCC)

The objective of the UNFCCC is to stabilize greenhouse gas concentrations "at a level that would prevent dangerous anthropogenic (human-induced) interference with the climate system". It states that "such a level should be achieved within a time-frame sufficient to allow ecosystems to adapt naturally to climate change, to ensure that food production is not threatened, and to enable economic development to proceed in a sustainable manner". It entered into force in 1994.

The Paris Agreement, agreed to in 2016, builds upon the Convention and requires countries to undertake ambitious efforts to combat climate change and adapt to its effects, with enhanced support to assist developing countries to do so. The Paris Agreement's central aim is to strengthen the global response to the threat of climate change by keeping a global temperature rise this century well below 2 degrees Celsius above pre-industrial levels and to pursue efforts to limit the temperature increase to 1.5 degrees Celsius. Additionally, the agreement aims to strengthen the ability of countries to deal with the impacts of climate change. Actions by countries such as PNG, in line with their own national objectives, are to be supported through new technology and enhanced capacity.

2.1.4 Convention on Biological Diversity (CBD)

The CBD is the primary multilateral environmental agreement directing biodiversity conservation. PNG was the twelfth country in the world to sign this treaty and was in the first group of 25 to ratify it when it came into force in December 1993. There are now 196 Parties to the CBD. The Convention has three main goals: the conservation of biological diversity; the sustainable use of the components of biological diversity; and the fair and equitable sharing of the benefits arising out of the utilization of genetic resources. For the report on PNG's progress under this Convention, please see the comprehensive sixth national report (Conservation and Environment Protection Authority, 2019).

Under the CBD, each country is required to prepare a National Biodiversity Strategy and Action Plan. PNG's Biodiversity Strategy (Government of Papua New Guinea, 2007) is now out of date, and a revised draft was in preparation for some years (Conservation and Environment Protection Authority, 2019), but has not been completed. In 2010, the CBD recognized that its 2010 target for slowing biodiversity loss had not been met, and developed the Strategic Plan for Biodiversity 2011-2020. This plan included time-bound targets for a range of biodiversity measures, known as the Aichi targets (CBD COP 10 2010) (Figure 12).[8]

Due to the Covid-19 pandemic, the revisions of the Plan and target have been delayed. The targets are due to be replaced in 2022, and there was pressure to raise the targets in response to the continuing drastic decline in biodiversity worldwide (Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services, 2019). The new targets have been drafted (Open-Ended Working Group on the Post-2020 Global Biodiversity Framework, 2022) and are likely to be accepted later in 2022 .

2.1.5 United Nations 2030 Agenda for Sustainable Development

The 17 UN Sustainable Development Goals (SDGs) are a call to end poverty, protect the Earth and improve the lives and prospects of all people (Figure 11).

In 2015 all UN Member States adopted the 17 goals. This was part of the 2030 Agenda for Sustainable

Figure 12: Aichi targets

Figure 13: UN Sustainable Development Goals

[8] For details of the targets, see https://www.cbd.int/sp/targets/

Development which sets out a 15-year plan to achieve the goals. Internationally, actions are not yet advancing at the speed or scale required to meet the goals. PNG's progress has been reported recently (Department of National Planning and Monitoring, 2020).

All of the goals are connected to a healthy environment, with goals 13, 14 and 15 most closely aligned to the environmental agenda. Many of the SDGs are closely linked with the CBD Aichi targets (Table 7).

Table 7: Links between SDGs and the Aichi Targets

	Sustainable Development Goal	Aichi Targets
1	End poverty in all its forms everywhere	2, 6, 7, 14
2	End hunger, achieve food security and improved nutrition and promote sustainable agriculture	4, 6, 7, 13, 18
3	Ensure healthy lives and promote well-being for all at all ages	8, 13, 14, 16, 18
4	Ensure inclusive and equitable quality education and promote lifelong learning opportunities for all	1, 19
5	Achieve gender equality and empower all women and girls	14, 17, 18
6	Ensure the availability and sustainable management of water and sanitation for all	8, 11, 14, 15
7	Ensure access to affordable, reliable, sustainable and modern energy for all	5, 7, 14, 15, 19
8	Promote sustained, inclusive and sustainable economic growth, full and productive employment and decent work for all	2, 4, 6, 7, 14, 16
9	Build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation	2, 4, 8, 14, 15, 19
10	Reduce inequality within and among countries	8, 15, 18, 20
11	Make cities and human settlements inclusive, safe, resilient and sustainable	2, 4, 8, 11, 14, 15
12	Ensure sustainable consumption and production patterns	1, 4, 6, 7, 8, 19
13	Take urgent action to combat climate change and its impacts	2, 5, 10, 14, 15, 17
14	Conserve and sustainably use the oceans, seas and marine resources for sustainable development	2, 3, 4, 5, 6, 7, 8, 10, 11, 12, 14, 15, 17, 19
15	Protect, restore and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification and halt and reverse land degradation and halt biodiversity loss	2, 4, 5, 7, 9, 11, 12, 14, 15, 16, 17
16	Promote peaceful and inclusive societies for sustainable development, provide access to justice for all and build effective, accountable and inclusive institutions at all levels	17
17	Strengthen the means of implementation and revitalize the global partnership for sustainable development	2, 17, 19, 20

Source: (CBD et al., undated)

2.1.6 Other international agreements

In addition to the key high-level obligations discussed above, PNG is a signatory to numerous multilateral environmental agreements, which have been adopted and supported by parliament (Table 8). Further details are provided in the following chapters on various topics. A full list of environment-related treaties of the United Nations, with links to the details, can be found here.

Table 8: Key international agreements, protocols and frameworks relating to the environment and ratified by Papua New Guinea

Key International Agreements
United Nations Framework Convention on Climate Change (Non-annex I Party) and associated protocols (e.g., Kyoto Protocol, Paris Agreement)
Comprehensive Nuclear Test Ban Treaty
Convention Concerning the Protection of the World Cultural and Natural Heritage (World Heritage Convention)
Convention on Persistent Organic Pollutants
Convention on the Conservation and Management of the Highly Migratory Fish Stocks of the Western and Central Pacific Ocean
Convention on the International Trade in Endangered Species of Wild Flora and Fauna (CITES)
Convention on the Prevention of Marine Pollution by Dumping Wastes and Other Matter (London)
Convention on the Protection of Natural Resources and Environment of the South Pacific Region
Convention on Wetlands of International Importance Especially as Waterfowl Habitat (Ramsar)
Coral Triangle Initiative on Coral Reefs, Fisheries and Food Security (CTI-CFF)
Fisheries Surveillance and Law Enforcement in The South Pacific Region
International Convention for the Prevention of Pollution from Ships (MARPOL)
International Plant Protection Convention
International Treaty on Plant Genetic Resources for Food and Agriculture
International Tropical Timber Agreement
International Convention relating to Intervention on the High Seas in Cases of Oil Pollution Casualties
International Convention on the Establishment of an International Fund for Compensation for Oil Pollution Damage
Kyoto Protocol to the United Nations Framework Convention on Climate Change
Memorandum of Understanding for the Conservation of Cetaceans and their Habitats in the Pacific Islands Region.
Memorandum of Understanding on the Conservation and Management of Marine Turtles and their Habitats of the Indian Ocean and South-East Asia;
Memorandum of Understanding on the Conservation and Management of Dugongs (Dugong dugon) and their Habitats throughout their Range
Pacific-European Union Marine Partnership Programme (PEUMP)
Palau Arrangement for The Management of The Western Pacific Purse Seine Fishery
Protocol for the Prevention of Pollution of the South Pacific Region by Dumping 1986
Protocol Concerning Cooperation in Combating Pollution Emergencies in the South Pacific
South Pacific offshore fisheries management agreements
South Pacific Tuna Treaty (The Treaty on Fisheries Between the Governments of Certain Pacific Island States and The Government of The United States of America)
Torres Strait Treaty (1978)
United Nations Convention on the Law of the Sea (LOS)
United Nations Convention to Combat Desertification in those Countries Experiencing Serious Drought and/or Desertification, Particularly in Africa
Stockholm Convention on Persistent Organic Pollutants
Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and Their Disposal
Waigani Convention to Ban the Importation into Forum Island Countries of Hazardous and Radioactive Wastes and to Control the Transboundary Movement and Management of Hazardous Wastes within the South Pacific Region 1995
Montreal Protocol on Substances that Deplete the Ozone Layer
Sendai Framework for Disaster Risk Reduction 2015-2030

2.2 Governance standards and environmental performance

2.2.1 Politics, governance and the public service

PNG's governance system is complex in nature. The country has 20 provinces plus the Autonomous Region of Bougainville (ARoB) and the National Capital District (NCD). Below this are 89 Districts, 313 Local Level Governments (LLGs) and 6,137 Wards[9]. There is a dominance of male participants in this system, with no women currently elected to the national parliament. This presents challenges for the coordination and delivery of services and government programmes and in achieving a community-wide voice for all citizens.

While there is a very high level of enthusiasm and commitment from some politicians and public servants, corruption has been a very significant issue at all levels (Human Rights Watch 2019), including in relation to extractive industries and the fair and equitable distribution of benefits to the customary landowners. In addition, government funds for natural resource management (NRM) and conservation activities are extremely limited and sometimes absent, or spending is unaccounted for.

Across all levels of government, staff numbers and capacity levels are often low, impacting on delivery of government business. Morale is variable, wages and conditions are often low (e.g., many government staff use their own internet services and phones for work purposes), with limited opportunities for training and effective workplace mentoring. Managers also often lack the necessary skills to support their staff, engage in required activities and deliver project outcomes on time. Many people have a lot of worries outside their work life, and their family health may be poor.

2.2.2 Governance standards, environmental management performance and human rights

Though PNG is very wealthy in natural resources and has many excellent environmental policies, this has not translated into strong environmental management. In the worst cases, displacement, poor health and extreme poverty among PNG's communities have resulted from extractive industry impacts (Busilacchi, Curth-Bibb, et al., 2020) and there are fears that this scenario could be repeated in future mining projects (Save the Sepik, 2020), land clearing and forestry activities. Regulatory and compliance systems are unable to effectively influence environmental outcomes and there is a lack of communication across agencies to enhance compliance. Improving environmental governance and the standard of governance generally is a key action to ensuring a better standard and quality of life for people in PNG, and for ensuring that they benefit more from their rich natural resources. This will be a focus of an investment by the European Union over the next five years (European Union, 2020).

A snapshot of PNG's political economy

(summarized from Teakey et al. (2021, p.3-4))

PNG's geography has shaped the character of the state and its political economy. The state is present, in a legal sense, all across the country as a result of the three levels of government: national, provincial, and local. Citizens tend to view the state as a somewhat distant and none too relevant concept.

The history of state formation in PNG is short and fractious. The state's dependency on natural resource rents and donor assistance limit state incentives for promoting broad-based economic growth and delivering public goods and services in exchange for taxes PNG's political economy has social roots.

Women are socio-politically marginalized in much of Papuan New Guinean society.

The informal rules of the game tend to 'trump' the formal rules. Behind the façade of the state, it is informal socio-economic networks, cultural norms and expectations, and the exercise of personal power that shapes governance and inhibits transparency.

Politics is highly personalized and localized. The independence of the government bureaucracy has been eroded in recent years.
The independence of the government bureaucracy has been eroded in recent years.

[9] A discussion of governance issues is beyond the scope of this report: see Teakey at al. (2021) for a recent review.

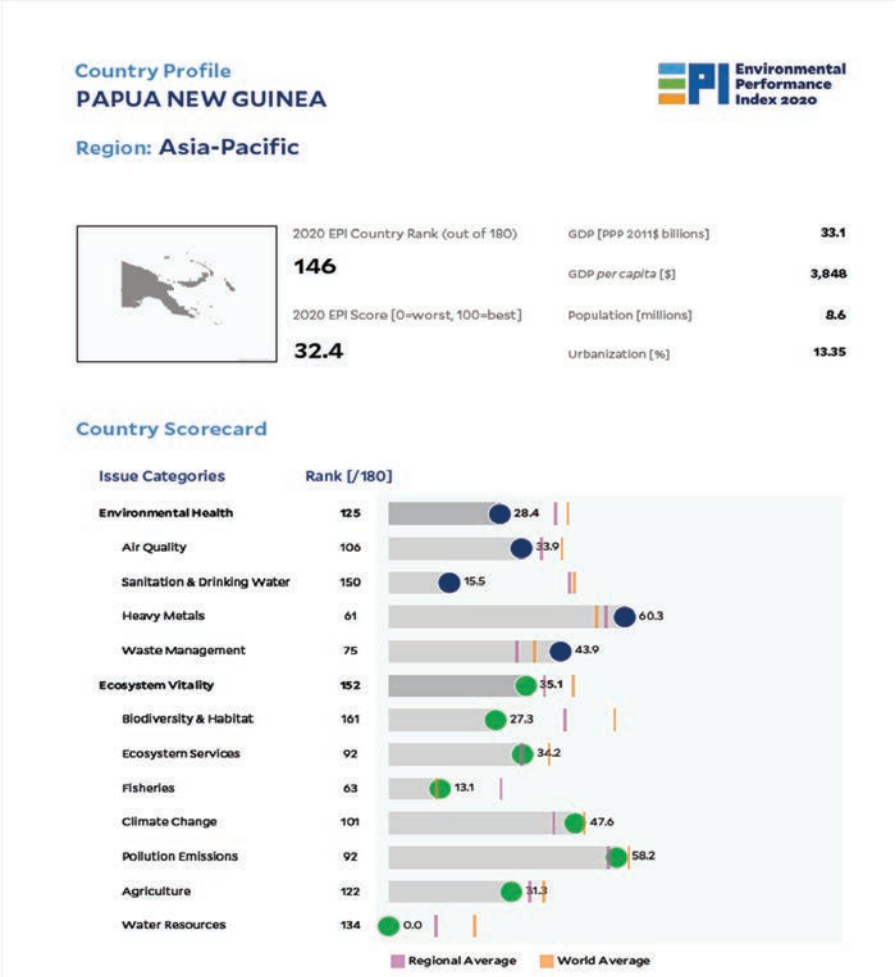

Figure 14: Environmental Performance Index 2020 for Papua New Guinea
Source: https://epi.yale.edu/epi-results/2020/country/png

PNG rates poorly on the international Environmental Performance Index, where it is ranked 146 out of 180 countries (Wendling et al., 2020).This index is based on 11 issues, which include environmental health and ecosystem vitality (Figure 14) .

The Worldwide Governance Indicator rating (The World Bank, 2021) shows PNG to be performing poorly in most aspects of governance, though it indicates an improvement since 2005 in the level of corruption (Figure 15).

While legislation appears to protect the rights of landowners and the community, in practice the law and agreements are not always enforced (Woods, 2019). The complex system of land ownership, combined with community poverty and the pressure to develop natural resources, leads to many instances of 'land-grabbing' (Woods, 2019), and to landowners trading their future sustainability for short-term cash incomes – not always with the full authority of the clan concerned. Disputes among landowners and between landowners and development projects not infrequently leads to conflicts and disputes.

In 2019, PNG was rated 137 out of 180 countries in Transparency International's Corruption Perception Index (Transparency International, 2020). Transparency International PNG (TIPNG) has called for the establishment of an Independent Commission Against Corruption to combat corruption and help fix budget woes (Transparency International, PNG, 2020). Examples of corruption in environmental management can include misappropriation of funds, payment of bribes and resultant favourable treatment, poor enforcement of laws, and gaining fraudulent consent. In turn, these impacts cause environmental damage, and a loss of faith in institutions and leadership, and make it difficult for initiatives to succeed. Civil unrest also flows – especially when the expectations of customary landholders in relation to promises associated with development are not met. Forestry, logging, mining and commercial agriculture processes are major targets for corruption allegations, as very large sums of money are involved.

Public sector integrity, the fight against corruption and the enforcement of the rule of law are included in PNG's Medium-Term Development Plan III 2018-

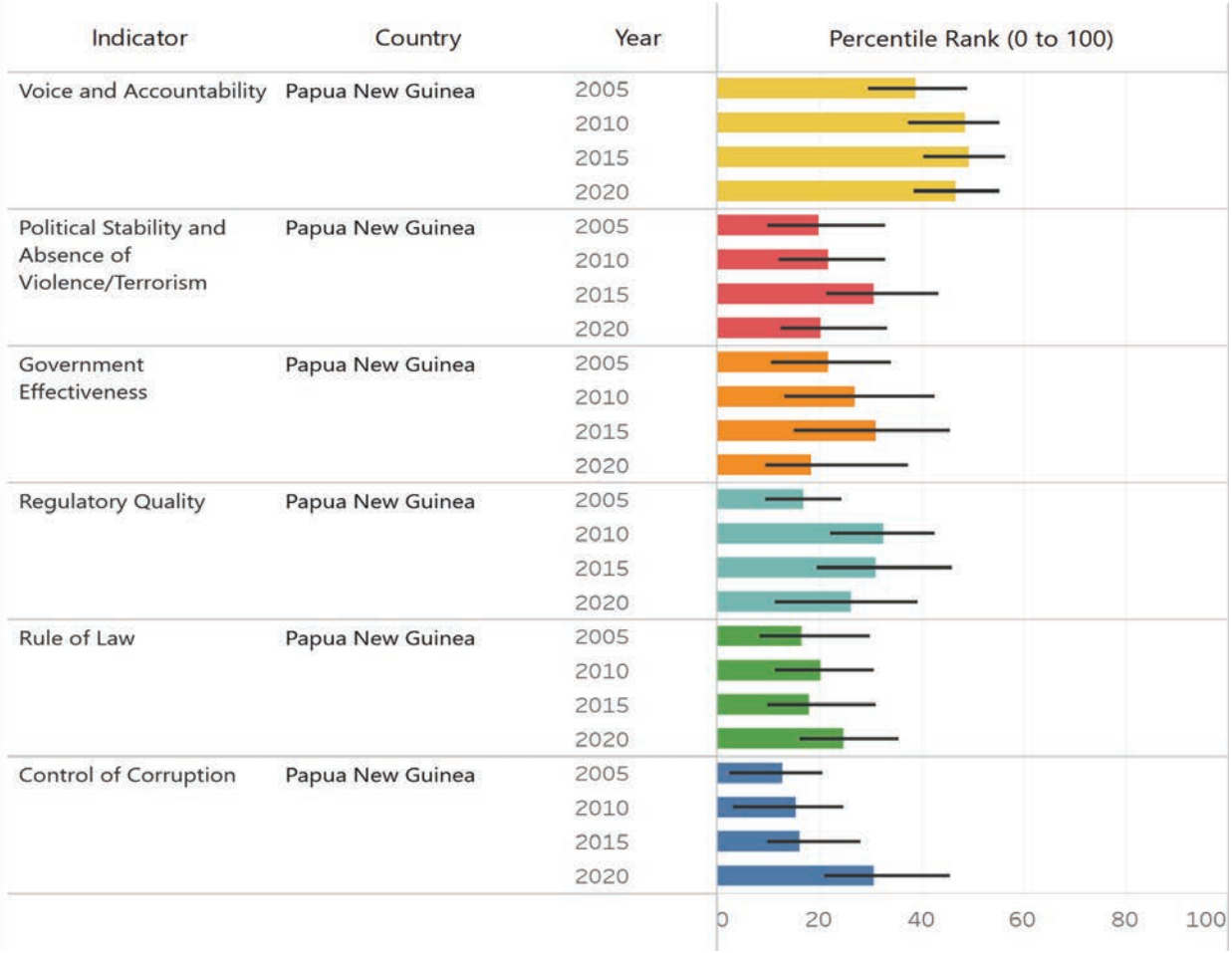

Figure 15: Worldwide Governance Indicator scores for PNG, 2005-2020
Source: World Bank (2021)

2022. In November 2020, the PNG Government passed the Organic Law on the Independent Commission Against Corruption (ICAC) 2019, in part to restore PNG's international reputation and people's faith in government institutions and increase the effectiveness and efficiency of government (Peter Aitsi, Chair of TIPNG, in press interviews, 18 November 2020). The ICAC is not yet fully functional. The full establishment and functioning of the Human Rights Commission remains on the Government's agenda, with legislation expected to be adopted in 2022 .

2.3 Legislation, policies and strategies

PNG's legal framework is composed of the Constitution, Organic laws (laws that are above the status of ordinary laws), ordinary statutes and customs (Secretariat of the Pacific Regional Environment Programme and Environmental Defenders Office, NSW, 2018). While the PNG Government has overall responsibility and legislation for environmental matters, under the Organic Law on Provincial Governments and Local-level Governments 1998, both provincial and local-level governments can make laws relating to "agriculture, fishing and fisheries, land and land development, forestry and agro-forestry, renewable and non-renewable natural resources".

While some key national-level environmental legislation (Table 8) is recent, other acts and regulations are outdated or require strengthening. For example, the Forestry Act 1991 requires modernizing to consider contemporary issues (a review is underway), and both the Fauna (Protection and Control) Act 1966, and the Environment Act 2000, also require review. Legislation relevant to the key themes is also listed in later chapters.

Table 9: Environmental legislation, Papua New Guinea

Key environmental legislation
Climate Change (Management) Act 2015
Conservation and Environment Protection Authority Act 2014
Conservation Areas Act 1978
Crocodile (Trade and Protection) Act 1978 and Regulation
Crocodile Trade (Protection) Act 1974
Disaster Management Act 1984
Dumping of Wastes at Sea Act 1979 and Regulation (DOWASA)
Dumping of Wastes at Sea Act 1979.
Environment Act 2000 and regulations
Environmental Contaminants Act 1978
Environmental Planning Act 1978
Fauna (Protection and Control) Act 1966
Fauna (Protection and Control) Crown Island Wildlife Sanctuary Rules 1978
Fisheries (Torres Strait Protected Zone) Act 1984
Fisheries Management Act, 1998 and regulations
Forestry Act 1991
International Trade (Fauna and Flora) Act 1979
Marine Pollution (Liability and Cost Recovery) Act 2013
Marine Pollution (Preparedness and Response) Act 2013 (May 2014)
Maritime Zones Act 2015
Merchant Shipping Act 1975
Mineral Resources Authority Act 2018
Mining Act 1992
Mining (Safety) Act 1977 and Regulations 1935
Mining (Ok Tedi Agreement) Acts
Mining (Bougainville Copper Agreement) Act 1967
National Capital District Commission Act 2001
National Cultural Property (Preservation) Act 1965
National Maritime Safety Authority Act 2003
National Seas Act 1977
National Water Supply and Sanitation Act 2016
Offshore Seas Proclamation 1978
Oil and Gas Act 1998 with amendments stated in the Oil and Gas (Amendment) Act 2016 and the Oil and Gas Regulation 2002
Organic Law on Provincial and Local Level Governments 1995 (Organic Law)
Papua New Guinea Planning and Monitoring Responsibility Act 2016
PNG Maritime Zones (Amendment) Act 2015 in June 2015
Prevention of Pollution at Sea Act 1979 (POPASA) and Regulation
Public Health (Septic Tanks) Regulation 1973
Public Health (Sewerage) Regulation 1973
Tourism Promotion Authority Act 1993
Quarantine Act 1953 and regulations
United Nations Paris Agreement (Implementation) Act 2016
Water Resources Regulation 1982

2.3.1 Policies and strategies

PNG has developed a number of specific and cross-cutting policies and strategies (Table 10) over the past decade, aimed at improving the sustainability of resource use and providing clear direction for governments and stakeholders. Each of the following chapters discusses policies relevant to these themes.

Table 10: Strategic national policies related to environment

Policies and strategies	Comments
Vision 2050 (National Strategic Plan Taskforce, 2011)	The national vision, launched in November 2009, is: "Papua New Guinea will be a Smart, Wise, Vibrant and Happy Country by 2050". The vision maps out PNG's development initiatives from 2010 to 2050 and is built on seven pillars that underpin all national goals: 1. Human Capital Development, Gender, Youth and People Empowerment 2. Wealth Creation 3. Institutional Development and Service Delivery 4. Security and International Relations 5. Environment Sustainability and Climate Change 6. Spiritual, Cultural and Community Development 7. Strategic Planning, Integration and Control
Development Strategic Plan (DSP) 2010-2030 (Department of National Planning and Monitoring, 2010)	Contains sector goals, objectives, targets, and indicators. It acts as the road map for achieving the long-term results of the Vision.
Strategy for Responsible Sustainable Development 2014 (StaRS) (Department of National Planning and Monitoring, 2015a)	StaRS recognises that previous planning documents, such as the PNG Development Strategic Plan 2010-2030, did not give the natural assets of PNG sufficient recognition. StaRS promotes cost-effective and resource efficient ways of responsible sustainable development and calls for a paradigm shift towards a green economy based on the need to protect assets that are the basis of the country's wealth and future development.
Medium term Development Plan 2018-2022 (Department of National Planning and Monitoring, 2018)	Sets the goal of "Securing our future through inclusive sustainable economic growth" by focusing on key investments to further stimulate the economic growth in the medium term. Sustainability is one of eight key result areas. The Plan makes no mention of biodiversity conservation or protected areas.
National Population Policy 2015-2024 (PNG Department of National Planning and Monitoring, 2014)	Aims to ensure that population growth does not constrain economic growth and responsible sustainable development. It addresses aspects including migration, health and women's rights.
Papua New Guinea's Sustainable Development Goal 13 Roadmap: 30 actions by 2030 (Government of Papua New Guinea, 2020b)	Outlines a phased cross-sectoral approach to achieving 30 actions by 2030, all relating to climate change and related SDG goals.
National Oceans Policy (Department of Justice and Attorney General, 2020)	Designed to provide a framework to improve ocean governance and management. The vision is a healthy ocean that achieves responsible sustainable development outcomes and aspirations of PNG, whilst addressing and mitigating impacts of climate change, natural disasters, anthropogenic waste and land-based sources of pollution. It aims to provide the strategic direction for planning, resource allocation and to promote sustainable management and use of ocean resources within and beyond PNG's national jurisdiction. The policy reaffirms the recognition of indigenous and local community ownership regimes of any ocean space and natural resources within PNG's national jurisdiction, recognizes the need for ecosystem-based management and sustainable use, promotes marine protected areas, and requires environmental impact statements using a precautionary approach for any likely impact.
Policy on Protected Areas (Independent State of Papua New Guinea, 2014)	The policy states that the vision for the PNG Protected Area Network is "Our protected area network across land and sea safeguards our precious and outstanding natural and cultural heritage. Together we manage these areas effectively for all the people of Papua New Guinea". It is based on five pillars: 1) governance and management; 2) sustainable livelihoods for communities; 3) effective and adaptive management; 4) managing the PNG Protected area network, and 5) sustainable and equitable financing for protected areas.
National REDD+ Strategy (2017-2027) (Government of Papua New Guinea, 2017)	Outlines activities as priorities, including strengthening forest management and enforcement.
National Disaster Risk Management Framework for 2017-2030 (National Disaster Centre, 2017)	Joint initiative with the NDC and UNDP to ensure that immediate and long-term disaster risk management challenges are addressed, aligned with Sendai Framework for Disaster Reduction and Recovery.

Chapter 3.

Threats to biodiversity and natural resource management


UN
DP

Internationally, the greatest impacts on terrestrial and freshwater ecosystems have been caused by land-use change and habitat destruction. This is followed by the direct exploitation, in particular overexploitation, of animals, plants and other organisms, mainly from harvesting, logging, hunting and fishing. In marine ecosystems, the greatest impacts have been from direct exploitation, mostly from fishing, followed by changes in the use of land and sea (Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services, 2019).

Several studies have examined the threats to biodiversity and environment in PNG (Adams et al., 2017; Alamgir et al., 2019; Government of Papua New Guinea, 2015; Kingsford et al., 2009; Leverington et al., 2017; A. T. White et al., 2014), and many threats are reviewed in the State of Environment Report (CEPA & SPREP, 2020). This chapter focuses on eight issues of particular concern: land clearing and habitat loss; extractive industries; sustainability of hunting; legal and illegal wildlife trade; invasive species; loss of biocultural knowledge; climate change; and pollution. Most of these threats are discussed further in later chapters.

The synergistic nature of threats to wildlife is also a significant consideration: for example, roads are a direct threat to wildlife through loss of habitat and impacts of clearing in road construction and because many animals are killed crossing roads; but perhaps more significantly, roads give access to illegal wildlife traders, settlers and loggers; weeds can be introduced; and there is a threat of pathogens such as the chytrid fungus. Similarly, logging activities can threaten habitats and kill animals directly, as well as increase fire risk and penetration of invasive species and provide a convenient route for illegal wildlife trade. Climate change will exacerbate many other threats.

3.1 Clearing and habitat loss

On an international scale, PNG's environment is remarkably intact. In 2015, an estimated 78 percent of the land was under forest cover, with five percent grassland and 4.6 percent wetland. Of the forests, 76.3 percent was considered 'intact', with the remainder disturbed through commercial logging, gardening, fire, portable sawmills and others (PNG Forest Authority, 2019)[10]. The role of PNG's intact forests on an international scale is critical, given the precipitous loss of wilderness areas and undisturbed forests worldwide (J. E. M. Watson et al., 2016, 2018). However, there is little formal protection for most natural areas, with under five percent in protected areas. Though Wildlife Management Areas (WMAs) were intended to be protected from development (Kwa, 2004), in practice they are not well protected from incursions.

The rate of land clearing and degradation in PNG, especially since 2000, has been of serious concern. A topical point in recent times is the global link between land clearing and zoonotic diseases, including Covid-19. Scientists point out that it will be far cheaper and more effective to reduce deforestation and stop pandemics, than to respond to them and suffer the social and economic impacts (Bernstein et al., 2022; Lawler et al., 2021).

The primary causes of habitat change in PNG include:

- Clearing for agriculture and plantations, including the Special Agriculture Business Leases (SABLs), which are often not followed through with planting
- Logging and other forms of forest degradation
- Intensified agriculture, including shortened fallow periods for shifting agriculture
- Fire, exacerbated by drought and climate change
- Road construction
- Urbanization and expansion of settlements.

Damming of rivers for generation of hydropower could also cause significant habitat loss: for example the proposed dam on the Purari River, is expected to flood 16,000 ha of high integrity forest, half a dozen villages of the Pawaia tribe and about 7,000 ha of the Crater Mountain WMA (Wildlife Conservation Society, pers. comm., 2022).

Official data show that between 2000 and 2015, about 261,500 ha of forest was cleared and converted to other uses, and a further 2.3 million ha was degraded.[11] Logging was responsible for most of the forest degradation, while almost all deforestation (99 percent) was due to land-use conversion from forest to shifting agriculture and clearing for plantations, mostly palm oil (Government of Papua New Guinea, 2022c; PNG Forest Authority, 2019). Data from the landuse and landuse change implementation roadmap (Global Green Growth Institute & CCDA, 2021a) indicates that in 2019 about 100,000 ha of forest was degraded, a significant area but the lowest level since 2001 (Section 6.3.1).

The decline in degradation from its earlier peak was mostly due to a decline in commercial timber harvesting, but the roadmap points out that any progress must be regarded as 'fragile' until other benefits reach the areas remaining in concessions (Global Green Growth Institute & CCDA, 2021a). See Chapter 6 for more information about forestry. In 2019 about 20,000 ha of forest was cleared, again lower than the peak recorded in 2013 (Figure 16). This decline was mostly due to the cancelling of some SABL licences (Global Green Growth Institute & CCDA, 2021a).

[10] It should be noted that the actual integrity of these forests, including the status of some wildlife species, may have declined more than these figures indicate.

[11] The Global Forest Change dataset provides a visualisation of forest clearing per year across the world.

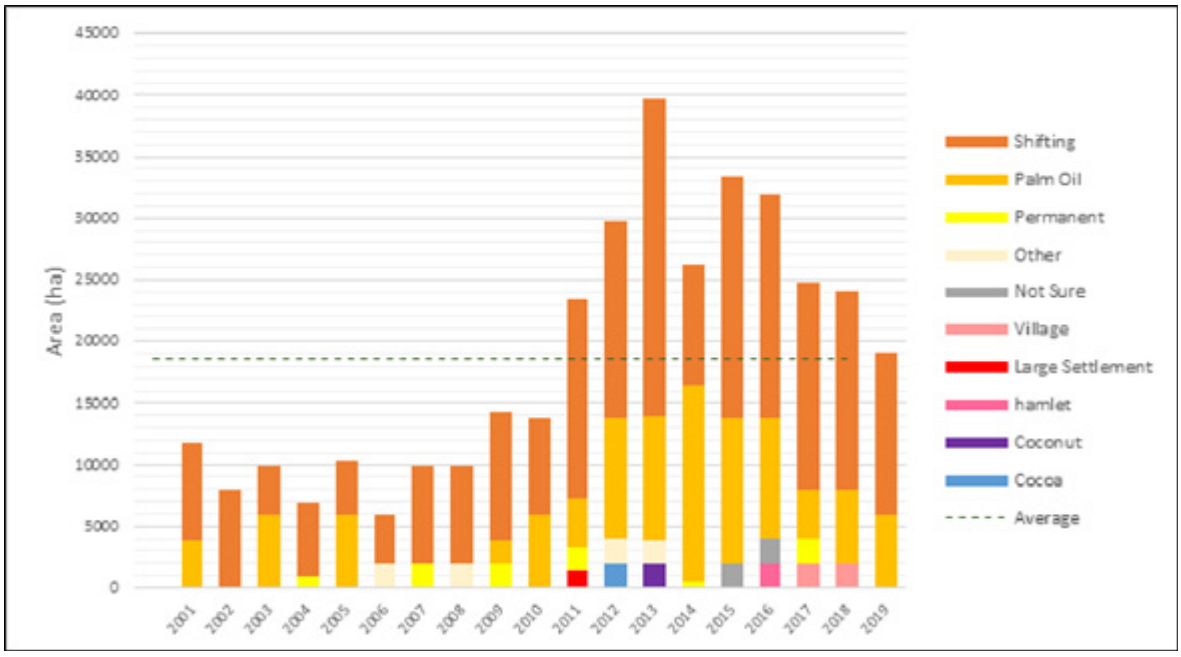

Figure 16 : Rates of forest clearing, 2001 to 2019
Source: Global Green Growth Institute and CCDA (2021, p. 31)

In 2021, the Prime Minister made a commitment to halt and reverse net forest loss and degradation by 2030.

Habitat change and its impacts on wildlife are not limited to forest ecosystems. Open grasslands, savannas and wetlands are also subject to clearing and degradation.

With one of the lowest road densities in the world, the PNG Government plans to improve its road infrastructure to facilitate development and allow better access to markets, and health and educational services. The planned expansion is outlined in the 2018-2037 National Road Network Strategy (Figure 17).

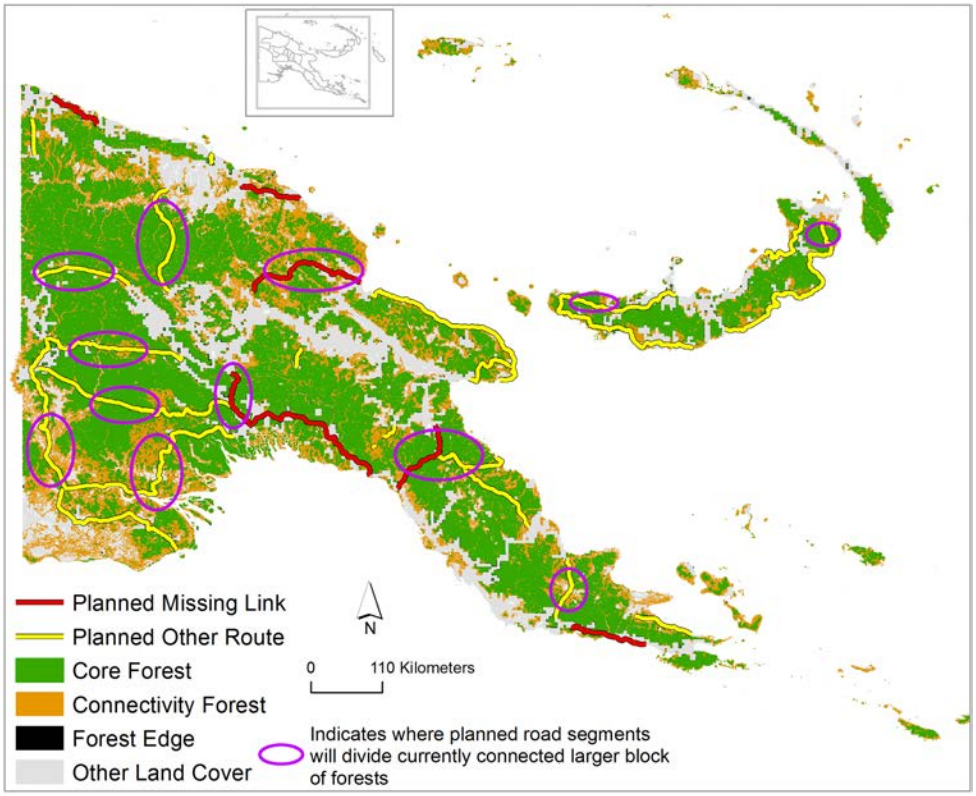

Figure 17: Papua New Guinea's planned road network, showing forest impacts
Source: Alamgir et al. (2019)

The anticipated consequences are critical for biodiversity, as many currently intact forests will be dissected and a number of species will be severely impacted, including species that are already threatened (Alamgir et al., 2019). In addition, clearing opens pathways for expanded industries, legal and illegal settlement, invasive plants and animals, hunting and 'new deforestation frontiers'. There are concerns about erosion and landslides and the effect of these on local communities (Alamgir et al., 2019). Meanwhile, roads within forest areas contained in SABLs and Forest Management Areas continue to proliferate, such as numerous logging tracks which were detected through satellite imagery in New Britain late in 2021 (Cannon, 2021a) and reports from villagers in West Sepik (Cannon, 2021b).

The Government also aims to develop Special Economic Zones to encourage investment and industrial development. Urbanization is accelerating, and also requires a considerable footprint of land for housing and infrastructure to support growing towns and cities (CEPA and SPREP 2020).

Effects of habitat change and loss on wildlife include:

- Immediate mortality when clearing occurs, such as where trees are felled and fires directly kill plants and animals;
- Displacement through loss of shelter, nesting spaces, and refuges;
- Loss of food resources;
- Increased vulnerability to hunting from people, dogs, and other predators;
- Fragmentation and isolation of remaining populations, reducing their viability;
- Increased invasive plants and animals;
- Increased likelihood of pathogens; and
- Increased 'edge effects, making surviving wildlife more vulnerable.

Some impacts of habitat loss are delayed for years or decades: for example, long-lived species of parrots may survive for decades after clearing, but their populations will slowly decline if there are no tree hollows in which to nest. This 'extinction debt' is especially marked in long-lived species (Mikko Kuussaari et al., 2009). An example of habitat clearing and species loss from New Britain has shown a dramatic effect on biodiversity, with increases in the threat level of at least nine species (Conservation and Environment Protection Authority, 2019). In addition, clearing opens pathways for illegal settlement and hunting, including wildlife trading.

3.2 Extractive industries

3.2.1 Agricultural development

The PNG Government proposes economic corridors to increase the volume of agricultural exports (CEPA and SPREP, 2020), including a possible agricultural corridor in the Markham and Ramu Valleys to boost agricultural production and productivity. The Medium-Term Development Plan III intends to increase the export volume of palm-oil (by 85 percent), coffee (155 percent), cocoa (298 percent), coconut (37 percent), and rubber (16 percent) (Department of National Planning and Monitoring, 2018). As part of this development, road infrastructure will be expanded and better linked to promote agricultural development. The Plan also intends to decrease the loss of primary forest rate for commercial agriculture, logging, mining and urban town development by four percent per year.

3.2.2 Logging

Logging is the extractive industry with the most impact on the environment in terms of forest degradation and land degradation (refer Chapter 6).

3.2.3 Mining, gas extraction and energy

Until very recently, mine wastes from major mines have routinely been approved to be discharged into rivers or oceans on a very large scale, leading to widespread environmental and social impacts at source and downstream, including in the marine environment. Disposal of mine waste to the marine environment results in increased sedimentation and lowering of available light which can lead to changes in species richness and ecosystem composition (Haywood et al., 2016). PNG has also experienced severe environmental degradation, loss of life and long-term disease impacts from mine disasters such as that at Ok Tedi. Many communities are mindful of these possible consequences and have been organising resistance to mine expansion. For more details on mining, oil and gas extraction, see Chapter 11.

Other environmental impacts include permanent changes in the landscape and opening of corridors which increase the risk of introducing invasive species, fragmentation of natural areas, and threats from humans to local habitats and species. Alteration of climate results from gas flaring and emission of excess gas into the atmosphere. Deep-sea mining, particularly of hydrothermal vents, can release methane and sequestered carbon contributing to greenhouse gas emissions and very harmful impacts on the marine environment (Childs, 2019; Department of Justice & Attorney General, 2020).

Many impacts can be reduced and some minimized through careful environmental management, though some are inevitable with any mining activity. Social impacts associated with mining, oil and gas extraction include gender inequality, displacement, destruction of social relationships and sacred places, displacement of traditional sustainable livelihoods and resulting food insecurity, poor health, violence and conflict. However, economic and social benefits also need to be acknowledged, and can be maximised with careful whole-of-life planning and management, including timely delivery of promised benefits.

Energy generation can also be a threat to biodiversity and socio-cultural stability. Renewable sources of power help to mitigate climate change impacts, but development of facilities for hydro-electricity (especially dams) and wind-power have the potential to cause major issues including loss of habitats in important areas of forest.

3.3 Unsustainable hunting and resource use

Papua New Guineans have hunted and fished for food for many thousands of years, and in many cases have developed sophisticated customs and limits to ensure this hunting is sustainable. Wildlife continues to play an important role in traditional diets as a source of protein and fat. As there are no large mammals in PNG, a wide variety of smaller mammals, birds and reptiles are eaten (CEPA & SPREP, in press; Mack & West, 2005), as well as a diverse range of fish, turtles and shell-fish species. Even where human populations are low, fishing does impact the numbers and diversity of some fish groups, especially larger species such as sharks and groupers (Drew et al., 2015). Sustainability of fishing is covered in more detail in Chapter 8.

Some meat and fish are traded in local markets, but most is caught for local consumption (known as wild meat harvest), rather than for the bushmeat trade, which causes major issues in some other countries (Mack and West, 2005). However, the amount of trade has increased in recent years, at least in some areas (Supuma, 2018).

Many animals are hunted for cultural purposes. A widespread custom is killing birds, especially parrots, pigeons and birds of paradise, for their feathers, which are used as bilas (traditional decoration and adornment) to celebrate one's culture. The trade in endemic bird plumes has increased over the last 30 years, partly in response to a need to increase cash incomes and also as a result of the increased value of these items over time, making them more attractive as a trading item (Supuma, 2018). Feathers of the vulnerable Pesquet's parrot are highly prized and widely traded and (Nugi & Whitmore, 2020) suggest that more dead birds exist in headdresses than are alive in the wild, so conservation efforts are needed to ensure the survival of the species in the wild. Since the 1970s, research has revealed that more than 150 species of birds have been used for food, trade and cultural purposes. The most commonly hunted species are the cassowaries (all three species), birds of paradise (20 out of 41 species), parrots (20 out of 46 species), pigeons and doves (16 out of 25 species) (Supuma, 2018). As many of these species are long-lived and have low reproduction rates, they can be easily driven to local extinction. For example, people from many protected areas report that cassowaries were once prized but are no longer present (Leverington et al., 2017).

Some species can withstand hunting pressure better than others. Based on reproduction rates, populations of some mammals including cuscus, wallabies, echidna and tree kangaroos are likely to be reduced through hunting pressure, while bandicoots and ringtail possums may be able to provide for sustainable hunting (Cuthbert, 2010). For most endangered and critically endangered mammals in PNG, the primary threat is human hunting, including hunting with dogs and sometimes guns. Hunting for food is listed as a major threat to endangered and critically endangered tree kangaroos, long-beaked echidnas, northern gliders, and giant bandicoots (IUCN, 2022). Some species are also prized for their pelts (Beehler et al., 2021). For a number of other species, hunting may reduce populations.

> *"Bushmeat cannot be thought of simply as survival food. Rather, the consumption of local wildlife is linked to status, tradition, ritual celebration, and complex beliefs and practices about health, sustainability, and our relationship with nature."*
> (SPREP, 2020, p.27)

Populations of Tenkile tree kangaroos declined rapidly from the 1960s when villagers began to hunt with guns, until by the 1980s their populations were so low that they were no longer able to be caught. In this and other instances hunters believed that there were still plenty of animals somewhere in the forest and did not perceive the hunting to causing a decline (Flannery, 1998)

In contrast, in 2016-17, a survey of people associated with 57 protected areas in PNG found people in almost all these areas were concerned that hunting was a threat to biodiversity, though all agreed that hunting was an important source of food. Some people considered that unsustainable hunting was due to an increase in human populations, meaning more hunting is needed to support the community. In other areas, the availability of rifles has made a difference. People also commented that outsiders with no understanding or respect for custom are responsible for decline in species. In a small number of areas, people thought that hunting was still sustainable. In some cases, areas were set aside for animals such as cuscus to breed up so they could be hunted elsewhere (Leverington et al., 2017). In isolated forest communities, most hunting occurs within a five km radius of the village settlements – so improved road access is likely to extend the range of hunters (CEPA and SPREP, 2020).

Important conservation programs in PNG are encouraging communities to forego the hunting of threatened species such as tree kangaroos in exchange for other benefits (e.g. community infrastructure), while allowing the hunting of other species outside of strict conservation zones (Dabek & Wells, 2021; Thomas, 2021). These programs place a strong emphasis on building capacity and awareness within the communities and ensuring that their livelihoods are improved and not depleted by their sacrifices.

In the management effectiveness survey discussed above, just over half of the protected area landowners were also concerned about gathering of plants (non-timber forest resources). Again, the main cause was reported to be people from outside the respective communities, although customary landowners were also involved.

3.4 Wildlife trade

Internationally, there is renewed attention on the problems caused by the wildlife trade, including its health implications – particularly after a number of new zoonotic diseases including Ebola and Covid-19 have mutated and been transmitted by humans. As wildlife trade brings stressed animals

into contact with people, outside the normal range of interactions, it creates an environment where diseases are more likely to be spread (Lawler et al., 2021). Recommendations are being made about how to reduce the chain of transmission (Bernstein et al., 2022; United Nations Environment Programme & International Livestock Research Institute, 2020). Efforts are being made at international level to address wildlife trading at the stages of supply, demand and the supply chain (UNEP, 2020). However, the extent of the problem, including the links to serious organised crime, make this a difficult issue to address for all countries, especially those with very high biodiversity, high levels of poverty and weak governance.

> *"The illegal trade in wildlife is a massive, multibillion-dollar market driven by international criminal networks and exacerbated by a nexus of poverty and corruption. Wildlife trade is a crime that, when combined with other threats like habitat loss and climate change, can drive thousands of species to the brink of extinction, lead to ecosystem breakdown and spread invasive species" (UNEP, 2020).*

No statistics are available to indicate the extent of the illegal wildlife trade in PNG, but anecdotal evidence and the few publicly available studies indicate it is of serious concern. Across the world, the complexity of the trading chains and poor reporting of both legal trade and known wildlife-related offences make it very difficult to understand the problem (Symes et al., 2017). In PNG and other countries in the Pacific, very little is known about the illegal wildlife trade. Annual reports on the topic are required to be submitted to CITES, but no reports are ever received (Karen Baird, SPREP, personal communication, 2020)

The PNG State of Environment Report concludes that there is widespread illegal, unreported and unregulated trade in plants and other wildlife both internally and across borders (CEPA and SPREP, 2020) to Indonesia, and through the Solomon Islands (Shepherd et al., 2012) and the Philippines. The trade in illegal wildlife for exotic pets from the Pacific area is increasing with the use of online platforms, and rare species are most valuable and sought after (Wasuka, 2019). Illegal trade routes are thought to include by air (through consignments, mail and in passenger luggage), through shipments including as part of logging exports, and by land or sea across the border with Indonesia (Karen Baird, personal communication, 2020).

As a signatory to CITES, PNG regulates international trade in protected or CITES-listed species under permits issued by CEPA. In 2017, approximately 181 Export Permits were issued for CITES Appendix II species by CEPA for personal effects, commercial, cultural and research use.[12] Of these, reptiles were dominant, consisting of crocodiles (69), monitor lizards (20) and snakes (12) (CEPA and SPREP, 2020). The CITES database (WCMC and CITES, 2020) records that only 20 live birds and no live reptiles or native mammals were legally exported between 2010 and 2019, with more than 1,700 live orchids exported to the Netherlands. All the records of live animals and plants were submitted by the importing country – not by PNG, though records of other exports (specimens, feathers, and skins) have been reported by PNG.[13] Many Pacific countries struggle to complete their reporting requirements, a situation that could be helped by adapting an electronic monitoring and reporting programme that is being rolled out through the CITES secretariat with assistance from SPREP (Karen Baird, personal communication, 2020).

Illegal trade is known to involve plants including sandalwood, ebony, agarwood, and Massoy barks (CEPA and SPREP, 2020). For desirable plants, collecting and harvesting can be a major threat. There is a legal trade in orchids (WCMC and CITES, 2020). Until 2000, there was thought to be extensive illegal trade in orchids but by 2015 few PNG orchids were sold overseas (de Vogel, 2015). Landowners at Lake Kutubu reported that orchids are taken from the WMA without permission (Leverington et al, 2017).

Animals in the illegal trade market most likely include birds, especially parrot and hornbill species; reptiles, including freshwater turtles, snakes, lizards and crocodile products; and small mammals such as gliders. Marine species of concern include turtle shells, giant clams, sea horses, beche-der-mer, live reef fish (CEPA and SPREP, 2020), shark fins and fish bladders (Busilacchi et al., 2018). PNG is considered a refuge for endangered species of threatened Indo–Pacific river sharks and sawfishes, so control in trading of these species is urged (Grant et al., 2021).

While turtle meat is not usually traded internationally, the presence of turtles in local markets (e.g., Daru) and the Port Moresby markets is cause for concern (Vagi Rei, personal communication, 2020). Trade in shell products, particularly of hawksbill turtles, is of concern internationally, and work is being undertaken to try to trace the DNA of these products to ascertain where they come from (Karen Baird, SPREP, personal communication, 2020).

It is important to try to understand motivations for illegal wildlife trade as money is not the only motivator. A study on illegal trade in fisheries products in the Torres Strait found that illegal trade with Indonesian middlemen continued in spite of lower prices for the products. This was because it was difficult for people to access the legal markets, as well as factors including kinship obligations, debt owing to the traders, and the need for quick cash (Busilacchi et al., 2022). Addressing illegal wildlife trade will generally require "a multipronged product specific approach, utilising market forces, community engagement alongside more traditional enforcement and monitoring approaches" (Symes et al., 2017, p. 275).

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[12] Appendix I: species threatened with extinction. Trade in specimens of these species is permitted only in exceptional circumstances; Appendix II: species not necessarily threatened with extinction, but in which trade must be controlled in order to avoid utilization incompatible with their survival.

[13] This contrasts with CITES records of more than 15,000 live birds, 4,700 reptiles, and 44 mammals exported from the Solomon Islands in the same 2010-2020 period.

Trade in crocodile products requires CITES permits, but this can be a legal and lucrative business. In the Sepik River wetland area, the community earns money through egg harvests via formal agreements with the permit holder, which has a hatchery and crocodile rearing facility in Lae (CEPA and SPREP, 2020). In accordance with CITES conditions, there is annual monitoring including aerial surveys and nest surveys in partnership with CEPA. A community group, the Sepik Wetland Management Initiative is heavily involved.[14] SWMI also conducts awareness programmes and other actions related to wetland conservation (G. Wana, personal communication, 2020).

3.5 Invasive species

Invasive species are those occurring beyond their accepted normal (or natural) distribution that threaten valued environmental, agricultural, fisheries, forestry or other social resources. Invasive species include plants, animals and pathogens. Generally, countries are more concerned about the impacts of invasive species on agriculture, but invasive species also affect biodiversity and their impact can be devastating. For example, feral predators can rapidly drive vulnerable animals to extinction; feral herbivores can cause extinction of their favoured plant foods; pest plants can outcompete native plants; and pathogens can decimate native forests, animal species and industries. However, some invasive species can be useful for landowners for a range of uses including firewood, timber and food.

PNG's relative isolation provides some protection from new invasive species, provided border protections are sufficiently robust. However, invasions can still occur through the Torres Straits and along the border with Indonesia, or through airborne and ship transport. PNG's land border with Indonesia (via Papua) is a biosecurity threat zone that is very difficult to patrol, and there is potential for non-native animals such as monkeys[15] and montane rusa deer populations to enter PNG with devastating consequences.[16] Pests including invasive fish (see below), several invasive plants, coffee berry borer and cocoa pod borer have come into PNG this way (CEPA and SPREP, 2020).

Quarantine is implemented at the borders, but there is no national body or partnership with other government agencies to coordinate the monitoring and control of invasive species, nor is there currently a national policy or targets relating to this topic. PNG's Food Security Policy 2018-2027 mentions that biosecurity is essential to protecting biodiversity and maintaining productive capacity for food security and to protect plant, animal and human health (PNG Department of Agriculture and Livestock, n.d., p. 12). Government concern about invasive species centres on agricultural impacts. Most quarantine services are provided by the National Agriculture Quarantine Inspection Authority (NAQIA) working under the National Agriculture Quarantine and Inspection Authority Act 1997, mainly to safeguard agriculture commodities. The Ballast Water Control Act 2013 aims to prevent, reduce and control the introduction of harmful aquatic organisms and pathogens to PNG waters, via ships ballast and water sediments. The 2015 draft National Biosafety Framework has not been formalised and legislated (Conservation and Environment Protection Authority, 2019), though the National Aquatic Biosecurity Strategic Plan for PNG 2019-2023 is in place.

Information is lacking on the number of invasive species, their distribution and impact (Conservation and Environment Protection Authority, 2019). A tentative list (2019) from NAQIA includes: 429 exotic plant species of major concern, one star fish, 28 fish, 16 insects, three snails, one bacteria and one fungus (CEPA and SPREP, 2020). The number of pest insects could be between 50-100 species and 50-100 pathogens, fungi and bacteria species (Warea Orapa, personal communication, cited in the SOE report, 2020).

Invasive plants

About 500 species of invasive plants are estimated to have established in PNG (Allen Allison, personal communication, 2020), with most restricted to disturbed areas but some invading more intact areas. Pest plants of concern to ecologists are those with the ability to change ecosystems, such as:

- Exotic grasses that increase under hot burning regimes and then further encourage fire, so outcompete native vegetation (exotic grasses were recorded on the Kokoda track wherever there were cleared grasslands);
- Introduced vines that climb and smother native trees, especially in riverine areas;
- Aquatic plants that choke waterways and cause pollution and deoxygenation as they decay, such as water hyacinth and salvinia, some which have been successfully controlled through biological controls (CEPA and SPREP, 2020).

Invasive animals

Feral animals in PNG include the cane toad, four species of birds, feral cats, feral pigs, rats and rusa deer, and many species of introduced fish (Conservation and Environment Protection Authority, 2019). Pigs are an important part of the PNG culture and diet, but feral pigs can be destructive in forests and wetlands, carry diseases and predate on eggs and small animals. The threat of macaques becoming established in PNG is of serious concern, as they are present close to the border in Indonesia (Beehler, 2020). Feral cats are present in some areas of PNG but are not mentioned

[14] Sales seem to have decreased to zero concomitant with covid-19, according to more than 100 interviewees from Sepik reported in June 2022 (A. Tejedor, pers. comm., 2022).

[15] Primates are native to Indonesia, but not to the provinces within the island of New Guinea. Escaped and smuggled pets are the risk.

[16] Rusa deer have escaped a deer farm and crossed the border from Merauke, Indonesia into Western Province. The species is grazing grass species, changing the ecology as (native) Melaleuca trees thicken on the floodplain (CEPA & SPREP, 2020).

as a biodiversity threat[17]; however, in Australia and other Pacific islands, they are recognised as one of the primary threats to native wildlife, and occur in most habitats, including tropical rainforest (Rowland et al., 2020; Tyrone H. Lavery et al., 2020) .

21 species of fish are known to have been introduced and established in the waters of PNG (Beehler, 2020), and 17 are currently listed (Froese and Pauly, 2019b). Small-scale aquaculture has developed into a significant farming enterprise in PNG, with about 60,000 farmers involved (Vira and Pandihau, 2016). Exotic fish have been introduced for fish farming into areas of PNG with irreplaceable endemic fish species, on the premise that there is very low risk of them invading natural systems. However, some have escaped into natural systems due to flooding or poor maintenance of fish farms, and these have reportedly caused a decline in native fish populations. Exotic fish have mixed impacts on local communities. In some areas the easy availability of species like tilapia has been a benefit for protein-poor diets, while in other areas people mourn the loss of more palatable fish, including barramundi (Leverington et al., 2017).

Little work has been done on the environmental impact of aquaculture in PNG. Though environmental regulations are in place to govern the activity, small-scale farms have not needed approval (Vira and Pandihau, 2016). Climbing perch and walking catfish are very invasive species; in the Fly River area, villagers are reportedly spreading these species deliberately (Conservation and Environment Protection Authority, 2019). These species and the striped snake-fish are air breathers and pose a threat to fisheries in both PNG and Australia (Gehrke, 2012). Crown-of-thorns starfish, while a native species, can become highly invasive and have caused damage to reefs in PNG, but have not caused the widespread destruction seen in other places (CEPA and SPREP, 2020).

Insect pests can devastate industries, especially where there is high reliance on one species for cash income. For example, the cocoa pod borer arrived in PNG in 2006 and caused harvests of cocoa to drop more than 80 percent – a blow to the more than 150,000 smallholders who rely on this crop for income. Integrated programmes of pest management — including better tree maintenance and hygiene – are now being implemented (ACAIR, 2018).

Pathogens

Pathogens can also be major threats both to agriculture and biodiversity. The amphibian chytrid fungus has caused mass mortality and extinctions of frog species across the world, and this is the most widespread disease-induced decline in vertebrates ever recorded. New Guinea island is the largest landmass with suitable climate for frogs that is, to our knowledge, still free of the fungus. As it has six percent of the world's frogs (and probably many undescribed species), New Guinea island can play a critical role in frog conservation – especially if this fungus-free status is maintained, or outbreaks are quickly addressed (Bower et al., 2019). Pathogenic diseases have been reported in Lake Kutubu WMA and affect fish stocks. Research indicates that tilapia may be vectors in the spread of epizootic ulcerative syndrome in the lake (P. T. Smith et al., 2016), which is home to a number endemic species of fish. The bacteria Cryptosporidium introduced through fish farming is widespread in all PNG fish (Vira and Pandihau, 2016).

Myrtle rust is a pathogen of many myrtaceous species, which are very common in PNG and include melaleucas and eucalypt as well as a range of rainforest trees. This fungus was first detected in Australia in 2010 and is now widespread. It has also been introduced to New Zealand and New Caledonia. It has the potential to seriously affect trees in native forests on a broad scale and vigilance is required (Makison, 2018).

3.6 Loss of biocultural knowledge

The loss of culture and particularly of local languages has been linked to the loss of biodiversity across the world (Maffi, 2005). Places with very high biodiversity, including PNG, coincide with high linguistic diversity (Gorenflo et al., 2015). PNG is one of the most linguistically diverse countries in the world, with nature, language, and culture closely linked.

In the management effectiveness survey of protected areas (Leverington et al., 2017), some customary landowners stated that Tok Pisin, the most widely used language in PNG, does not have names for many species that have names in Tok Ples (local language). Therefore, when language is lost, knowledge of biodiversity is lost too. Many people were also concerned about the loss of knowledge related to traditions and practices involving hunting, fishing and gathering, including the resultant impact on populations of wildlife (for example, dugongs in the Torres Straits). They saw cultural decline as a result of increasing adoption of western culture and language, a decline in respect for elders, an increased engagement with formal education systems, the influence of Christian churches, and movement of people from protected areas to larger towns and settlements.

Many traditions relate to sustainable use, tying wildlife and environment closely with the cycles of human life. However, these languages and traditions are in decline in some parts of the country:

> *The rainforest dwelling societies, in PNG and elsewhere, are well known for detailed knowledge of the natural environment, including classification and ecological knowledge of their plants, birds and mammals [. . .] High cultural diversity in PNG is a product of the past tribal isolation and as such can become impractical in modern life. While PNG languages still thrive in the village environment, only 52 [percent] of respondents were fluent in their local language among urban internet users, compared to 95 [percent] of their parents (Baro, 2015).*

[17] For example, these were not recorded in camera traps in the Bismark Ranges (A.Tejedor, pers. comm., 2022) or in the Torricelli Mountain Ranges (J. Thomas, pers.comm., 2022).

Baro (cited in Novotny & Toko, 2015, p. 84) documented that ethno-biological knowledge is linked to fluency in local language, and that the loss of Tok Ples reflects a decline in biological knowledge, even in many remote villages.

There are between 843 to 1,020 languages in day-to-day use in PNG (CEPA and SPREP, 2020) (Figure 18). The loss of linguistic diversity is occurring very rapidly and this is paralleled with loss of ethnobiological knowledge (Kik et al., 2021).

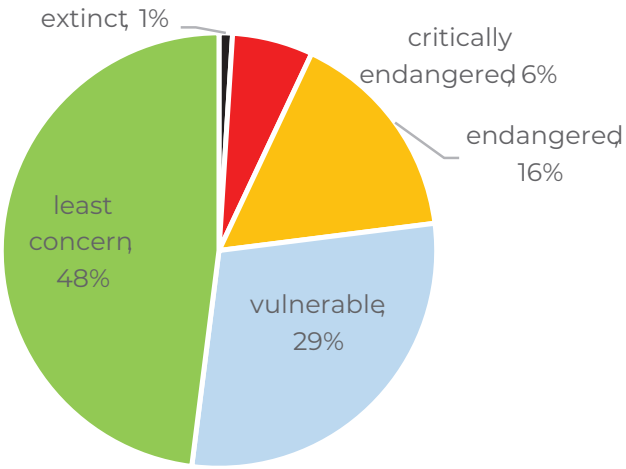

Figure 18: Threat status of Papua New Guinean languages
Source: CEPA and SPREP (2020)

3.7 Climate change

Some of the current and projected impacts on biodiversity in PNG from climate change are the result of changed temperature, sea level rise, ocean acidification and changed rainfall patterns (Table 10).

Table 11: Impact of climate change on biodiversity and natural resource management

Climate change factor	Biodiversity impact
Changes in temperature[18] Warming of around 3.6°C is projected by the 2090s, compared to the 1986–2005 baseline under the highest emissions pathway (RCP8.5). Maximum and minimum temperatures will rise more, with more impacts on people, crops and wildlife	Any species can be affected, especially those with a limited climatic threshold for survival. Species particularly at risk include those in high elevation (such as alpine grass/shrubland) and upper montane forests, and restricted range endemics. Montane forests in the Pacific region may disappear by 2100.[19] Some montane systems will be resilient to higher temperatures provided they retain moisture[20], but the small extent of montane forest (1% of PG's forests) is likely to be reduced further. About 63% of plant species will have smaller geographic ranges, and 37% will have larger ranges; while the diversity of plants in ecoregions will decline by an average of seven species[21]. A high reduction in species richness in the lowlands is of special conservation concern. Some animals will move to live higher up slopes, where there is suitable habitat. Montane tropical bird species are more sensitive to temperature changes than temperate birds in PNG, with clear evidence of upslope migrations[22]. Higher temperatures may also lead to the spatial isolation of some populations, which might survive in high or cooler patches, but not be able to interbreed. Other species may die out if there is nowhere to move, either because elevations are not high enough or because there is discontinuity in habitat.[23] Other impacts from an increase in temperature include: increased vulnerability to fire, severity of fires, and increased problems with invasive plants. Turtle gender balance is determined by temperature and is likely to be altered: for example, 99% of green turtles hatching in the northern Great Barrier Reef are now female[24]. There is also a high likelihood of coral bleaching. In the 2016-17 coral bleaching event, an estimated 15% of PNG's coral reefs were affected.[25]

[18] Information from The World Bank Group (2021)

[19] Taylor and& Kumar (2016)

[20] Hope (2014)

[21] Cámara-Leered R. et al.(2019)

[22] Freeman & Class-Freeman (2014)

[23] This means that it is very important to secure areas of protection that include a continuous altitudinal gradient from lowlands to high mountains.

[24] Jensen et al. (2018)

Climate change factor	Biodiversity impact
Sea level rise[26] Average of 7 mm per year since 1993, more than double the global average. Estimates of a 10cm increase by end of the century.	Sea level rise will lead to an inward migration of coastal ecosystems, or loss of the systems and communities. Coastal erosion will increase, with loss of existing beaches and near-shore communities. Even a small rise in sea level will lead to wide scale alteration and loss of sand cays, islets, atoll islands, river deltas such as the Fly, mangrove forests and freshwater swamps.[27] Sea level rise will affect species that nest on cays and beaches, including seabirds and turtles. According to communities, some turtle nesting beaches have already been lost[28], and saltwater invasion into freshwater systems is a common experience in coastal communities in PNG.[29]
Ocean acidification[30] Acidification of PNG's waters is occurring slowly. Globally since the preindustrial era (~1850), there has been more than a 26% increase in acidity in the global ocean.[31]	More acid seas occur as the ocean takes up carbon due to increased CO2 levels. Increased acidification means that coral develop weaker exoskeletons, so there is a reduction in the growth of coral reefs. Inshore marine areas in PNG are likely to suffer seriously from reef decline, with resultant impacts on fisheries and other marine industries. Many coastal residents are highly dependent on reef-related fisheries.
Changed rainfall patterns – unclear future[32] Overall, the projection for PNG is for higher rainfall but greater variability, and for more extreme rainfall events, which cause erosion, landslides and floods.	Many community members feel that they can no longer rely on the seasons and don't know when to plant crops anymore.[33] Severe droughts during the El Nino events in recent years caused loss of crop diversity[34] and increase in fires, including in forests.[35] It is unclear if there will be more or more serious droughts. PNG's population is already very vulnerable to flooding after heavy rainfall events, and this vulnerability is expected to increase, with possible doubling of people affected by coastal flooding. Heavy rainfall events are catastrophic for both people and wildlife when they occur in catchments with dam tailings. Heavy rainfall, of either short or long duration, is also associated with landslides[36], which also destroys villages, crops and forests.

[25] Dr A. Lewis, quoted in the State of Environment Report (2020)

[26] Papua New Guinea National Weather Service et al (2015)

[27] CEPA (2019)

[28] Peterson and Peterson (2017)

[29] Dr J Poulsen, pers comm; and many protected area management committees (Leverington et al., 2017).

[30] Papua New Guinea National Weather Service et al (2015)

[31] CMEP (2018)

[32] Papua New Guinea National Weather Service et al (2015), The World Bank Group (2021)

[33] Leverington et al. 2017 (2017)

[34] Conservation and Environment Protection Authority (2019)

[35] Bryan & Shearman (2015)

3.8 Pollution and sedimentation[37]

Water pollution stems from poor sanitation provision, mine waste disposal, industrial effluent and agricultural runoff. Only 41 percent of the population has access to safe drinking water and 13 percent to improved sanitation (2017) (Department of National Planning and Monitoring, 2020), including only 12 percent of the PNG urban population (Ellery M, undated). In Port Moresby, about seven percent of faecal waste is safely transported and treated. There are major concerns about the impact of mine waste disposal on shallow and deep marine biodiversity and ecosystem processes. Over the years, the Ok Tedi and Porgera mines have polluted the extensive Fly River system and adjacent coastline forcing villagers (who were previously wealthy in terms of natural resources and subsistence living) to migrate to Daru.[38]

Rugged mountainous terrain, exceptionally heavy rainfall, tectonic activity, the rapid growth of both human populations and commercial activities (including logging and commercial agriculture) have combined to create some of the highest soil-erosion rates in the world.[39] Increased sediment and nutrient loads on inshore reefs due to oil palm development are frequently cited by customary landowners in New Britain.

The 2017 USAID biodiversity assessment (US Department of the Interior International Technical Assistance Program, 2017) found that pollution is a high threat to biodiversity. The assessment defines pollution as "*any environmental contaminants resulting from human activities. Includes household sewage, solid waste, industrial effluents, and agricultural chemicals*".

Marine pollution and debris

An analysis of the 2003—2015 purse seine fishing boat observer data across the Western and Central Pacific found that 44 percent (4,706) of pollution events occurred in the PNG Exclusive Economic Zone (EEZ). Of the total events, 71 percent were documented as waste dumped overboard; 16 percent as oil spillages/ leakages, and 13 percent as abandoned, lost or dumped fishing gear. The dumped waste comprised 37 percent plastics, 15 percent metals, nine percent waste oil, eight percent general garbage, and two percent chemicals. PNG-flagged vessels perpetrated the largest proportion of pollution incidents (18 percent), with 85 percent of pollution incidents by PNG-flagged vessels occurring within the PNG EEZ (Richardson et al., 2015).

Until very recently, mine wastes from major mines were approved to be discharged to rivers or oceans on a very large scale, leading to widespread environmental and social impacts at source and downstream, including in the marine environment. Disposal of mine waste to the marine environment results in increased sedimentation and lowering of available light which can lead to changes in species richness and ecosystem composition (Haywood et al., 2016). Regional sewage treatment facilities all discharge to either the sea and/or fresh waterways.

Plastic waste

A large amount of plastic waste finds its way to the environment and to landfill.

The new National Oceans Policy of PNG 2020—2030 (Department of Justice and Attorney General, 2020, p. 33) emphasises the importance of the Government ensuring that there are "efficient and effective controls and standards in place, in accordance with international agreements to help coordinate prevention, mitigation and response measures to marine pollution nationally and internationally".

Air pollution

PNG does not yet have an air pollution framework, nor has it set vehicle emission standards. In major towns and cities, including Port Moresby and Goroka, there is a noticeable air pollution haze arising from dust, vehicular exhaust, and the burning of fuel wood, hard rubbish and plastic (CEPA and SPREP 2020).

3.9 Relationship of threats to targets and later chapters

Each of the threats discussed above can be linked to a target for improvement in international agreements, and further discussion and recommendations are found in later chapters, as linked in Table 12.

[36] Robbins (2016)

[37] See Chapter 10 for context and progress towards goals

[38] Busilacchi, Curth-Bibb, et al. (2020)

Table 12: Targets and relationship to threats and more detailed discussions

Threat	Target	Links	Comment
Clearing and habitat loss	**Aichi Biodiversity Target 5** Habitat loss halved or reduced: By 2020, the rate of loss of all natural habitats, including forests, is at least halved and where feasible brought close to zero, and degradation and fragmentation is significantly reduced. Relates to **SDG 15** **Proposed Biodiversity Target 1**. Ensure that all land and sea areas globally are under integrated biodiversity-inclusive spatial planning addressing land- and sea-use change, retaining existing intact and wilderness areas. **Proposed Biodiversity Target 2**. Ensure that at least 20 percent of degraded freshwater, marine and terrestrial ecosystems are under restoration, ensuring connectivity among them and focusing on priority ecosystems. **Proposed Biodiversity Target 3**. Ensure that at least 30 percent globally of land areas and of sea areas, especially areas of particular importance for biodiversity and its contributions to people, are conserved through effectively and equitably managed, ecologically representative and well-connected systems of protected areas and other effective area-based conservation measures, and integrated into the wider landscapes and seascapes. **SDG 15** Protect, restore and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification, and halt and reverse land degradation and halt biodiversity loss	3.1 Clearing and habitat loss Chapter 5 Protected and conserved areas Chapter 6 Forests and forestry Chapter 8 Marine conservation Chapter 9 Sustainable Land Use Planning	PNG status 2019: moving away from target (Conservation and Environment Protection Authority, 2019).
Extractive industries	**Proposed Biodiversity Target 15**. All businesses (public and private, large, medium and small) assess and report on their dependencies and impacts on biodiversity, from local to global, and progressively reduce negative impacts, by at least half and increase positive impacts, reducing biodiversity-related risks to businesses and moving towards the full sustainability of extraction and production practices, sourcing and supply chains, and use and disposal.	3.2 Extractive industries Chapter 6 Forests and forestry Chapter 11 Environmental impacts of mining, oil and gas extraction	
	Proposed Biodiversity Target 10. Ensure all areas under agriculture, aquaculture and forestry are managed sustainably, in particular through the conservation and sustainable use of biodiversity, increasing the productivity and resilience of these production systems.	3.2.1 Agricultural development Chapter 6 Forests and forestry	
Unsustainable hunting and resource use	**Proposed 2030 Biodiversity Target 4**. Ensure active management actions to enable the recovery and conservation of species and the genetic diversity of wild and domesticated species, including through ex-situ conservation, and effectively manage human-wildlife interactions to avoid or reduce human-wildlife conflict.	3.3 Unsustainable hunting and resource use Chapter 4 Biodiversity and wildlife conservation	
Wildlife trade	**Proposed 2030 Biodiversity Target 5**. Ensure that the harvesting, trade and use of wild species is sustainable, legal, and safe for human health.	3.4 Wildlife trade 3.3 Unsustainable hunting and resource use Chapter 4 Biodiversity and wildlife conservation	

Threat	Target	Links	Comment
Invasive species	**Aichi Target 9**: By 2020, invasive alien species and pathways are identified and prioritized, priority species are controlled or eradicated, and measures are in place to manage pathways to prevent their introduction and establishment. Relates to **SDG 14, 15, 2** **Proposed 2030 Biodiversity Target 6**: Manage pathways for the introduction of invasive alien species, preventing, or reducing their rate of introduction and establishment by at least 50 percent, and control or eradicate invasive alien species to eliminate or reduce their impacts, focusing on priority species and priority sites.	For more details, see the PNG State of Environment Report (CEPA and SPREP, 2020). 3.5 Invasive species Chapter 4 Biodiversity and wildlife conservation	PNG status: mixed (Conservation and Environment Protection Authority, 2019)
Loss of biocultural knowledge	**Aichi Target 18**: Traditional knowledge Relates to **SDG 14, 15, 2, 16**. **Proposed 2030 Biodiversity Target 20**. Ensure that relevant knowledge, including the traditional knowledge, innovations and practices of indigenous peoples and local communities with their free, prior, and informed consent, guides decision- making for the effective management of biodiversity, enabling monitoring, and by promoting awareness, education and research.	3.6Loss of biocultural knowledge Chapter 4 Biodiversity and wildlife conservation	PNG status: progress towards targets but at an insufficient rate (Conservation and Environment Protection Authority, 2019).
Climate change	**Achi target 10**: Ecosystems vulnerable to climate change **Proposed 2030 Biodiversity Target 8**. Minimize the impact of climate change on biodiversity, contribute to mitigation and adaptation through ecosystem-based approaches, contributing at least 10 GtCO2e per year to global mitigation efforts, and ensure that all mitigation and adaptation efforts avoid negative impacts on biodiversity	3.7Climate change Chapter 7 Climate change and green energy	PNG progress towards target: progress but an insufficient rate (Conservation and Environment Protection Authority, 2019).
	Proposed 2030 Biodiversity Target 7. Reduce pollution from all sources to levels that are not harmful to biodiversity and ecosystem functions and human health, including by reducing nutrients lost to the environment by at least half, and pesticides by at least two thirds and eliminating the discharge of plastic waste.	3.8 Pollution and sedimentation Chapter 10 Managing water, waste and pollution	

Chapter 4.

Biodiversity and wildlife conservation


UN
DP

4.1 Context for biodiversity and wildlife conservation in Papua New Guinea

This chapter addresses the conservation and use of wildlife, both plants and animals, including sustainable community use and illegal trade. Aspects of wildlife conservation concerning protected areas, forestry, mining and marine environments are also covered in later chapters. PNG's outstanding biodiversity values were outlined in Section 1.3.4.

4.1.1 Wildlife conservation: international context and update

In spite of increasingly desperate calls for international attention, the decline in biodiversity loss has not slowed, and the scientific consensus is that we are well into the sixth mass extinction event. Internationally, the rate of biodiversity loss over the last 50 years has been unprecedented in human history (Figure 19): we are experiencing dramatic loss of species, huge declines in the numbers of wildlife, degradation of natural ecosystems, and loss of nature important to Indigenous people and local communities (Bradshaw, 2020; Díaz et al., 2019; Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services, 2019). The key goal of the CBD's Strategic Plan for Biodiversity "To slow the rate of biodiversity loss by 2020" has not been achieved, and most of the "Aichi targets" of the plan have not been met, though evidence suggests that conservation action has saved 9–18 bird and two to seven mammal extinctions since 2010 (Bolam et al., 2021).

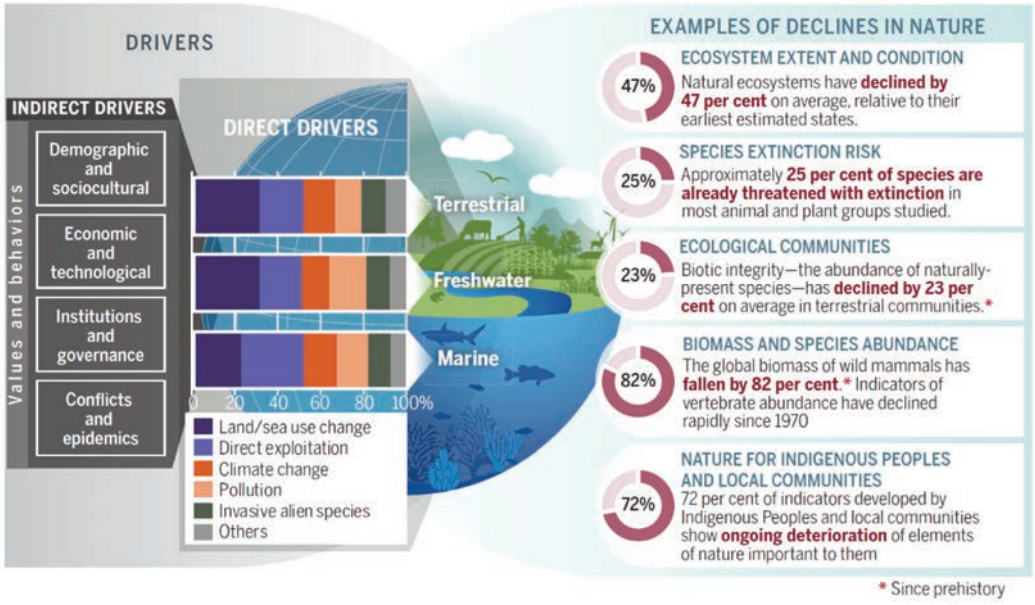

Figure 19 : Decline in biodiversity internationally, showing direct and indirect drivers.

This decline in biodiversity is having an impact on the achievement of the Sustainable Development Goals (SDGs) worldwide, including on hunger and sustainability of cities and communities (Figure 20).

Selected Sustainable Development Goals	Recent status and trends in aspects of nature and nature's contributions to people that support progress to selected targets		
	Poor/Declining	Mixed	Unknown
No poverty	↓↓		
Zero hunger	↓	→→→	
Good health and well-being			??
Clean water and sanitation	↓↓↓	→	
Sustainable cities and communities	↓↓↓↓	→	
Climate action	↓	→	???
Life below water	↓↓↓↓	→→→	
Life on land	↓↓↓↓↓↓	→→→→→	

Figure 20: International summary of the impacts of biodiversity loss on key Sustainable Development Goals

4.1.2 Knowledge about biodiversity

A common theme in most biodiversity reports is that PNG is extremely rich in species and diversity, but that current scientific knowledge is poor and there is a risk of losing species before they are identified and catalogued. We also have little understanding of the cultural knowledge and local perspectives of the environment across all the languages and cultures of PNG (David Mitchell, personal communication 2020). The focus of conservation concern is often animals, but PNG is also an important centre of diversity and endemism for plants, which are poorly known (Cámara-Leret et al., 2020; de Vogel, 2015; Gideon, 2015). Without a continuing and expanded research and monitoring program, there is a risk that species could be lost before they are recorded. However, it should be stressed that enough is known about PNG's biodiversity and its distribution to progress conservation actions, as "we have a good understanding of the centres of biodiversity in PNG and can focus initial conservation efforts of those areas" (Allen Allison, personal communication, 2020).

> *"Lack of knowledge should not hamper creation of new protected areas, development of stronger legislation for protection, or other strategies to prevent biodiversity loss. There are hardly any conservation projects that have failed because they lacked adequate biodiversity information and were therefore erroneously protecting a species poor forest"* (Novotny and Toko, 2015, p. 83).

Large, steep elevation gradients concentrate most of the diversity of mammals, birds, and frogs, whereas reptiles have centres of diversity in the trans fly savannas and the lowlands at the head of the Huon Gulf (Tallowin et al., 2017). Although similar analyses are lacking for plants and invertebrates, congruence of frog, plant, and insect diversity in other tropical regions suggest that large elevation gradients will be found to harbour the greatest species richness in PNG for these groups as well (A. Tejedore, per. comm., 2022).

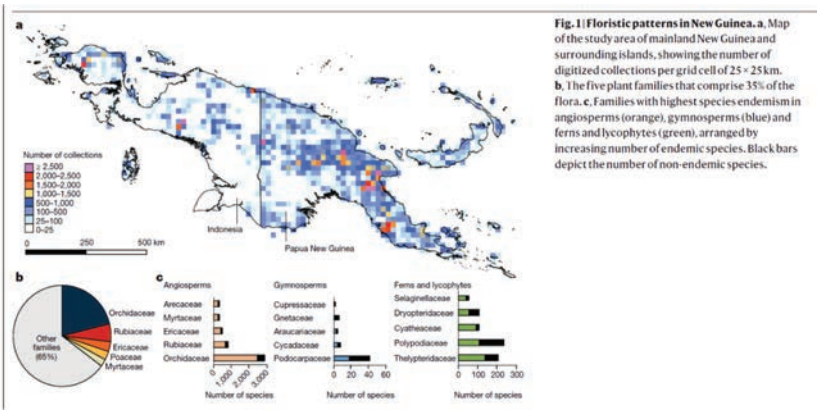

Fig. 1 | Floristic patterns in New Guinea. a, Map of the study area of mainland New Guinea and surrounding islands, showing the number of digitized collections per grid cell of 25 × 25 km. **b**, The five plant families that comprise 35% of the flora. **c**, Families with highest species endemism in angiosperms (orange), gymnosperms (blue) and ferns and lycophytes (green), arranged by increasing number of endemic species. Black bars depict the number of non-endemic species.

Figure 21: Floristic patterns and statistics for New Guinea Island
Source: Cámara-Leret et al. (2020, p.2).

The scientifically-known number of species in PNG is likely to increase as research continues to find new and undescribed plants and animals. The number of known reptiles and mammals may increase by 25 percent, with numbers of frog species expected to double (Allison and Tallowin, 2015). PNG's biodiversity is both rich and irreplaceable. If we lose a species from PNG, it is most likely to be lost entirely. Since 1970, 2,812 new species have been published, estimating that in 50 years 3,000–4,000 more vascular plant species may be described (over the whole of New Guinea Island) (Cámara-Leret et al., 2020). Collection sites for plants (Figure 21) and for animals (Figure 22) show there have been widespread collections, but these are still sparse by world standards. In addition, plants are usually identified from their floristics, so repeated collections are required across the year due to seasonal flowering and fruiting (Bob Johns, personal communication via D. Mitchell, 2020).

Figure 22: Collection sites of amphibians and reptiles in PNG represented by specimens in museums
Source: Allison and Tallowin, 2015, p.90.

PNG has had a long history of foreign naturalists and biological research (Allison and Tallowin, 2015; Beehler, 2020; Cámara-Leret et al., 2020). However, there is an urgent need for more PNG people to be trained and resourced to formally study their

own biodiversity. PNG could capitalise better on its resources to enable students from across the world to undertake field studies in tropical ecology research. Many of the non-government field stations and centres from the past have closed.

> *"Many countries have established national biological surveys to manage their biodiversity. In PNG this would involve the development of a cooperative agreement between the PNG National Museum, the PNG National Herbarium (PNGFRI) and CEPA, together with the development of a training programme through UPNG, PAU, Unitech and overseas universities, herbaria and museums" (Allen Allison, personal communication, 2020).*

Rural people have strong cultural ties with the environment, and with vision and resources, PNG's tertiary institutions could also become world leaders in ecological, environmental, anthropology, sociology and customary governance.

The development of the National Forest Inventory looked very promising and the first field surveys have been undertaken (Turia et al., 2022), however, funding has not yet been secured for its full implementation.

4.2 Legislation, policy and agreements relating to biodiversity and wildlife conservation

In addition to instruments discussed in Section 2.3, key legislation, policies and international agreements most relevant to biodiversity are listed in this section (Table 13). PNG has made commitments to conserving its wildlife, but the actual wildlife legislation is very outdated and requires strengthening. The Biodiversity Strategy is also outdated.

Table 13: Key legislation relating to biodiversity and wildlife conservation

Legislation	Comments
Fauna (Protection and Control) Act 1966	Provides for the conservation and management of PNG fauna, particularly through the establishment of Wildlife Management Areas (WMA), administered by local interest groups through a Wildlife Management Committee; and for the protection of fauna through the declaration of protected fauna (dugong and leatherback), protected areas, WMAs and sanctuaries. It does not provide protection against development or provide for threatened species. It needs revision.
Conservation Areas Act 1978	Conservation areas (CAs) can be under any form of ownership including customary, government and private. They are established to be communally managed by, and with consent of, landowners. The principal purpose of a CA is conservation - any alteration of land use, or development (e.g. commercial logging, mining, road construction etc.) within them is controlled under the Act. CAs provide protection against unplanned development, foster sustainable use of natural resources while supporting meaningful social, cultural and religious institutions and conserving biodiversity.
International Trade of Endangered Species (Fauna and Flora) Act 1978 (ITESA) and Regulation	Gives effect to the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES), controlling and regulating the trade, possession, transport, exportation and importation of certain species of fauna and flora, and for related purposes.
Fisheries Management Act 1998 (FMA) and Regulation	Provides for and gives effect to the National Goals and Directive Principles and in particular to promote the management and sustainable development of fisheries, and for related purposes

There are several national strategies and policies of direct relevance (Table 14) (refer Section 2.3).

Table 14: National policies and strategies relating to biodiversity and wildlife

Policies and strategies	Comments
National Biodiversity Strategy and Action Plan 2007	Out of date. Draft for new strategy under development.
PNG Marine Program on Coral Reefs, Fisheries and Food Security National Plan of Action 2014-2017	Provides an overarching framework for managing PNG's marine environment, including targets and goals for establishment of the marine protected area network. Needs to be updated.
National Action Plan for Sharks and Rays	Published in 2021.

There are several key international conventions and agreements relating to biodiversity and wildlife conservation with perhaps the most important international agreement in relation to biodiversity being the Convention on Biological Diversity (CBD) (refer Table 15 and Section 2.1.4).

Table 15: International conventions and agreements

International Conventions and agreements	Comments
Convention on Biological Diversity	Key agreement for conservation (refer Sixth national report) (Conservation and Environment Protection Authority, 2019).
Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES)	PNG ratified the CITES convention, which is the basis for international controls on trade in specimens of wild animals and plants to ensure their survival.
Convention on Wetlands of Importance, especially as Waterfowl Habitats, (Ramsar)	PNG has been a party to the Ramsar Convention since 1993. Ramsar is concerned with designated Ramsar sites and also with "the conservation and wise use of all wetlands through local and national actions and international cooperation, as a contribution towards achieving sustainable development throughout the world". PNG has two sites listed (Lake Kutubu and the Tonda WMA).
Convention for the Protection of the World Cultural Natural Heritage	There is one World Heritage Area in PNG, with another seven proposed areas on the "tentative" list. All properties inscribed on the World Heritage List must have adequate long-term legislative, regulatory, institutional and/or traditional protection and management to ensure their safeguarding. This protection should include adequately delineated boundaries.
Convention for the Protection of the Natural Resources and Environment of the South Pacific Region and related Protocols (SPREP Protocol)	PNG must take all appropriate measures to protect and preserve rare or fragile ecosystems, and depleted, threatened or endangered species and their habitats. PNG should establish protected areas, and prohibit or regulate any activity likely to have adverse effects on species, ecosystems or biological processes that such areas are designed to protect.
Convention on Migratory Species	PNG is not a Party to the Convention on Migratory Species but is a signatory to three agreements concluded under its auspices as part of the "CMS Family".
International Treaty on Plant Genetic Resources for Food and Agriculture	Deals with conservation and sustainable use of all plant genetic resources for food and agriculture and fair and equitable benefit sharing, for sustainable agriculture and food security. [40]
United Nations Convention on the Law of the Sea (UNCLOS), including Conservation and Management of Straddling Fish Stocks and Highly Migratory Fish Stocks (2001)	PNG must take all appropriate measures to protect and preserve rare or fragile ecosystems, and depleted, threatened or endangered species and their habitats. PNG should establish protected areas, and prohibit or regulate any activity likely to have adverse effects on species, ecosystems or biological processes that such areas are designed to protect.
The Nagoya Protocol on Access to Genetic Resources and the Fair and Equitable Sharing of Benefits Arising from their Utilization to the Convention on Biological Diversity	Aims at sharing the benefits arising from the utilization of genetic resources in a fair and equitable way (CBD Secretariat, 2020). Not yet ratified by PNG.
Torres Strait Treaty (1978)	Bilateral obligations are met between Australia and PNG under the Treaty, including conservation and management of the Torres Strait Protected Zone (TSPZ) commercial fisheries and traditional fishing.

4.3 Current status and progress towards biodiversity conservation goals

The world's primary targets for biodiversity are established as part of the CBD's Strategic Plan, and the 2020 targets are known as the Aichi targets (CBD COP 10, 2010; CBD Secretariat, 2018) (refer to sections 2.1.4 and 4.1.1). The Aichi targets were due for completion by 2020, but due to the Covid-19 pandemic, meetings were delayed until 2022. The proposed new targets are more ambitious. PNG's progress towards the Aichi targets has been reviewed in regular reports to the CBD, and the most recent review in 2019 is largely current and highly informative (Conservation and Environment Protection Authority, 2019). All of the Aichi targets are highly relevant to this chapter, but some are dealt with in other chapters.

[39] Standish (2019)

Table 16: Goals most relevant to biodiversity conservation

Source	Target/ goal	Comment
SDG Goal 15: Life on land	Protect, restore and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification, and halt and reverse land degradation and halt biodiversity loss.	
SDG Goal 14: Life below water	Conserve and sustainably use the oceans, seas and marine resources for sustainable development	See Chapter 8

4.3.1 Threatened species

Source	Target/ goal	Comment
Aichi Target 12: Extinction prevented	By 2020 the extinction of known threatened species has been prevented and their conservation status, particularly of those most in decline, has been improved and sustained.	Status: progress but at an insufficient rate (Conservation and Environment Protection Authority, 2019)
Proposed 2030 Biodiversity Goal A	...the rate of extinctions has been reduced at least tenfold, and the risk of species extinctions across all taxonomic and functional groups, is halved...	
Proposed 2030 Biodiversity Target 4	Ensure active management actions to enable the recovery and conservation of species and the genetic diversity of wild and domesticated species, including through ex situ conservation, and effectively manage human-wildlife interactions to avoid or reduce human-wildlife conflict. Indicator: The increase in the extinction rate is halted or reversed, and the extinction risk is reduced by at least 10 percent, with a decrease in the proportion of species that are threatened, and the abundance and distribution of populations of species is enhanced or at least maintained.	

Progress towards the Aichi target was assessed at "progress but at an insufficient rate" (Independant state of Papua New guinea, 2019, p. 108). This appears to be an overly optimistic conclusion, given the continuing deforestation and other pressures on wildlife and the information below. While there are some noteworthy activities working towards these targets, there is no evidence that species decline or the status of most threatened species is being halted.

This Aichi target was clearly not met on an international scale: there is no indication that the rate of extinction is slowing, though some species extinction has been avoided through conservation action (Bolam et al., 2021). Status of species in the Pacific is also considered to be in decline (SPREP, 2020d). In PNG, both the 2020 draft State of Environment Report (CEPA & SPREP, 2020) and the sixth National Report to the CBD (Conservation and Environment Protection Authority, 2019) indicate that the status of species is in decline overall. For the PNG species that have been assessed for the Red List[41] and where the population trend is known, 40 percent of animal species and 28 percent of plant species are listed as decreasing. The population trend of most species is unknown (Figure 23) (IUCN, 2022). No threatened species are listed as increasing, though some are stable.

The status of threatened marine mammals in the EEZ of PNG, the Solomon Islands and Indonesia has improved (Department of Environment and Conservation, 2019). There is evidence that some animal species have been saved from the brink of extinction in PNG, at least for the present. For example, declines of several species of tree kangaroos have been halted and possibly reversed since the 1980s, due to conservation efforts which have persuaded local communities to forego hunting (Valentine et al., 2021). Two of these species are now listed as stable on the Red List (IUCN, 2022).

The number of threatened plants and animals has increased greatly since 2014 (Table 17), but this should be considered in the context of the increase in numbers of species assessed, especially for plants.

[40] See: http://www.fao.org/plant-treaty/overview/en/

[41] The Red List of Threatened Species is compiled and maintained by the IUCN and is the accepted reference for the classification of species globally. The IUCN Red List Categories and Criteria are intended to be an easily and widely understood system for classifying species at high risk of global extinction. It divides species into nine categories: Not Evaluated, Data Deficient, Least Concern, Near Threatened, Vulnerable, Endangered, Critically Endangered, Extinct in the Wild and Extinct. Its website states that "The majority of assessments appearing on The IUCN Red List are carried out by members of the IUCN Species Survival Commission (SSC), appointed Red List Authorities (RLAs), Red List Partners, or specialists working on IUCN-led assessment projects. However, assessments can really be carried out by anyone who has sufficient knowledge of a species and submitted to IUCN for consideration. While most mammals, birds, reptiles, amphibians and fish that have been described by science are included in the List, other species groups, particularly invertebrates, are less likely to have been assessed. For example, only 402 of the hundreds of thousands of insects in PNG have been assessed on the Red List (March 2022). It should also be noted that a species may be less threatened globally but at risk of extinction in a region, country or locality. For this reason, many countries also have their own lists of threatened species.

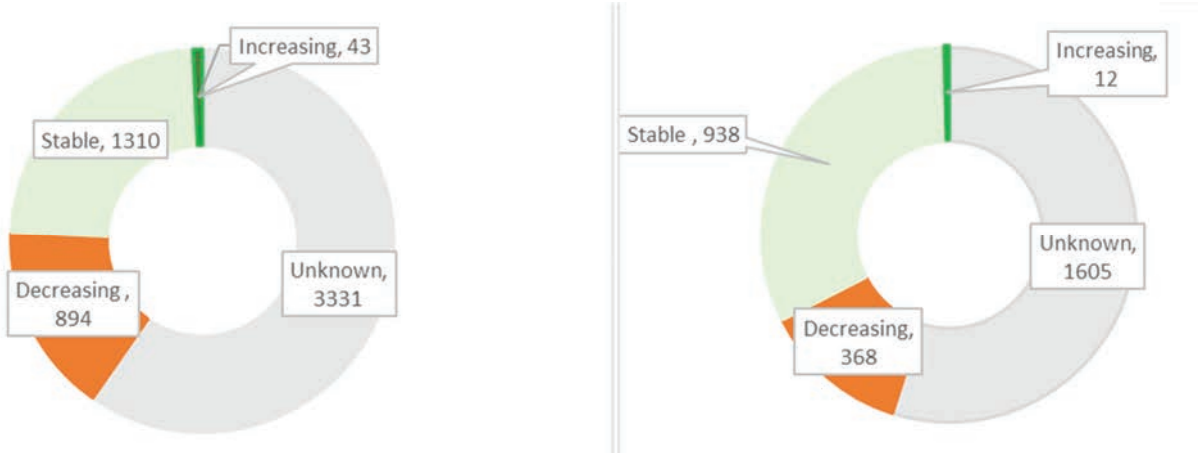

Figure 23: From the Red List of Threatened Species 2022, total numbers of Papua New Guinea's assessed animals (left) and plants (right) whose populations trends are unknown, stable or changing

Table 17: Change in listings of plants and animals in Papua New Guinea, 2014 - 2022 (IUCN Red List)[42]

Category	Plants 2014	Plants 2020	Plants 2022	Animals 2014	Animals 2020	Animals 2022
Critically endangered	17	40	153	20	25	64
Endangered	18	58	283	42	62	95
Vulnerable	11	176	187	257	292	322
Near threatened	38			251	273	294
Least concern	313	1,134	1,791	1,970	3,874	4,264
Total assessed						

Source: 2014 figures from fifth national report to the CBD (Department of Environment and Conservation, 2014); 2020 and 2022 figures from IUCN (2020, 2022)

Three species of fungus, 623 plants and 481 animals are currently listed as threatened (critically endangered, endangered or vulnerable) in PNG (IUCN, 2022) (Table 18). Of particular concern is the number of threatened mammals, including 10 that are critically endangered. One in five of PNG's mammals is threatened.

Table 18: Numbers of threatened and endemic species in Papua New Guinea (August 2022)

	Frogs	Reptiles	Birds	Mammals	Bony fish	Sharks, rays	Insects	Anthozoa (hard corals)	Plants
Critically Endangered	8	1	2	10	18	10	1	n/a	153
Endangered	5	4	4	18	22	21	2	6	283
Vulnerable	15	8	35	26	36	32	10	151	187
Threatened species total	**28**	**13**	**41**	**54**	**76**	**63**	**13**	**157**	**623**
% of assessed PNG spp	8%	3.75%	5.53%	18.37%	3.23%	56.25%	3.40%	28%	20.85%
Near Threatened	8	7	61	15	21	19	6	151	124
Least Concern	302	265	671	193	2118	24	220		1791
Data Deficient	52	62	9	32	141	6	162	214	450
Species total assessed	362	347	741	294	2356	112	402	38	2988
Endemic assessed	292	120	114	85	102	10	174	not assessed	1340
% endemic	81%	35%	15%	29%	4%	9%	43%		45%

Source: data from the Red List, accessed February 2022 (IUCN, 2022)

[42] Note that the dramatic increase in total numbers in this table is due to additional species being assessed by scientific panels.

These figures can be interpreted in the light of international trends; for example, 8 percent of frogs (amphibians are threatened in PNG, compared with 41 percent across the world (IUCN, 2022) .

Threats to biodiversity are discussed in Chapter 3. The main cause of declining vertebrate species is from the combined effects of hunting and habitat loss, which has caused the localised extinction of species including the long-beaked echidna and Goodfellow's tree kangaroo (Allison and Tallowin, 2015). Land clearing, mostly from logging and clearing for plantations, is the main cause of increased rarity in plants. Levels of threat for all terrestrial species are likely to increase in the near future due to increased developments, including the planned network of roads and other infrastructure (Alamgir et al., 2019), and due to the expected lag between habitat destruction and species decline.

Frogs are a good indicator species for environmental change. In 2019 a specialist group reviewed the status of amphibians and recommended that a number of frog species should be added to the endangered category (IUCN, 2020), as their populations were decreasing due to large-scale land clearing from logging and oil palm plantation (CEPA and SPREP, 2020). Frogs in PNG are particularly important as they have to date escaped the chytrid fungal infections that have ravaged populations in most tropical countries (Bower et al., 2019).

4.3.2 Conservation of genetic material and property rights

Source	Target/ goal	Comment
Aichi target 13:	By 2020, the genetic diversity of cultivated plants and farmed and domesticated animals and of wild relatives, including other socio-economically as well as culturally valuable species, is maintained, and strategies have been developed and implemented for minimizing genetic erosion and safeguarding their genetic diversity.	PNG status: progress towards target but at an insufficient rate (Conservation and Environment Protection Authority, 2019).
Aichi Biodiversity Target 16	Nagoya Protocol on access and benefit-sharing	PNG status: Progress towards target but at an insufficient rate (Conservation and Environment Protection Authority, 2019).
Proposed 2030 Biodiversity Goals	Goal C The benefits from the utilization of genetic resources are shared fairly and equitably, with a substantial increase in both monetary and non-monetary benefits shared, including for the conservation and sustainable use of biodiversity.	
Proposed 2030 Biodiversity Target 13.	Implement measures at global level and in all countries to facilitate access to genetic resources and to ensure the fair and equitable sharing of benefits arising from the use of genetic resources, and as relevant, of associated traditional knowledge, including through mutually agreed terms and prior and informed consent.	Also Relates to SDG 14, 15,

.

The Nagoya Protocol on Access and Benefit Sharing (ABS) is a supplementary agreement to the CBD, and this agreement has not yet been ratified or acceded to by PNG. However, the Pacific Regional ABS Project is currently underway (SPREP, 2012), and with this support the PNG Government is moving towards a legal framework and ratifying the treaty. This project has four key components: 1. A baseline analysis to identify common assets issues and needs between countries; 2. Support to national authorities to help countries ratify the Nagoya Protocol; 3. An enabling environment to help Pacific countries implement basic provisions now in place and the development or review of strategies and action plans; and 4. Pacific regional coordination and technical support.

In 2019, PNG, through CEPA and the German Government development agency (GIZ), signed an ABS agreement. Further work is needed. At present there is no legislation or policy in place to protect landowners' intellectual property or to ensure benefit sharing from genetic material on the lands or in their gardens.

> *"With the ABS agreement in place, a policy must be developed and legislations amendment must be sponsored by the PNG government to ensure PNG's gene bank and Intellectual Property Rights (IPR) on genetic resources are preserved for local people and the country to benefit from any benefits derived from those genetic resources" (CEPA and SPREP, in press, p. 684).*

In the past, it has been possible for outside bodies to take advantage of PNG's genetic resources without any benefit for landowners or the country. The PNG Government is now concerned about community and national rights to genetic material. For example, it has included benefit sharing agreements as a requirement of formalisation of protected areas in the draft Protected Area Bill. Permits have been issued to several international research and development institutions to conduct biodiscovery activities in PNG with the primary aim of finding new drugs to fight diseases (Conservation and Environment Protection Authority, 2019). Policy frameworks and institutional arrangements already in place can work toward the intent of the Nagoya Protocol (Conservation and Environment Protection Authority, 2019). PNG also participates in the International Treaty on Plant Genetic Resources for Food and Agriculture.

Any threats to species' overall status (Section 4.3.1) threaten genetic-level diversity, but localised species loss and decline is also likely to reduce the overall genetic diversity. The result of this loss has lessened the ability of species to adapt to a changing environment and to survive shocks and stresses such as climate change and extreme climatic events, volcanic eruptions, and disease outbreaks.

Much of the focus on genetic-level conservation is oriented to food crops. PNG has outstanding diversity of varieties in its common food crops and is the centre of diversity for crops including bananas (241 varieties in collections) and sweet potato (851 varieties). Most of this genetic diversity is held in people's gardens, and there is pride in growing local varieties. However, a loss of genetic diversity within people's gardens is being observed – partly due to cultural and economic change and partly because of severe and prolonged droughts. There are ex situ efforts to conserve this diversity, but they are inadequate, and collections are declining (Conservation and Environment Protection Authority, 2019).

Research is lacking into the genetic potential of wild relatives of crops and food plants to improve domesticated varieties, which is thought to be very high. Wild species and varieties of vanilla, bananas, and sugar cane could be used to improve resilience and disease resistance of commercial crops, giving benefits to landholders as well as to international agriculture (CEPA and SPREP, 2020). Species such as the protein-rich galip nut are beginning to be marketed and have greater potential. Selected varieties of PNG's staple food crops, fruits and nuts are conserved within planted gene-banks at centres of the National Agricultural Research Institute (NARI) located throughout the country. Some of this diversity is also held in gene-banks in overseas collections (Conservation and Environment Protection Authority, 2019).

4.3.3 Equity and representation in biodiversity decision-making

Source	Target/ goal	Comment
Proposed 2030 Biodiversity Target 21	Ensure equitable and effective participation in decision-making related to biodiversity by indigenous peoples and local communities, and respect their rights over lands, territories and resources, as well as by women and girls, and youth.	Has been lacking but is now a focus of many development programmes.
Proposed 2030 Biodiversity Target 20	Ensure that relevant knowledge, including the traditional knowledge, innovations and practices of indigenous peoples and local communities with their free, prior, and informed consent, guides decision-making for the effective management of biodiversity, enabling monitoring, and by promoting awareness, education and research.	

No analysis is available relating to progress towards these targets for biodiversity, but many of the projects discussed in this report are working towards them. Many land use developments in PNG have not had adequate free, prior and informed consent, particularly of women (Chapter 9).

4.3.4 Mainstreaming of biodiversity values

Source	Target/ goal	Comment
Proposed 2030 Biodiversity Target 14	Fully integrate biodiversity values into policies, regulations, planning, development processes, poverty reduction strategies, accounts, and assessments of environmental impacts at all levels of government and across all sectors of the economy, ensuring that all activities and financial flows are aligned with biodiversity values.	Much work remains to be done in PNG in this important area, as at present there is outdated legislation, lack of policies, lack of an offsets system, and inadequate oversight and law enforcement in relation to a wide range of activities affecting biodiversity.

A recent review of the regulatory and institutional framework for protected areas and biodiversity conservation in PNG concluded:

> *"...the limited or lack of regulatory, funding, partnership, capacity, and community agreements, which create negative impressions in conservation, are huge challenges to be tackled. The challenge for CEPA now is to ensure everything, including government agencies, laws, and institutions are synchronised. Conservation activities at the national, provincial and local level must be coordinated and improved in order to get the regulations, activities, research, monitoring of activities" (Bito, 2021).*

4.4 Opportunities in biodiversity conservation

4.4.1 Biodiversity research

PNG has the potential to be a leading centre for tropical ecology research including for the study of biological variability within large, continuously forested areas, across a range of soil, hydrological and climatic conditions. Research projects and stations with opportunities for students and ecotourists can be established in forests with largely intact vegetation and vertebrate fauna, and this could be a complementary source of income for local people, as in the New Guinea Binatang Research Centre (Novotny and Toko, 2015). Supporting these opportunities also benefits biodiversity research, through attracting international scientists but more importantly providing opportunities for PNG researchers. Several well-recognized research centres have now closed and fallen into disrepair, and the primary organization for employing qualified PNG biologists - the Papua New Guinea Institute of Biological Research Inc (PNGIBR) - ended in 2017, so any such initiatives need to carefully consider built-in sustainability, preferably not built on short-term grants.

4.4.2 Tradition, tambu systems and local practices for conservation

The State of Environment report (CEPA & SPREP, 2020) poses the question: "How do we make traditional conservation work in PNG?" People in PNG have many traditions and practices to ensure that resources are used sustainably. However, as populations and demand for natural resources increase, these traditional practices are under pressure.

Communities framing and enforcing their own laws is effective, and legal support may be required for this process. For example, communities at Pokili WMA have instituted a system for limiting the harvest of megapode eggs, and voluntary 'bush rangers' patrol the area. In the YUS Landscape, communities have agreed not to hunt tree kangaroos, and have pledged to declare certain parts of their land as protected, where they allow no hunting of any species (Leverington et al., 2017). There is a wide range of permanent and periodic tambu systems (restricted, sacred), which can be effective in achieving some conservation outcomes. However, experience has shown that initiatives to build on traditional systems should be led by local landowners (Whitmore et al., 2016). Gains by local communities can lead to outsiders poaching within closed areas, as reported by a number of marine protected areas (Leverington et al., 2017).

4.4.3 Payment for Ecosystem Services

PES is "(a) a voluntary transaction where (b) a well-defined environmental service (ES) or a land use likely to secure that service (c) is being 'bought' by a (minimum one) service buyer (d) from a (minimum one) service provider (e) if and only if the service provider secures service provision (conditionality)" (Wunder, 2005).

PES "is based on contractual payments, voluntarily made by people or entities purchasing an ES, to providers of the same service, subject to the condition that the provider maintains pre-defined standards and conditions that result in environmental improvements" (Crane, 2015, p. 7). These contractual arrangements could be relevant to communities who are being asked to forego certain benefits, such as cash income from logging or mining, or protein from hunting, in order to protect species or ecosystems. They are a several ways for private enterprise or philanthropic payments to be invested to ensure conservation, while providing reliable compensation to the people who are being asked to make sacrifices. While there are many possible issues and hurdles, PES programs hold promise and should be further investigated (Figure 24).

Figure 24: Summary of Payment for Ecosystem Service options
Source: Crane (2015, p.57)

4.4.4 Robust civil society support

In PNG, both international NGOs and national community-based organisations (CBOs) play an extremely important role in conservation programmes of all kinds. CBOs are critical in assisting local communities in their conservation efforts while supporting their social well-being. Their support includes legal assistance, facilitation of land dispute resolution, implementation of local actions, training, and environmental education, and awareness campaigns. In some cases, the local CBOs work in productive partnerships with international NGOs and other supporters.

4.5 Wildlife conservation and those left behind

Sustainable use of wildlife is a pillar of survival for many rural people in PNG, as a source of food especially protein, medicine, firewood, and building materials. Wildlife is also an integral part of cultural and traditional life. As discussed, sustainability has become more difficult to ensure due to increasing human populations, as well as a decrease in natural areas and wildlife populations. The people who suffer most from this decline are the poorest (who have no capacity to purchase meat or fish), and women and children.

4.6 Partners projects and programmes in biodiversity conservation

A selection of current recent programmes is outlined below.

4.6.1 Area-based projects

Several programs, such as initiatives in the YUS Landscape and the Torricelli Mountains, have begun primarily as initiatives to save particular critically endangered species, and have broadened in scope as wider needs for conservation have become apparent. These projects appear to be having considerable success in stabilising populations of their target species, which act as flagships for less charismatic species. These activities all play a major role in biodiversity conservation (refer to Chapter 5 for projects involving protected areas and Chapter 8 for projects in marine areas).

USAID Lukautim Graun "Look After the Environment" works both within and outside protected areas in the Bismarck Forest Corridor, several provinces including Eastern Highlands, Jiwaka, Madang, Morobe, Simbu, Milne Bay, the National Capital District and YUS Conservation Area, with a wide range of projects related to biodiversity and supporting communities. In these areas they are working with civil society, local level governments, provincial administrations and CEPA. As well as working to establish protected areas, the project is supporting women's empowerment and cultural strengthening, including the Thousand Tribe campaign aimed at championing artisan skills to drive development of the nation's creative economy.

4.6.2 Ex situ conservation

Ex situ conservation initiatives for wildlife include continuing work by a number of zoos and wildlife parks. Within PNG, a leader in this field is the Port Moresby Nature Park, the only internationally welfare-accredited zoological facility in PNG. It focuses on providing educational opportunities, including the chance for national and international visitors to see PNG's endemic species, and also undertakes research, wildlife rescue and captive breeding activities, including investigations about animals' tolerance for climate change (M. Supuma, personal communication, 2020). UNDP, GEF (Global Environment Facility) and CEPA are co-sponsors, along with private enterprises and government departments. A new Tree Kangaroo Facility and educational area focused on highlighting the benefits of protected areas in PNG opened in 2020, cosponsored by CEPA, GEF, UNDP and ExxonMobil PNG. Pig-nosed turtles were raised from eggs in the park and then released into the wild in Kikori. The Nature Park has been under extreme financial pressure due to COVID-19, as international tourism ceased (Togiba, 2020).

A number of international zoos breed PNG animals and also contribute to in situ conservation initiatives, including Woodland Zoo, and Perth Zoo.

4.6.3 Species and ecosystem conservation

The UNDP, funded through the GEF, has been the largest contributor to biodiversity conservation action in the country. Projects have supported the national regulatory framework for protected area management – namely, the Policy on Protected Area, the management modalities for effective protected area management, and most recently, the sustainable financing of the system of protected areas, specifically to design and implement a national Biodiversity Fund as a legally independent institution.

A number of funding opportunities are available for time-bound projects relating to particular species or ecosystems. For example, the Mohammed bin Zayed Species Conservation Fund supports PNG wildlife projects including research and conservation efforts into Beck's petrel, pig-nosed turtle, and endemic rhododendrons. The UK government's Darwin Initiative funds projects that help countries rich in biodiversity but poor in financial resources to meet their objectives under international biodiversity conventions. One current project is funded, integrating rainforest conservation and health.

The Critical Ecosystems Partnership Fund focuses on civil society in the world's biodiversity hotspots, i.e., biologically rich ecosystems that are essential to humanity, yet highly threatened. Within PNG, a CEPF officer within CEPA supports projects only within the "east Melanesian Hotspot" with projects in the Bainang Ranges, Manus, New Ireland and Bougainville. The fund is a joint program of l'Agence Française de Développement, Conservation International, the European Union, GEF, the Government of Japan and the World Bank.

Piku Biodiversity Network is a PNG civil body seeking to assist with biodiversity conservation, including the protection of the pig-nosed turtle. It has been supported by an Australian University but is obtaining grants from a range of sources to continue work independently. Recent projects have included monitoring and seeking methods to support communities conserving turtles, dolphins, rays and sharks in the Kikori Basin area. The network has trained and employed 'turtle rangers' to help in all activities including community education and release of Piku turtles.

Sustainable Wildlife Management Programme is a major international initiative that aims to improve wildlife conservation and food security by developing "innovative, collaborative and scalable new approaches to conserve wild animals and protect ecosystems, whilst at the same time improving the livelihoods of indigenous peoples and rural communities who depend on these resources". The consortium includes the Food and Agriculture Organization of the United Nations (FAO), French Agricultural Research Centre for International Development, Centre for International Forestry Research and Wildlife Conservation Society (WCS). In PNG, projects are being implemented through WCS. The aim in the project areas is to maintain the current populations of terrestrial wildlife and develop alternative sources of protein in villages by establishing community-led wildlife management initiatives, supporting community tree nurseries, and distributing preservation kits to extend the life span of traditional attire. Two conservation deeds protecting a combined area of 7100 ha have been signed in 2021 and 2022 in the Bismarck Range was, and volunteer community rangers are being trained.

The Wildlife Conservation Society also supports a number of other wildlife-related projects including biodiversity surveys. They have been attempting to reduce the harvest of wild birds for feathers and head-dresses through promotion and education campaigns and providing preservation kits for head-dresses. WCS has partnered with UNDP to assist CEPA in delivery of the GEF 6 project, working towards sustainable financing and management of protected areas.

4.6.4 Genetic materials

SPREP with UNEP is also coordinating the Pacific Regional Access and Benefit Sharing Project for the ratification and implementation of the Nagoya Protocol in the countries of the Pacific Region, funded by GEF and supported by UNDP (SPREP, 2017). PNG is a partner in this initiative. Other projects in relation to genetic diversity include the German government's GIZ ABS Initiative Project, which will develop and support institutional capacity in ABS policy, legal and administrative frameworks, analysis of potentials for bio-trade and associated value chains. GEF 7 will support national and regional implementation (and facilitate ratification if required) of the Nagoya Protocol (Conservation and Environment Protection Authority, 2019).

4.6.5 Awareness, knowledge and capacity building

Knowledge is a pillar of biodiversity conservation, and many organisations support research in plants, animals and conservation of biocultural conservation. Within PNG, leading institutions include the University of Papua New Guinea, Binatang Research Centre (BRC), Museum of PNG (for cultural heritage) and the National Forest Institute (NFI). Other partners in biodiversity studies include museums, zoos, research institutions and academic organizations from all over the world.

Botanical research and collections in PNG are important due to the extremely high plant diversity, and the risk that many endemic species are found at high altitudes and may be vulnerable to climate change impacts. It is important to train and employ in-country botanists at all levels to be leaders of biodiversity research and conservation within PNG ((Cámara-Leret et al., 2020).

New Guinea Binatang Research Centre is a biological research and conservation non-profit organization in Papua New Guinea. It specializes in: training Papua New Guineans in biology on all levels, from field technicians through para-ecologists to post graduate students; advancing biodiversity research in PNG; and developing educational and nature conservation programmes, targeting grassroots audiences.

The BRC closely collaborates with the Wanang proposed CA and assists the landowners with conservation management of their forests. They are also developing a conservation and research area with rainforest owners at Mt Wilhelm. BRC and the local communities have established a research transect comprising eight study sites at 500 m elevation increments, spanning from 200 to 3,700 m asl. This transect encompasses a complete rainforest elevation range and is open for research.

PNG tertiary institutions offer courses at different levels in wildlife and conservation. These programmes are essential in developing wildlife conservation professionals in the future. In addition, scholarships and capacity building programmes in many overseas countries expand the options, particularly at post-graduate level.

The Research and Conservation Foundation (RCF) is one of the oldest national NGOs in PNG and is one of the first and largest dedicated to the environment, conservation and education. RCF addresses landowners' concerns about the declining population of unique and rare species and the rich biodiversity of PNG highlands and helped established the Crater Mountain WMA in 1993. RCF currently focuses on environmental education through training voluntary community environmental-awareness leaders on sustainable use of wildlife and inserting wildlife conservation in school curricula (A.Tejedor pers. comm., 2022).

The Pacific Regional Environment Programme (SPREP) supports biodiversity programmes including the PNG environment portal which stores data and reports in a user-friendly accessible interface.

ExxonMobil PNG has supported biodiversity-related projects including research and biodiversity surveys, capacity building including environmental studies scholarships, and communication including annual seminars which are the most important cross-fertilisation of conservation ideas and initiatives in PNG.

The IUCN Species Survival Group provides invaluable data and analyses to keep the IUCN Red List of Endangered Species as accurate and up to date as possible for all PNG species, with information on status and threats.

4.7 Gaps in biodiversity conservation and risks in not conserving wildlife

Unlike other areas of environmental concern, there has been little recent work at national level on policy, or programs for wildlife and biodiversity conservation generally.

- National Biodiversity and Action Plan (Government of Papua New Guinea, 2007) is over 10 years old, and the new draft version has not been completed.
- There is no up-to-date legislation or policy regarding biodiversity protection, and the Fauna (Protection and Control) Act 1966 is outdated and limited in its ability to conserve biodiversity. Sixteen years ago, after a review of biodiversity policy and law in PNG, Kwa (2004) wrote:

  > *"PNG has made a concerted effort in addressing biodiversity issues. The sectoral approach it adopted since independence is indicative of the global practice of that time. However, over the years, the global community has moved away from sectoral to a holistic approach. PNG has unfortunately not been able to capture this paradigm shift. [. . .] [T]he law and policy on biodiversity is incoherent in PNG. There are national policies and laws that target biodiversity, but on a sectoral basis. There are also glaring gaps in the policy and legal framework in relation to issues such as: access to biological resources; benefit sharing from the development of biological resources[,] and IPR. Clearly a national biodiversity policy in the form of a NBSAP and a national biodiversity law are required in PNG".*

  While some aspects have improved since then, including the establishment of CEPA, and will be further advanced with the passing of the Protected Areas Bill, there are still considerable gaps and policy dissonance in relation to biodiversity conservation, with the strong development paradigm leading thinking into the future. In addition, enhanced legal requirements are needed for environmental impact assessments and remediation actions for all extractive industries.
- No threatened species recovery plans or coordinated species' working groups exist in a formal sense, and there is no action to address decline in species
- No branch or staff within CEPA are addressing the issues, except for a minimally staffed unit within the regulatory division to manage CITES permits and wildlife trade.
- Most provinces have no capacity for any biodiversity work. A notable exception is West New Britain Province, where an environment and climate change division has been established (D. Varghelo, pers. comm., 2022).
- Research and monitoring are not sufficient to record species and understand their ecological needs. However, there is enough knowledge to move forward with conservation programmes.
- The issue of invasive environmental pests receives inadequate attention.

Risks for biodiversity loss persist, as evidenced by the number of species currently threatened with extinction in PNG. The very high biodiversity values, combined with high development pressures, mean failure to act toward protecting wildlife is a high risk.

Risks for cultural heritage loss are high due to the very close relationship between natural and cultural values. The continuing decline in natural systems puts at risk the loss of traditional bio-cultural knowledge and many words are lost from local languages.

Socioeconomic risks, especially to those left behind, are related to the loss of species used for a wide range of livelihood needs from food to firewood and building materials. Conflicts and displacement are more common when resources are not adequate for the populations needing to use them.

Risk of losing community support and willingness to cooperate in conservation-oriented projects, unless livelihood benefits are seen as part of the solution.

4.8 Recommendations for conserving biodiversity

4.8.1 Update legislation and policy

The ***Fauna (Protection and Control) Act 1966*** is in urgent need of a significant review and overhaul to meet current expectations, especially regarding recognition and protection of threatened species and ecosystems.

A meaningful **National Biodiversity Strategy and Action Plan** should be completed and CEPA provided with resources for its implementation. This strategy should provide detail about the protection of threatened species in the light of the many threats outlined in this document and the draft State of Environment Report. Further policies and national strategies are needed to address invasive species in PNG, including environmental pests.

Participation in the Nagoya Protocol should be finalised for PNG; and legislation and policies and procedures addressing genetic property rights and

access benefit sharing agreement could also be considered.

Policies to ensure that **biodiversity values are included in national and sub-national accounting** are needed, to reduce the perverse incentives currently applying to development (Conservation and Environment Protection Authority, 2019).

The draft **offset policy should be finalized**, with emphasis on avoiding and mitigating environmental and social damage wherever possible. Offset payments are a last resort and should fairly compensate for damage. **Pass necessary legislation to give effect to the policy as quickly as possible**.

4.8.2 Plan to protect areas of land and waters from intensive development

In a rapidly developing country, it is essential that **land use planning and marine planning define areas that are protected from large-scale development**. Well-intended projects such as infrastructure, mineral, oil and gas developments, forestry and settlement schemes may otherwise destroy areas of irreplaceable value, including habitats for critically endangered species (Alamgir et al., 2019).[43] Guidance can be given by considering Key Biodiversity Areas and the maps showing priority interest areas for protection (Adams et al., 2017; Tulloch et al., 2021).

Better environmental impact requirements are needed for all developments and substantive changes in land use. The hierarchy of avoid, mitigate and offset should be used for both common and threatened species.

4.8.3 Improve resourcing and capacity at national and provincial level

The **SEP** (Sustainable Environment Programs) **wing within CEPA should be properly resourced to undertake biodiversity work**, including the national commitments under the CBD and other international agreements. It is generally preferable for wildlife staff to work together in a work unit concerned primarily with conservation, so enforcement is seen as a part of the whole picture. The wildlife staff would also need management and administrative support, including resources for travelling.

At provincial level, environmental services need to be better supported. Wildlife trading and extractive activities need to be monitored at the local level – for example, where there are logging operations, or other likely sites for illegal trading and export. Well-trained staff in provinces are required to address wildlife and conservation issues, in cooperation with other agencies.

Transparency, accountability and anti-corruption measures are essential in any jobs related to environmental approvals, forest and agriculture operations and wildlife trade.

Support biodiversity research especially PNG-based organizations and researchers.

4.8.4 Support environmental efforts of civil society

Support CBOs that work effectively for environmental and social benefits to spread benefits and implement environmental programs throughout the diverse communities of PNG. For example, UNDP small grants can be catalytic in building on-ground capacity.

4.8.5 Increase wildlife conservation awareness programmes

Wider promotion of biodiversity values needs to be undertaken, especially in villages where people live with wildlife, and to decision-makers in governments at all levels.[44]

4.8.6 Proactively address invasive species including environmental pests

An improved and coordinated effort is needed in PNG to address the threat of invasive species, including environmental pests. This would include increased surveillance and monitoring, and strategic actions to control pests across all landscapes with full involvement of local communities and provincial and local-level governments. It is important to develop comprehensive lists of introduced species and identify species of highest concern (Allen Allison, personal communication, 2020). National management strategies are needed and should be urgently implemented for the most serious pests. There should be thorough consideration of invasive potential before any new species or varieties are introduced for use in agricultural, forestry, horticultural or aquaculture initiatives.

4.8.7 Manage special species sustainably

Three groups of plant and animal species require specialized management and possibly plans or strategies: 1. Those being exported requiring CITES permits; 2. Threatened species (especially critically

[43] Areas of biodiversity importance continue to be identified in PNG, the most recent being the land-sea planning exercise (Adams et al., 2017). Some of these areas will become protected areas, while others should be developed only in ways that reflect their national and international values, with compensation considered where appropriate. It is desirable for all national mapping layers to include indications of areas of high and very high biodiversity values. Input of biodiversity specialists into all land use plans is highly recommended.

[44] Awareness has been achieved through the teaching of formal education subjects (e.g. Environmental Studies and Community Living) from elementary to fifth grade. However, much more needs to be done across the community, including with policy and law makers and with customary landowners. Supporting CBOs and NGOs work effectively in this field including in remote situations is an efficient solution.

endangered and endangered species); and 3. Plants or animals that are intensively utilised, such as those that are targets for hunting. Species management plans can be for local areas or nation-wide, depending on the context and need. For species that are hunted, the priority is to focus on those species that are known to be declining. In the marine sphere, several species management plans are being or have been developed, for example for sharks and rays. Some species management plans will require legal backing in the form of regulations and enforcement and special attention in operations such as forests, road construction and mining. Threatened ecosystems may also need special attention wherever they occur.

Research and monitoring are helpful in the formulation and application of species management plans, as the data on population numbers, reproduction rates and life histories are lacking. However, this lack should not prevent moving forward with active attempts to reduce impacts where needed.[45]

Local regulations can be formulated within protected areas or in local level government areas to protect certain species or their habitats, and to set limits on hunting and other forms of exploitation.[46]

4.8.8 Mainstream payments for and consideration of ecosystem services, benefit sharing agreements and alternative livelihoods

It is urgent to find and apply sustainable livelihood mechanisms for customary landowners. The strategies listed here are working in those directions but are still slow. They are mostly trials, and not adequately comprehensive.

Incorporate ecosystem services into national and sub-national accounting.

Livelihood projects: in PNG, these can relate to protected areas or landscape-scale species conservation, though providing alternative sources of fuel, food or cash enabling people to change their hunting or collecting practices. Sustainability of such projects is critical.

Ecotourism and research payments: Provided benefits can be properly distributed (see below), wildlife tourism has the potential to benefit people in high biodiversity areas both close to centres like Port Moresby and Madang, and in more remote locations. Research programs can also be a source of income through employment of local scientists, guides, paraecologists, and research assistants, purchase of food and accommodation, and direct payments (see also Section 4.4.1).

Benefit sharing agreements are essential so that customary landowners and local communities benefit from wildlife tourism, research projects and future PES projects. Work is being undertaken in PNG and across the Pacific to develop models of benefit sharing, but it is important that these models are applicable at community level as well as nationally.

4.8.9 Support customary conservation and sustainable use traditions

Supporting, promoting or strengthening customary systems can be a positive way to protect species, while also enabling customary resource use. Such programs need to be led by customary landowners.[47] Material such as 'how to' guides for developing and enacting conservation deeds could be widely distributed to assist communities trying to protect their lands.

4.8.10 Captive breeding and reintroductions

A complementary strategy to in situ wildlife conservation is captive breeding in zoos or other specialised facilities. Captive breeding can assist in establishing insurance populations; populations for study, education and research; and possible pools of animals for later reintroduction. Breeding populations of several PNG's threatened species are being cared for in Port Moresby Nature Park and international zoos.

Captive breeding as a conservation mechanism is regarded as a last resort but can be important where populations are very low or restricted to only one or two areas. Where populations are very low and isolated, translocation or reintroduction of species into suitable habitat, such as protected areas, islands or fenced refuges, is a possible solution. 'Reintroduction biology' has become an important field of research and endeavour. Attention must be paid to many issues such as the presence of threats, genetic viability, and unintended consequences. IUCN has published guidelines for translocations and reintroductions; any such endeavours should be part of a well-planned and sustainable strategy (IUCN, 2015).

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[45] Such monitoring is being conducted in YUS Conservation Area and Torricelli Mountains, using the SMART, PAMapp and Lukimgather applications. Mack and West (2005) suggest that for hunted species, research should prioritise the species that make up most of the protein consumed: feral pigs, cassowaries, tree kangaroos, cuscus, echidnas, ringtail possums and megapodes. However, it is not possible to wait for all the necessary knowledge before trying to regulate hunting – for example by communities re-installing tambu systems (Whitmore et al., 2016).

[46] Mack and West (2005, p. 13) concluded that "We believe that different management techniques, such as closed areas, closed seasons, regulation of techniques (e.g., no guns), bag limits, regulating who hunts, etc., which have proven effective in other places and with other game, can be adapted to the PNG context. If undertaken in collaboration with the people who own the resource, and designed in ways that are most appropriate for each community, we believe rural people can maintain a steady and reliable source of meat that does not require cash expenditure".

[47] Examples have been seen in a number of marine areas, where Gwala and Vala have been revived by landowners supported by local CBOs, with good results (Conservation International, 2020).

Chapter 5.

Protected and conserved areas


UN
DP

5.1 Context for protected and conserved areas in Papua New Guinea

5.1.1 Protected areas in Papua New Guinea

Customary landowners (custodians of up to 97 percent of land in PNG) have recognized many areas of land and sea as "*tambu*" – that is, areas of special spiritual and cultural significance. As the PNG Policy on Protected Areas states: "Over thousands of years, communities all over PNG have been conserving nature for cultural and spiritual reasons, while pursuing traditional livelihoods in these landscapes and seascapes" (Independent State of Papua New Guinea, 2014, p. 7). The earliest formal protected area was McAdam National Park, which was gazetted in 1970 (CEPA, 2016). Around the time of Independence, there was a promising start in developing a protected area system based on customary land ownership and management, through declaring Wildlife Management Areas (WMAs). These protected areas are declared over customary land and waters, with the agreement of customary landowners and usually on their initiative. Declaration of these protected areas across terrestrial and marine environments was innovative on an international scale, but WMAs are not fully protected against land development. More recently, two large community Conservation Areas (CAs) have been declared, and many more potential protected areas are awaiting assessment or declaration.

In 2022, there were 61 formally gazetted protected areas in PNG, with an area totalling just over 2.2 million ha, representing 4.8 percent of the land (Figure 25). Four protected areas have been gazetted since 2010, and one has been substantially expanded. Another very significant protected area (Torricelli Mountain Range Proposed Conservation Area) is due to be declared in the near future.

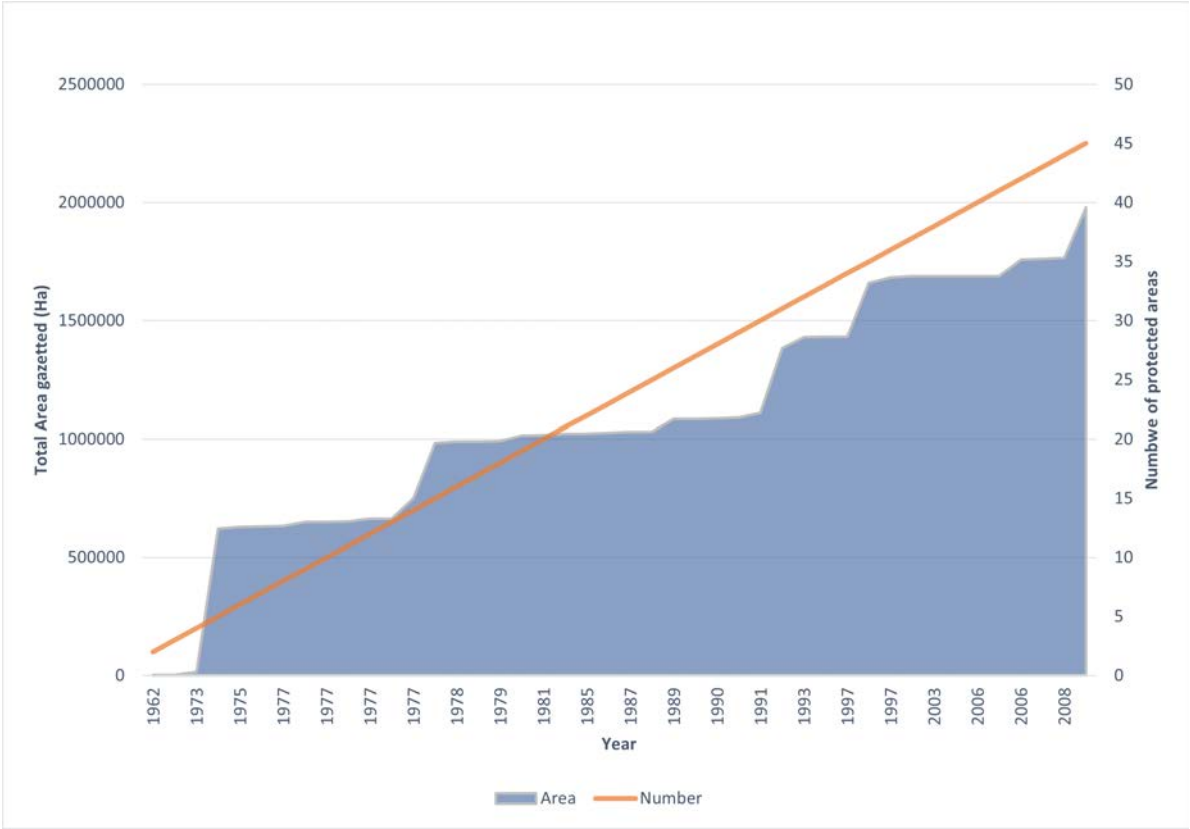


Figure 25: Papua New Guinea's protected area network 1962-2022
Source: graph drawn from data provided by CEPA

Currently most formal protected areas are WMAs, gazetted under the Fauna (Protection and Control) Act 1966, with two large newer Conservation Areas under the Conservation Areas Act 1979 (Table 19). Formally protected areas and other community conserved areas are located in all provinces of PNG (Figure 26). While protected areas have been established on paper, their management has remained patchy and problematic, with continuing poor resourcing and management effectiveness (Chatterton et al., 2006; Leverington et al., 2017). A significant effort is needed to meet international protected area targets and PNG Government commitments.

Table 19: Gazetted protected areas in Papua New Guinea, recognized LMMAs, and current and proposed international designations

Protected area type	No.	Area (ha)	Notes
Conservation Area	2	522,683	
District Park	1	12	
Historical Reserve	1	71	Kokoda Track, a very small part of the Kokoda Interim Protection Zone (area estimated only).
Memorial Park	3	167	
National Park	5	8,241	
Natural Reserve	2	272	
Provincial Park	1	77	
Protected Area	3	2,576	Three protected areas of unknown designation.
Reserve	1	41	
Sanctuary	1	741	
Scenic Reserve	1	13	
Wildlife Management Area	36	1,629,177	
Wildlife Sanctuary	4	75,205	
Total gazetted protected areas	61	2,151,181	
Locally Managed Marine Area (recognized under local govt. law)	14	176,221	Not yet gazetted under national legislation (not included in total).
Locally Managed Marine Area (voluntary not yet officially recognized)	17	20,577	In addition, there are records of more than 80 possible LMMAS, which are either draft, proposed or not mapped.
Wetland of International Significance (Ramsar)	2	590,000	Not included in total area above as they overlap with national protected areas.
World Heritage Site	1		Kuk Early Agricultural Site.
Proposed World Heritage Sites	7		Included on UNESCO tentative list; some proposals in active preparation.

Sources: PNG register of protected areas (CEPA) 2022; complemented by METT data 2017 where there are gaps

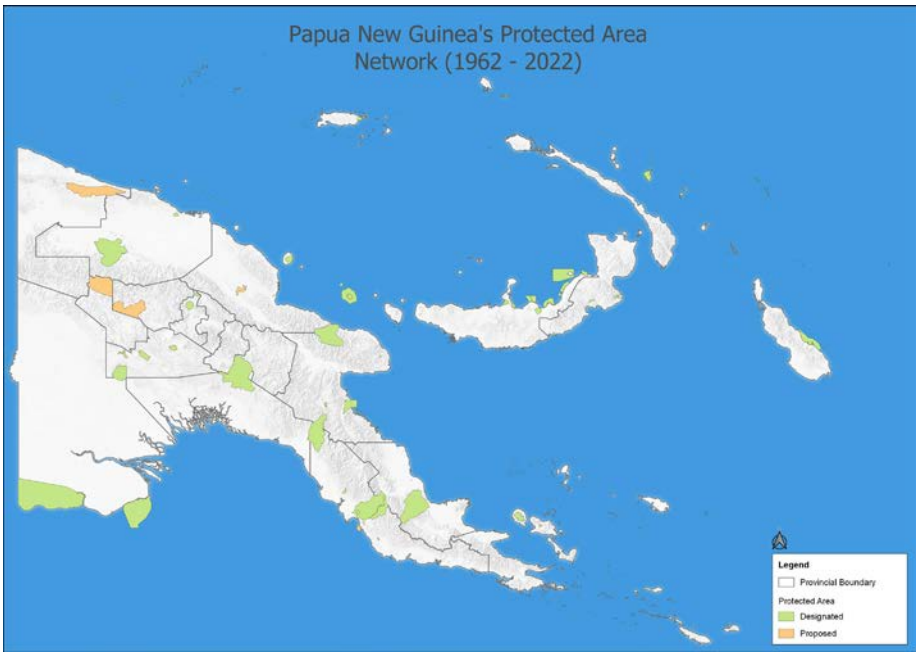


Figure 26: Location of Papua New Guinea's protected areas 2021
Source: provided by CEPA

5.1.2 International context

Globally, 15.8 percent of terrestrial areas and 17.2 percent of marine areas are recorded on the World Database on Protected Areas (WDPA) (Figure 27) (UNEP-WCMC, 2022). Across IUCN's Oceania region, marine coverage is 19.5 percent, and terrestrial coverage is six percent.[48] Marine coverage in the region has increased rapidly in recent years (Bingham et al., in preparation). Considerable shifts have occurred in thinking and practice over the last 20-30 years, with a growing emphasis on the needs, rights and leadership of local communities, especially indigenous peoples. While many people still regard protected areas as "locking [the] country away", this is not the case in the vast majority of protected areas. The international conservation community is moving to greater consideration of "other effective means" (OECMs) for site-based conservation, which are also included in the Aichi Target (IUCN-WCPA, 2019). Other effective area-based conservation areas include:

> *"a geographically defined area other than a Protected Area, which is governed and managed in ways that achieve positive and sustained long-term outcomes for the in situ conservation of biodiversity, with associated ecosystem functions and services and where applicable, cultural, spiritual, socio–economic, and other locally relevant values"* (Convention on Biological Diversity, 2018).

Diversity of governance is encouraged as well as an emphasis on governance quality. The four principal governance types are: 1) Governance by governments; 2) Shared governance with collaboration; 3) Private governance by private individuals, NGOs or corporations, and 4) Governance by indigenous people and local communities (community-based). The 2008 IUCN guidelines recognizes that governance can sit alongside the protected area categories to create a matrix of management objectives and governance types. This means that any type of governance can be applied to any protected area category. This thinking is reflected in the PNG Policy on Protected Areas (Independent State of Papua New Guinea, 2014).

The status of protected and conserved areas across the IUCN Oceania region is included in the Pacific Islands State of Environment Report (SPREP, 2020d) and is also being reviewed in a publication currently in preparation (Van Nimwegan et al., in preparation). This review demonstrates that the state of knowledge about protected areas is lacking, especially in the understanding of governance aspects. Information for these analyses is taken from the World Database on Protected Areas.

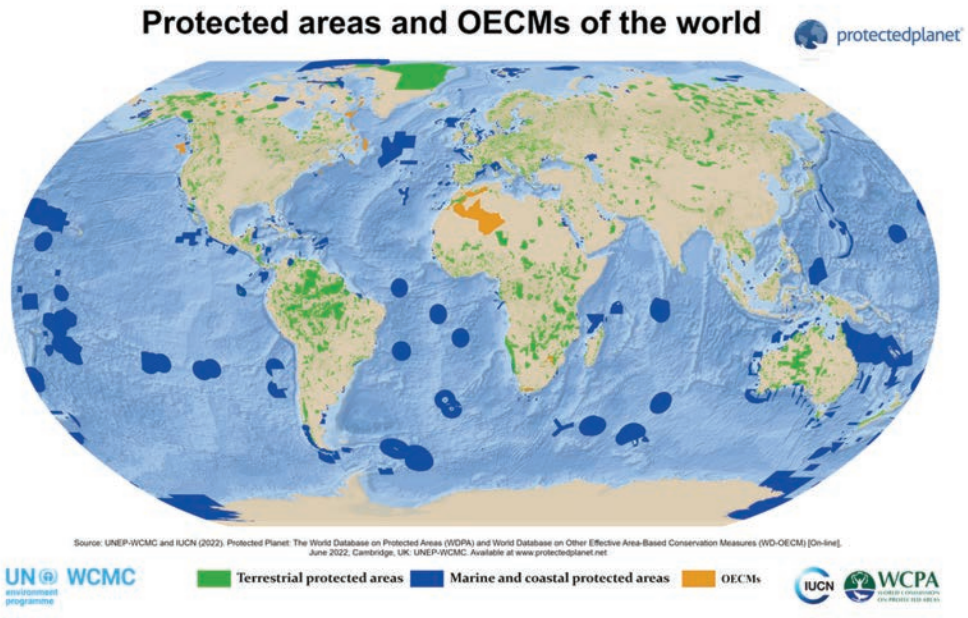


Figure 27: Protected areas and OECMs of the world

[48] These figures are based on WDPA and do not always reflect the latest country data.

5.2 Legislation, policies and agreement relating to protected areas

5.2.1 International agreements

Key international agreements relevant to protected areas are listed in Table 20.

Table 20: International conventions and agreements

International Conventions and agreements	Comments
Convention on Biological Diversity (CBD)	Key agreement for conservation. For report on progress of Aichi targets under the CBD, see the comprehensive sixth national report (Conservation and Environment Protection Authority, 2019).
Convention for the Protection of the World Cultural Natural Heritage	There is currently one existing World Heritage Area in PNG, while another seven proposed areas are on the "tentative" list. All properties inscribed on the World Heritage List must have adequate long-term legislative, regulatory, institutional and/or traditional protection and management to ensure their safeguarding. This protection should include adequately delineated boundaries.
Convention on Wetlands of Importance, especially as Waterfowl Habitats, (Ramsar)	PNG has been a party to the Ramsar Convention since 1993. Ramsar is concerned not only with designated Ramsar sites but with "the conservation and wise use of all wetlands through local and national actions and international cooperation, as a contribution towards achieving sustainable development throughout the world". PNG currently has two sites listed (Lake Kutubu and the Tonda WMA).

While many Acts and Regulations can impinge on protected area management (Section 2.3), the key instruments are listed in Table 21. The former national park legislation, the National Parks Act 1982, has been repealed.

Table 21: National legislation relating to protected areas

Legislation	Comments
Organic Law on Provincial and Local Level Governments 1995 (Organic Law)	The institutional framework within this law provides a strong basis for communal and locally-based management of land and sea, including communities owning and managing protected areas and local level governments legislating for protection.
Fauna (Protection and Control) Act 1966	Provides for the conservation and management of PNG fauna, particularly through the establishment of Wildlife Management Areas (WMAs), administered by local interest groups through a WMA Committee. The Act provides for the protection of fauna through the declaration of PNG protected fauna (dugong and leatherback), protected areas, wildlife management areas and sanctuaries. It does not provide protection against development or provide for threatened species (under IUCN or CITES), and needs revision.
Conservation Areas Act 1978	Conservation areas (CAs) can be under any form of ownership including customary, government and private; they are established to be communally managed by and with consent of landowners. The principal purpose of a CA is conservation - any alteration of land use, or development (e.g., commercial logging, mining, road construction, etc.) within them is controlled under this Act. CAs provide protection against unplanned development, foster sustainable use of natural resources, while supporting meaningful social, cultural and religious institutions and biodiversity conservation.

The Protected Areas Bill has been in the review process prior to the enactment by the National Executive Council (NEC) for more than five years. The Bill will enable provincial governments and local level governments, in consultation with CEPA, to create regional protected areas. CEPA will take lead responsibility for the management of national protected areas, whereas regional protected areas may be managed by customary landowners, provincial governments, local level governments or a private sector corporation. The Bill will establish new types of protected areas and have requirements for equitable and effective management. Most protected areas in PNG will be managed by local communities with the assistance and oversight of provincial and local level mechanisms (Table 22).

Table 22. Provincial government administrative mechanisms for protected areas

	Administrative mechanisms for protected areas	Example
Provincial development and business planning	Five-year development plans and provincial business planning, including integration of protected area management, conservation zoning, sustainable land use planning, and conservation targets into the planning process. Some provincial governments are currently reforming their business and strategic plans in partnership with the Australian Bilateral Aid programme; therefore, it is opportune to include protected areas as a planning priority.	West Sepik, Central, Oro and New Britain provinces are currently reforming their business and strategic plans
PNG FA and PNG NFA model	The PNG Forest Authority (PNG FA) and PNG National Fisheries Authority (PNG NFA) have provincial officers representing respective interests. Although CEPA does not yet have officers working in the provinces, provincial governments can use this model for its environment officers, particularly in relation to advising CEPA on priority issues.	n/a
DLPP model	The PNG Department of Lands and Physical Planning (DLPP) employs provincial officers. In 2022, DLPP launched the National Sustainable Land Use Policy containing conservation zones. Provincial governments have an opportunity to work with these officers and DLPP to identify conservation zones.	n/a
Impact Assessment	Resourcing constraints and industry-focused priorities can impact negatively on protected areas through encroachment of agriculture, pollution and urbanization. As part of an improved planning process, development proposals need to be thoroughly assessed at provincial and national levels with respect to impact avoidance, mitigation and offset. An improvement to impact assessment guidelines and processes at the national level will assist provincial governments.	West New Britain has raised concerns that the impact assessment process at the national level does not function effectively

5.2.2 Policy on Protected Areas 2014

In 2014, the PNG Government approved the Policy on Protected Areas. The policy states that the vision for the PNG Protected Area Network is "Our protected area network across land and sea safeguards our precious and outstanding natural and cultural heritage. Together we manage these areas effectively for all the people of Papua New Guinea" (Independent State of Papua New Guinea, 2014). It is based on five pillars (Figure 28 and Table 23): 1. Governance and management; 2. Sustainable livelihoods for communities; 3. Effective and adaptive management; 4. Managing the PNG protected area network; and 5. Sustainable and equitable financing for protected areas.

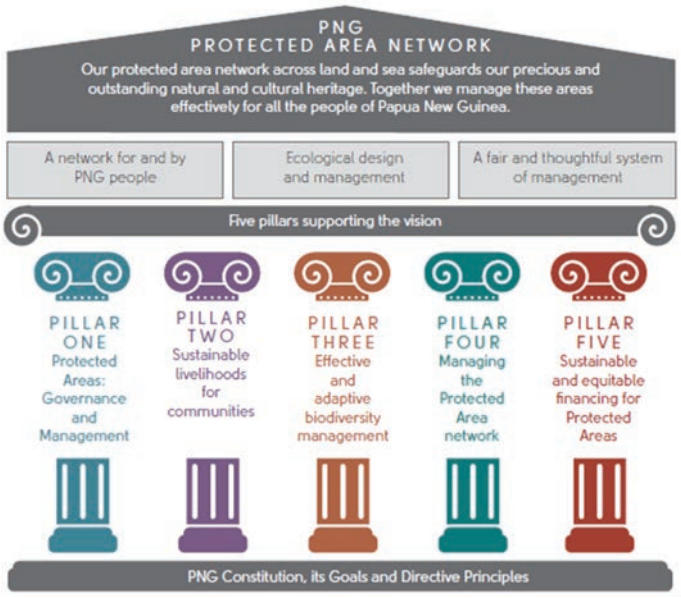


Figure 28: Five pillars of the Policy on Protected Areas

Table 23: Pillars and objectives for the Papua New Guinea Policy on Protected Areas

Governance and management: ▸ Ensure effective arrangements are in place for national, provincial, district and local level governments, communities including customary landowners, on-ground protected area managers and other partners to work in cooperation ▸ Support customary landowners in their initiatives to establish effective protected areas on their lands ▸ Deliver improved scope and support for volunteers, mentors and partners to work with governments and communities in protected area management.
Sustainable livelihoods for communities: ▸ Ensure that local arrangements governing use of natural resources in protected areas are fair and sustainable, and continue to support traditional livelihoods ▸ Build capacity; support and empower communities, customary landowners and protected areas to sustainably manage the protected areas ▸ Develop Conservation and Benefit Sharing Agreements with customary landowners for all protected areas.
Effective and adaptive management: ▸ Develop and apply policies for biodiversity management planning, monitoring and reporting, natural and cultural resource management, and law enforcement ▸ Effectively manage activities on protected areas including biodiversity protection, compatible development, recreation, research and traditional use ▸ Evaluate management effectiveness every three years to demonstrate the successes and challenges for each protected area PNG ▸ Ensure protected area management is well resourced, efficient and effective, with capable, knowledgeable and helpful staff.
Managing the PNG Protected area network: ▸ Establish a relevant, comprehensive, adequate, representative and resilient PNG Protected Area Network according to the range of reserve types and network design principles established in this Policy ▸ Build upon traditional management and traditional ecological knowledge ▸ Ensure a smooth transition from the 2014 protected area types to the updated Network, with no loss of values.
Equitable financing for protected areas: ▸ Develop and implement a Biodiversity Trust Fund to support the Protected Area Network through mechanisms such as biodiversity and ecosystem services off sets, Payment for Environmental Services (PES), green contributions such as levies and taxes, and donations and philanthropic contributions ▸ Develop small grant programmes to deliver funding directly to support local communities in the establishment and management of protected areas.

5.2.3 Other relevant policies

The policies with most relevance to protected area declaration and management are listed in Table 24.

Table 24: Policies and strategies relevant to protected area management

Policy	Notes
National Biodiversity Strategy and Action Plan 2007	Out of date- draft new strategy still under development
PNG Marine Programme on Coral Reefs, Fisheries and Food Security National Plan of Action 2019-2023	Provides an overarching framework for managing PNG's marine environment, including targets and goals for establishment of the marine protected area network.

5.3 Current status and progress towards protected area goals

After a number of years with very slow progress in protected area establishment and management, there has been considerable progress between 2015 and 2022. Some of the most significant advances are listed below. It should be noted that progress is possible only with the enthusiasm and support of the protected areas' communities.

In 2015, the PNG Policy on Protected Areas (Independent State of Papua New Guinea, 2014) was published following cabinet endorsement. This policy is the basis for future expansion and management of the protected area network, and includes the proposal for new protected area types, and a strong continuation of community-based management. CEPA prepared the Protected Areas Policy Implementation Plan (PAPIP), 2018-2028, in collaboration with UNDP between 2016-2017.

After extensive consultation, the Protected Area Bill was drafted. Extensive work has also been completed on accompanying regulations. The new legislation is currently awaiting final approval (Ms. Kumaras Kay Kalim, Director SEP Wing, personal communication, March 2022). The delays in finalising this Bill are causing issues at all levels, from national to community.

Clarification on many protected area policies and procedures has been developed or is currently in process.

5.3.1 Protected area targets

The world's primary targets for protected areas have been the Aichi targets (CBD COP 10, 2010; CBD Secretariat, 2018). New targets for protected and conserved areas are likely to be more ambitious in the forthcoming CBD Conference of Parties: IUCN is proposing a target of 30 percent of land protected,[49] while many scientists believe that at least 50 percent of the earth needs to be conserved (Visconti Piero et al., 2019). PNG's progress towards the Aichi targets has been reviewed in regular reports to the CBD (Conservation and Environment Protection Authority, 2019), and an overall report for the Oceania region, included in the forthcoming state of protected areas (Van Nimwegan et al., in preparation).

Source	Target/goal	Comment
Aichi Target 11	"By 2020, at least 17% of terrestrial and in land water areas and 10% of coastal and marine areas, especially areas of particular importance for biodiversity and ecosystem services, are conserved through effectively and equitably managed, ecologically representative and well-connected systems of protected areas and other effective area-based conservation measures, and integrated into the wider landscape and seascape"	Refer to Section 5.1.1 Status of terrestrial protected areas: Progress towards target but at an insufficient rate Status of marine protected areas: No significant change (Conservation and Environment Protection Authority, 2019).
Proposed 2030 Biodiversity Target 3	Ensure that at least 30% globally of land areas and of sea areas, especially areas of particular importance for biodiversity and its contributions to people, are conserved through effectively and equitably managed, ecologically representative and well-connected systems of protected areas and other effective area-based conservation measures, and integrated into the wider landscapes and seascapes.	
SDG 14 **Life under water**	Target 14.6: By 2020, conserve at least 10% of coastal and marine areas, consistent with national and international law and based on the best available scientific information.	Refer to Aichi Target 11
SDG 15 Life on Land	Target 15.1 By 2020, ensure the conservation, restoration and sustainable use of terrestrial and inland freshwater ecosystems and their services, in particular forests, wetlands, mountains and drylands, in line with obligations under international agreements.	Refer to Aichi Target 11

Note that as well as coverage, there is a focus on ecological representation, connectivity and effective management. In addition to committing to the CBD's targets, PNG has set further targets in the Policy on Protected Areas. A summary of progress towards these targets (Table 25) and the more detailed discussions in later sections show that there is still a lot of considered work to do before these targets are met.

[49] Proposed new targets for the CBD goals include "Target 3. Ensure that at least 30 percent globally of land areas and of sea areas, especially areas of particular importance for biodiversity and its contributions to people, are conserved through effectively and equitably managed, ecologically representative and well-connected systems of protected areas and other effective area-based conservation measures, and integrated into the wider landscapes and seascapes"(Convention on Biological Diversity, 2021).

Table 25: Progress towards protected area targets set in the Papua New Guinea Policy on Protected Areas

Targets	Comment	PNG status 2020
CBD targets		
17/30 percent of terrestrial and in land water areas.	Many proposals in train. Does not include areas conserved by 'other effective means'.	61 protected areas Approximately 4.8% of land area[50] See Section 5.1.1
10 percent of coastal and marine areas.		17 non- gazetted LMMAs make up 0.21% of the EEZ
Areas of particular importance for biodiversity and ecosystem services.		16.7% of the area of Key Biodiversity Areas have some representation in protected areas (Bingham et al., in press)
Effectively and equitably managed.	See section 5.3.6 for PAME assessment. Gender equity further addressed in GEF6-resourced projects.	64% no progress towards effective management 24% some progress, high concern 5% 7% very good progress[51]
Well-connected systems integrated into the wider landscape and seascape	Use as guideline for future development. This was a key consideration in the land/sea planning work (Adams et al., 2017).	No data available
Policy on Protected Areas		
CBD targets as above are supported noting that they include areas under effective management not necessarily within formal protected areas.		As above
10% of territorial waters and the coastline within a variety of marine protected areas by 2025 (CBD targets). Minimum of one million ha (2050 vision).		Unclear
25% of target 2 (i.e., 2.5% of territorial waters) under a combination of no-take zones and zones which allow fishing only by customary landowners for subsistence use by 2025.	Needs of local community fishing to be taken into account, but to be protected from outside exploitation of resources.	17 non-gazetted LMMAs comprise 0.21% of the EEZ.
10% of offshore areas outside territorial waters but within the EEC will be included in national marine sanctuaries by 2025.	To be managed in cooperation with neighbouring countries to maximise conservation of turtles and other marine life.	Seascapes and marine sanctuaries under investigation
Any priority identified terrestrial and wetland areas that are not subject to resource use by customary landowners to become national parks by 2020, along with other high montane areas considered of value to the CARR system.	To maintain connectivity and increase their value, establishment of community conservation areas adjacent to these national parks may be of particularly important.	Not yet undertaken
At least one major, well-managed national park in each of the nine terrestrial ecoregions by 2025. 20 national reserves, wilderness areas and national parks (2050 vision).	These should be adequate in size and should include some of the most valuable areas of endemism and biodiversity in the country. Priority identified areas to be given preference.	Not yet undertaken
80% of all identified vegetation types and landforms to be included in protected areas to at least a 5% level by 2020; a 10% level by 2025.	A variable level of protection is acceptable as small (rare) ecosystems will require a higher proportion within protected areas.	No current figures available. (See Section 5.3.3.) Recent gazettals and proposals in train (e.g., Nakanai Ranges and Torricelli Mountain Ranges) will improve representation.
All rare and threatened and restricted range vertebrate species have at least 30% of their habitat in some form of protected area by 2025.		A 2010 analysis for terrestrial biodiversity in protected areas found 14% of the fauna evaluated are represented within protected areas at greater than 10% (Lipsett-Moore et al. 2010).

[50] Data from PNG registry on protected areas, with minor corrections.

[51] Data from 2017 management effectiveness evaluation – level has improved in some places since this assessment.

5.3.2 Coverage of Key Biodiversity Areas

CBD target 11 included a commitment to protect the most important areas for biodiversity (CBD COP 10 Decision X/2, 2010) and this is also included in the new CBD targets. In an effort to prioritise efforts for conservation, international scientists have put effort into the identification of global priority regions, including the site-specific Key Biodiversity Areas (KBAs).

Agreed international methods for identification and criteria for KBAs are summarised (IUCN, 2016) under the following headings:

- Threatened biodiversity: threatened taxa and ecosystems
- Geographically restricted biodiversity: species, assemblages and ecosystem types
- Ecological integrity
- Biological processes: demographic aggregations (species aggregations during part of the life cycle), ecological refugia, source populations
- Irreplaceability through quantitative analysis.

The coverage of KBAs in protected areas was analysed for the Oceania State of Parks report using protected area data from the WDPA. In PNG, 129 KBAs have been identified (Figure 29). Five of these are large marine areas, totalling 2.5 million ha, and none of these are currently represented in marine protected areas. The remaining 124 KBAs are terrestrial, island and inshore areas, and their combined area totals 10.2 million ha of which 16.7 percent is in existing protected areas. Eight KBAs are mostly (>60 percent) covered in protected areas, and another 15 have less than half within protected areas. A number of KBAs are contained in proposed protected areas and World Heritage sites. These proposals represent high priorities for action.

5.3.3 Representation of ecological diversity and habitats

Protected area networks should ideally cover the range of ecosystems and habitat types. The Policy on Protected Areas states that 80 percent of all identified vegetation types and landforms should be included in protected areas to at least a five percent level by 2020, and a 10 percent level by 2025. No recent analyses are available to indicate how much of this target has been met. It would be desirable for this analysis to be regularly conducted using a standardised method and classification of ecosystems, allowing statistics to be tracked.

The latest available analysis is from 2010, when a group of experts investigated three surrogates for biodiversity representation (Lipsett-Moore et al., 2010) indicated:

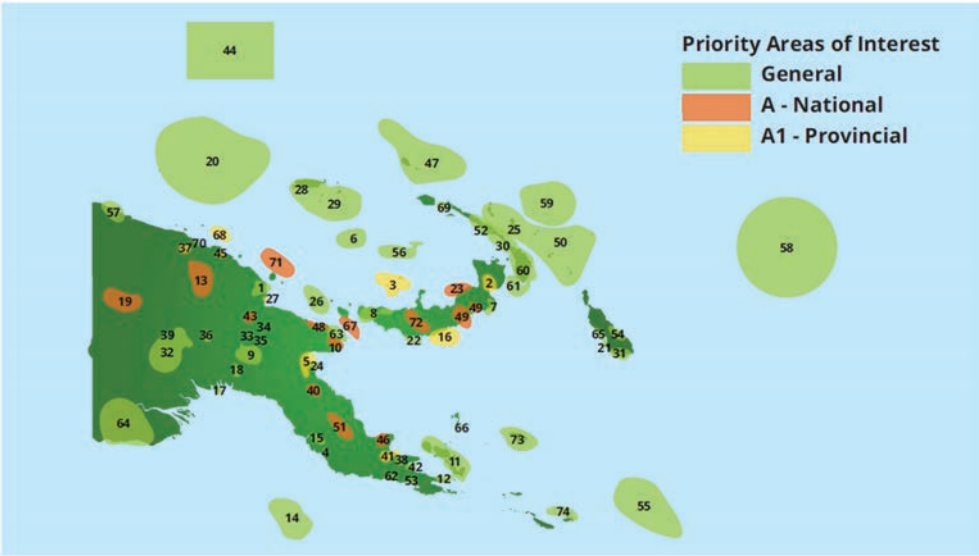
Figure 29: Key Biodiversity Areas which are unprotected (in red).
Source: Bird Life International.

- 59 land systems (abiotic classification), 10 of which were more than 10 percent represented within the existing protected area system;
- 57 vegetation types, of which six were more than 10 percent represented within the existing protected area system;
- 123 restricted range endemic reptiles and 26 mammals (those conservation features with narrow geographic and climatic ranges likely most vulnerable to climate change), of which only 14 percent had 10 percent or more of their habitat protected.

It would be valuable for CEPA to conduct this kind of analysis on a regular basis to measure progress towards conservation goals.

5.3.4 Planning for expansion of the protected area network

To complement the plan for terrestrial areas completed in 2010 (Lipsett-Moore et al., 2010), the National Marine Conservation Assessment aimed to progress towards achieving goals under the CBD and the Coral Triangle Initiative (Government of Papua New Guinea, 2015). The assessment identified gaps in the marine protected area system and priority areas for expanding PNG's MPA network. In 2015-17, a project entitled "Review and Integration of the Terrestrial and Marine Program of Works on Protected Areas" used reserve planning software combined with expert panel recommendations to analyse priorities and propose ways to integrate conservation planning across landscapes and seascapes (Adams et al., 2017) (Figure 30).



1 Adelbert Range, RRE
2 Baining
3 Bali Witu Islands
4 Bootless Bay
5 Buang
6 Circular Reef
7 Coastal Pomio
8 Coastal West New Britain
9 Crater Mt
10 Cromwell Range
11 D'Entrescascau Islands
12 East Cape
13 East sepik WHA
14 Eastern Fields
15 Galley Reach
16 Gasmata
17 Goaribari Island
18 Gulf
19 Hindenberg Wall
20 Island chain northwest of Manus
21 Jaba River
22 Kandrian Coast
23 Kimbe Bay
24 Lake Trist
25 Lihir
26 Long Island
27 Madang Lagoon
28 Manus
29 Manus neighbouring islands
30 Mid New Ireland
31 Mt Balpi catchment area
32 Mt Bosavi
33 Mt Elimabari
34 Mt Gahavisuka
35 Mt Micheal
36 Mt Murray / Mt Giluwe
37 Mt Puru
38 Mt Simpson and Damen
39 Mt Sisa
40 Mt Strong
41 Mt Suckling
42 Mt Thompson
43 Mt Whilhelm
44 Murdogado Square
45 Murik Lakes
46 Musa Plains
47 Musau Group of Islands
48 N Huon Coast
49 Nakanai
50 NI east islands
51 North Owen Stanley
52 Northern New Ireland
53 Orangerie Bay
54 Pirung Eight Islands
55 Pocklington Reek
56 Proposed Whale Sanctuary
57 Scotchio
58 Sea Abyss (plains and hills)
59 Sea basin and plateau
60 Southern New Ireland
61 St Georges Channel
62 Table Bay
63 Tewae, RRE
64 Tonda
65 Torokina Caves
66 Vakuta Island
67 Vitiaz Strait
68 Vokeo Island group
69 Waters north of Kavieng
70 Wewak coast
71 North Coast Madang
72 Whiteman range
73 Woodlark Island
74 Yela Islandipsum

Figure 30: Priority areas of interest
Source: Adams et al. (2017)

In spite of these and previous attempts to identify priority areas, none of the reserve plans have yet been implemented. It should be noted that there is a lot of work to select, identify and propose practical protected areas within the broad areas of identified priorities. These proposals cannot be advanced without full, prior and informed consent of landholders as well as support (or at least lack of objection) from other stakeholders including local level and provincial governments and other interests such as mining and forestry.

Four new protected areas have been gazetted since 2015: Sulei WMA (2,480 ha); Managalas CA (360,000 ha); Lego Forest WMA (50 ha), and Inaina WMA (3967 ha) (James Sabi, personal communication, 2021) and there has been a substantial addition to YUS CA (87,600 ha).

The most significant of the newer protected areas, Managalas CA, protects an important gradient from lowland tropical rain forest to mid-montane forest and grassland at 2,856 m. Another very significant conservation area, the Torricelli Mountain Range Proposed CA, is also awaiting gazettal. This area has active conservation and community programmes and protects critically endangered species including the Tenkile and Weimang tree kangaroos.

Extensive planning and community engagement have been conducted in relation to the management of the Kokoda Track and the proposed surrounding protected area (the Interim Protected Zone). CEPA staff have undertaken many field trips and developed strong community relations, which has developed their capacity and knowledge of the area as well as paving the way for future formalization of protection (Conservation and Environment Protection Authority, 2019).

Detailed work has been undertaken in New Britain towards planning for expanded and new protected areas, including in proposed world heritage areas. These include areas of outstanding biodiversity, cultural and geological importance. Several proposed protected areas have support from landowners and have active management committees and land use plans (Modi, 2018).

Many customary landowners are very passionate about protecting their lands and have been trying for a decade or more to have their lands protected. The Policy on Protected Areas stresses that these people should be supported in their endeavours wherever possible.

As an interim step or an alternative to declaration of formal protected areas, several organizations are pursuing conservation deeds with communities to protect land and water. These provide legal protection and are easier to finalize than gazettals.

5.3.5 World Heritage Sites

In PNG there is one World Heritage Site (Kuk), and seven proposed World Heritage Areas (WHAs), which are on the tentative list (UNESCO World Heritage Centre, n.d.). In 2015, a review was carried out to investigate the tentative sites (Hitchcock and Gabriel, 2015). The review found that:

- No progress had been made on any of the nominations
- Two of the sites, the Trans-Fly complex and the Huon Terraces, were judged as being relatively straightforward to prepare, while the other five will require complex negotiations with customary landowners
- Most of the sites still retained most of the values present in 2006; in some cases, additional values have been recognized or are now better understood
- The range and magnitude of threats to the sites on this list were higher, and the areas were in urgent need of protection
- The seven sites appeared to represent the most important major landscapes with potential for recognition of Outstanding Universal Values, and thus nomination for World Heritage listing for natural values
- Extensions to boundaries, and addition of smaller more specific sites for natural Outstanding Universal Values might be considered.

Since 2015, considerable work has been undertaken in New Britain to further investigate the Nakanai Ranges section of the 'Sublime Karst' proposal (Gabriel et al., 2018). This work has included biodiversity investigations, cultural mapping, community discussions and investigation of livelihood options, including high-value coffee and cocoa. WWF is continuing to work with communities to advance protection of the Kikori River Basin tentative site. The Australian Government is working with the PNG Government through the Kokoda Initiative Program to progress a potential World Heritage nomination of the Owen Stanley Ranges and Kokoda Track region. A detailed report on the values of this area has been completed (Allen Allison, personal communication, 2020), with conclusions and recommendations strongly supporting the outstanding natural and cultural values of the area.

5.3.6 Effectiveness of management

Evaluation of effectiveness

Efforts to improve effectiveness of protected areas have gained momentum in recent years, but the most recent comprehensive data is from 2016-17, when all protected areas and a number of proposed protected areas in PNG were evaluated (Leverington et al., 2017). Overall progress in PNG's protected area system was very limited (Figure 31). Only four protected areas (YUS CA, Torricelli Mountain Range proposed CA, Kokoda Track/IPZ and Kokoda Memorial Park) were rated as achieving very good progress, and another three protected areas were achieving some progress, though there were still some concerns.

In most cases, protected area management committees did not have the systems or support to manage these areas. With few exceptions, there were no staff, support, equipment or resources for management. Most protected areas did not have a budget, or infrastructure and equipment. Participants confirmed that the absence of even the most basic resources severely limited their ability to manage their protected area. Sustainable financing was absent from almost all protected areas assessed: 83 percent of protected areas reported no annual budget; 91 percent reported they had no budget security for the future.

Further assessments have been conducted on a limited number of protected areas and proposed protected areas in later years, and resultant summaries and reports are now available for 69 existing and proposed protected areas.

Management effectiveness

A management planning methodology for PNG, based on the Open Standards approach (Conservation Measures Partnership, 2020) was developed between 2018-20 (Leverington, 2018; Leverington, Peterson, Wolnicki, et al., 2019). Training in the Open Standards methodology and the methodology for producing management plans was undertaken and interim statements of management intent (the first step to management plans) have been completed for 46 protected areas. Recommendations have been made for transitions to new protected area types for the existing protected areas and allocations suggested for proposed reserves (M. Wolnicki, personal communication, 2021). In time, this will result in all current protected areas being transitioned to the new legislation with full support and involvement of the communities, and the development of relevant and useful management plans. If successful, this engagement should be a major transformative step in advancing protected areas. However, this advance will only be achieved if there is follow-up action, capacity building and sustainable financing.

Management planning work has been undertaken for the Kuk WHA and the Kokoda Interim Protection Zone and is being negotiated (Mat Wolnicki, personal communication, 2020), and management plans have been developed for the YUS CA and Torricelli Mountain Range proposed CA. Varirata National Park has a draft Management Plan awaiting review and approval from CEPA.

Community relations

Through consultation for the Policy on Protected Areas and Bill, and management effectiveness evaluation of the protected areas, many communities were contacted by CEPA, whose staff became involved in their protected areas for the first time in many years. This contact helped to mitigate initial feelings of the communities and management committees that they had been totally abandoned by the Government. Since 2014 CEPA staff, with UNDP and other partners, have worked with communities and visited many protected areas, including in remote localities. Two Protected Area Forums have been conducted in 2021 and 2022 to bring a wide range of managers and stakeholders together to discuss issues and form a working protected area network.

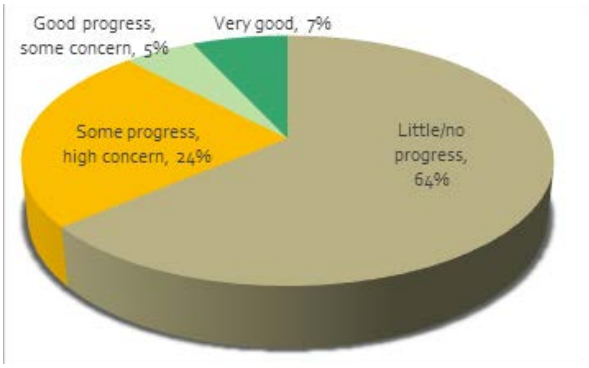


Figure 31: Overall progress in management effectiveness for protected areas in PNG Percentage of 58 assessed protected areas achieving each rating.
Source: Leverington et al., 2017, p. 54

Values

In spite of the low level of management, key values of 70 percent of the protected areas were still considered to be in good to very good condition (Figure 32), and at the macro-level this could be confirmed for most protected areas through examining remote imagery. A total of 275 values were defined, and of these 71 percent were estimated to be in good to very good condition. However, when area was considered, only 45 percent of the protected area system was in good to very good condition. The extent of deforestation and degradation in the largest protected area – Tonda WMA– was of most serious concern, especially since this is also a Ramsar site and part of a potential Trans-Fly Complex WHA. Across the protected area network, 50 percent of values were considered to be stable, with 19 percent declining in condition. In 53 percent of protected areas, at least some important values were declining.

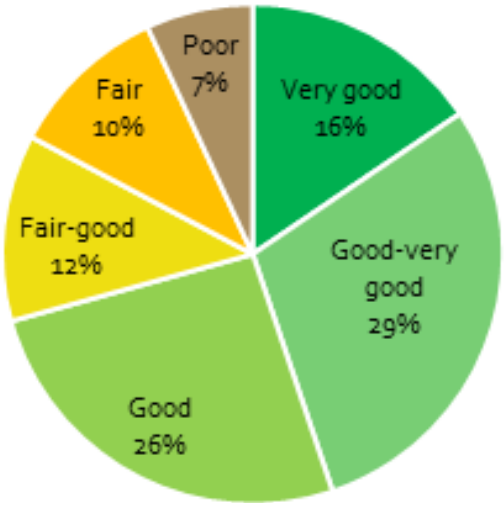


Figure 32: Overall values condition ratings for Papua New Guinea's protected areas (n=58) (Percentage of 58 assessed protected areas achieving each rating).
Source: METT data 2016-17

Projects currently underway will substantially raise the management effectiveness of protected areas. A key activity is working towards economic sustainability through the establishment of a Biodiversity and Climate Fund for Papua New Guinea (Section 5.7.1).

5.3.7 Governance diversity and quality

PNG led the world in the establishment of community-based protected areas with WMA legislation. The first WMA was declared in 1975, as a partnership of local communities and NGOs with the Government. Since then, the vast majority of protected areas in PNG have been owned and managed by customary landowners through management committees.[52]

However, quality of governance is generally very low, as seen in the results from the management effectiveness study (Leverington, Peterson and Peterson, 2017). It was clear from community feedback that a shared governance model is desired and is essential to lift the standard of governance and management. Landowners alone rarely have the capacity to fund and manage their protected areas without assistance. In most cases NGO support was active in the establishment phase, but ceased after a period of time, leaving the community disillusioned and without resources to continue management.

5.3.8 Management capacity

Significant programmes have been implemented over many years in PNG to increase the capacity of the national protected area management agency. As the national coordinating body with responsibility for the protected area network, the Sustainable Environment Programs (SEP) Wing within CEPA has a critical role in implementing legislation, setting policies and standards, supporting implementing partners, and directly overseeing management of national protected areas. The small staff numbers make carrying out these tasks extremely difficult, no matter how many training courses they attend.

The lack of any staff outside Port Moresby combined with a very low travel budget (except for that allocated through external projects) exacerbates the situation. The final evaluation of the GEF 5 project commented that human resources for the protected area network are still inadequate, and further training programmes will not fix this problem. “Although the technical capacity of current staff within the Sustainable Environment Programme (SEP) Wing of CEPA (the Wing responsible for protected area management) has been enhanced through the project efforts, its capacity to translate this enhanced technical capacity to on-the ground implementation of conservation efforts is still very limited due to lack of sufficient staff and lack of adequate budget to pay recurrent operational costs involved in managing protected area” (Carter & Yuave, 2020, p. 5).

It should be stressed that a shared governance model requires commitment and resources to implement, and in PNG the cultural expectation of long-term reciprocal relationships makes this even more important. The capacity of CEPA and other partners for management has been developed through a number of external projects, and staff have worked in partnership with local communities, other levels of government, UNDP, colleagues from other Pacific countries and international consultants. However, capacity remains low, with a very small number of staff employed to cover a wide range of functions.

Ranger training and capacity building has been undertaken in a small number of protected areas and proposed areas, including Torricelli Mountain Range proposed CA, YUS CA, Varirata National Park and Wanang proposed CA.

In addition, many training opportunities have been offered to management committees and communities of existing and potential protected areas since 2020. These include training in adaptive management, financial management, gender equality and development of conservation deeds. This training has been keenly attended, but this is only the beginning of a large task needed across the protected area network.[53]

5.3.9 Provincial governments

Provincial governments have a major responsibility in protected areas, but have played a limited role in the establishment, planning, management and resourcing of protected areas of all types. (Wolnicki et al., 2019). Provincial governments can become directly involved in protected area management by stepping into the following three roles: acknowledging the benefits of protected areas in the province; advocating for protected areas in the province; and mobilizing and coordinating resources for effective protected area management. However, few provincial governments are equipped to take on this role, as many have little understanding of protected areas.

Between 2018 to 2019, work was undertaken in consultation with five provincial governments to clarify the roles and processes, and to define the existing and future administrative mechanisms which can be used (Wolnicki et al., 2019). Mechanisms include the proposed Protected Area Round Tables, impact assessment, provincial government five-year development plans and provincial business planning. Planning at provincial level could involve integration of protected area management, conservation zoning, sustainable land use planning and conservation targets. While CEPA has no staff in provincial offices, some provinces do employ environmental officers. National agencies including the PNG Forest Authority (PNG FA), PNG National Fisheries Authority (PNG NFA) and Department of Lands and Physical Planning (DLPP), have provincial officers representing

[52] A few national parks were established under the formal colonial government but most are not of an adequate standard to be considered as national parks. The exception is Varirata National Park.

[53] For example, recent opportunities for training have been offered by CEPA and UNDP following the 2022 National Protected Area Forum, and in specific areas by the Lukautim Graun Project, Piku Biodiversity Network, and the Treaty Villages Program.

respective interests. MoUs with provincial government provide a good basis for cooperation.

However, much more needs to be done, and dedicated staff within CEPA are needed to develop and sustain strong relationships with officers based in provincial offices. CEPA also needs to maintain strong relations and establish effective coordination with key national government resource agencies.

5.4 Threats to protected areas

Most of the threats to biodiversity (Chapter 3) apply to protected areas. As part of the 2017 management effectiveness assessment, workshop participants rated threats using the standard international threat classification system (Conservation Measures Partnership, 2016) (Salafsky et al., 2008). In addition to these ratings, assessors compiled many interesting comments. This information will be incorporated into future protected area management planning.

The most commonly reported 'level one' threats (Figure 33) include:

- Impacts related to climate change, especially sea level rise, temperature extremes, storms and flooding, and drought (see also Section 3.7)
- Unsustainable hunting or fishing, as previous sustainable practices were being undermined. This was due to increased populations, immigrants, loss of traditional controls, and lack of law enforcement
- Invasive species were an issue in most protected areas, though they were not included in the most severe threats. However, increased settlement, especially by 'outsiders' was a cause for concern, as were increasing populations creating more pressure on all resources.

5.5 Opportunities in protected areas

Supporting communities and livelihoods

Protected and conserved areas offer opportunities for PNG communities, including those in remote areas. Sites that are recognized internationally can be a good focus for funding and attention. The flexibility of modern protected area concepts means that conservation objectives can be achieved along with social and economic progress. This is well recognized with projects based around YUS CA, but scaling this approach up to a national level is challenging. A possible parallel is the Indigenous Protected Area program in Australia, with the associated indigenous ranger programme, which provides a focus for investment, training and employment in remote communities, and has resulted in documented economic and social benefits (van Bueren et al., 2015). The Policy on Protected Areas promotes a protected area network, where a variety of protected area types can be funded, governed and managed by a range of government and non-government entities while sharing standards and a common image.

Training and employment

Benefits that can be delivered from protected area programmes include training and employment.

An important recommendation in the Policy on Protected Areas, which was strongly supported by communities in the management effectiveness study, is the establishment of a national ranger network, and this idea has been taken up in further fora such as the Protected Area Forums in 2021 and 2022, and a meeting in 2018 (Leverington et al., 2018), which recommended three types of ranger programme be explored:

- Rangers who work solely or mostly within one or more protected areas, and whose employment has been specifically targeted at conservation of the area;

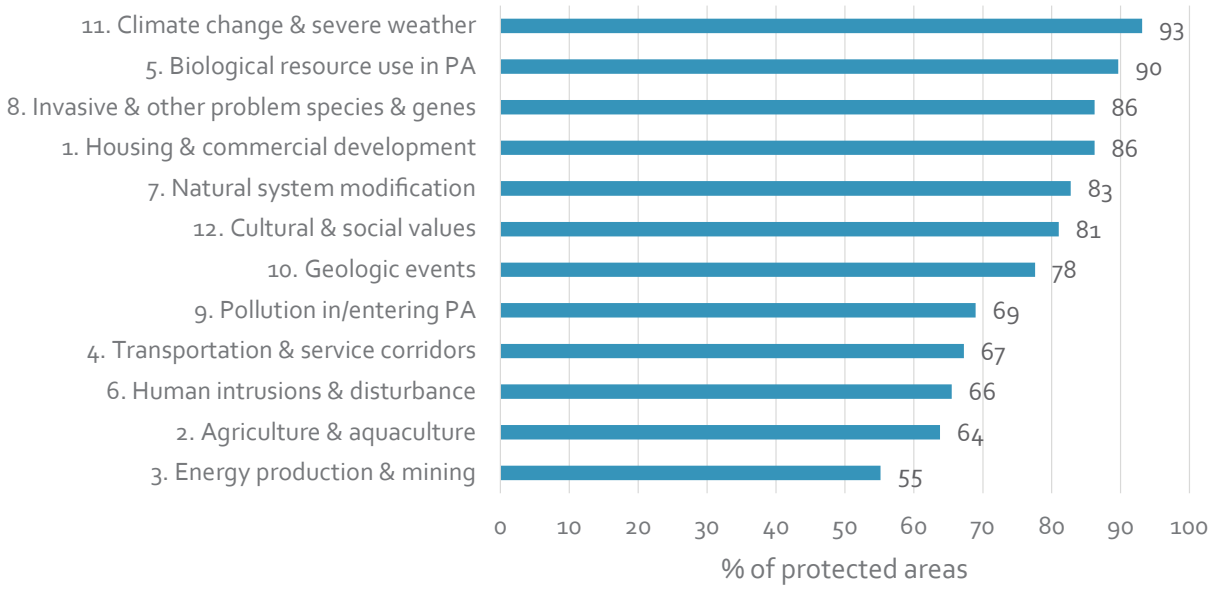


Figure 33: Proportion of Papua New Guinea's protected areas reporting each level 1 threat
Source: Leverington et al., 2017, p. 97

- Rangers, who are employed to undertake a range of tasks within one or more communities, and assist with a range of community needs, including patrolling, sanitation and water supply, facilities maintenance and training; and,
- Rangers who work within their protected area on a mainly voluntary basis – usually customary landowners.

With support and training, an on-ground ranger presence can enable:

- Conservation of biodiversity and cultural heritage, such as through management of invasive species and fire, rehabilitation of degraded areas, and reintroduction of threatened species;
- Effective monitoring of both natural and cultural heritage;
- Engagement with local communities including community education;
- Management of tourism and recreation, and engagement with tourists;
- Patrols and, where needed, effective enforcement of rules;
- Community assistance in sanitation, education, first aid and livelihood activities; and,
- Reinforcement or reinvigoration of communities carrying out customary traditions and obligations, including management of land and waters.

Ranger employment is a way to provide people with meaningful work in local areas, including in remote places. This provides immense social and economic benefits to the individual and the community, including those most 'left behind'. Employment conditions can be tailored to fit local circumstances: in the YUS Ranger programme, part-time employment means that Rangers can be with their families and tend their gardens and other responsibilities in between patrols. Tailored and flexible employment also enhances opportunities for women to enter the Ranger workforce.

Increased ability to gain employment in other places is also a benefit of well-run Ranger programmes. Rangers can provide a boost to conserving and re-invigorating cultural practices and language, for example through working with elders to record their knowledge, working with school children, taking both old people and youngsters into the bush or onto the water). Training and employment of community rangers in the PNG Torres Strait has developed a cadre of people equipped to tackle a range of issues including water and sanitation, building and maintenance of public facilities, emergency and first aid response, and patrols of near-shore waters. The programme has provided options for technical qualifications and career pathways, both for men and women, including people living with disabilities in a very disadvantaged environment (Reef and Rainforest Research Centre, 2019b).

At the Protected Area Forum in 2021, USAID Lukautim Graun Program made a commitment to support the development of a ranger network: to commit up to half a million dollars to develop the structure for the national ranger programme. This should be a professional service – a network and association that helps build the capacity of people who support the communities (M. Knight, personal communication, 2021).

Supporting customs

Many customary landowners feel frustrated that traditions, languages and cultural heritage are being lost and that customary ways of sustainable livelihoods are not respected. Protected area programmes can offer many mechanisms to strengthen cultural heritage and language, including through ecotourism, research and recording, and supporting cultural festivals. For example, the Kundu and Digaso cultural festival at Lake Kutubu celebrates and preserves local culture in a proposed world heritage area and is associated with a number of protected areas in the region.

While in the past, protected areas have not always upheld their promises, there are high levels of opportunity to build on local interest and commitment, to strengthen management, and to deliver many benefits in existing and new protected areas.

Ecotourism

Generally in PNG, the ecotourism potential of natural areas has not been developed, and a Ranger workforce may well be the missing link in providing the reliability and personal security that is needed to attract both overseas and domestic tourists. A session to explore this potential has been held at the 2022 National Protected Area Forum.

5.6 Protected areas that are left behind

In PNG, most protected areas are owned by the customary landowners. They are not on State land being supported by government funding. In fact, most long-established protected areas have received no funding and support. Hence, many protected area communities feel 'left behind'.

The vast majority of landowners and others in protected area communities can be considered in the category of people who are 'left behind' due to their remoteness, lack of infrastructure and facilities including access to even basic education and healthcare, and lack of cash income. Access to healthcare or shops often involves people walking for more than a day on rough tracks before travelling by mission plane or travelling long distances by sea. However, many of these people do own land and have reliable supplies of freshwater, shelter, firewood and basic food, and have very rich and relatively intact cultures and languages.

Protected areas can have (and be perceived to have) negative effects on some of the most disadvantaged communities because the commitment to conserve land means people cannot engage with other opportunities to generate immediate income, such as mining, logging and plantations. In effect, protected areas in PNG are an international public good due to their extremely important roles in protecting biodiversity and ecosystem services contributing to carbon storage. Local people are those who bear the lost opportunity costs, especially for short-term cash income.

5.7 Development partner projects and programmes in protected areas

5.7.1 Global Environment Facility (GEF) - supported projects

Three consecutive projects have been working to strengthen the protected area system in PNG. These projects have been partially overlapping, financed by GEF and implemented by CEPA with support from UNDP.

GEF 4: Community-based Forest and Coastal Conservation and Resource Management in Papua New Guinea (2016-2019)

The preparation for this project was based on extensive reflection about mistakes and issues in previous protected areas projects, summarised as: 1. Competing with industry; 2. Conflicting government mandates; and 3. Agendas of NGOs and lack of benefits to local people.[54] The plan for GEF 4 was intended to take a different approach, with a long-term vision "to establish a national system built upon existing community-based resource management structures, which conserves a comprehensive, adequate, representative and resilient network of priority biodiversity assets that support sustainable economic growth ...This project proposes to deal with community conservation as a resource management issue, and thus align national conservation needs with landowner value systems" (UNDP in PNG, 2011).

Key activities and outputs of the project included:

- Development and approval of the Policy on Protected Areas (see below), after extensive consultation
- Legislative review
- Development of the Protected Areas Bill, including extensive consultation
- Evaluation of the management effectiveness of all protected areas in PNG (Leverington et al., (2017)
- Land-sea conservation assessment (Adams et al., 2017)
- Biodiversity surveys of part of New Britain
- Policy and methodology for biodiversity offsets mechanism. [55]

GEF 5: Strengthening the Management Effectiveness of the National System of Protected Areas (2017-2020)

This project had two components: management capabilities of the PNG State to oversee protected area management; and strengthening the capacity of the State and local communities to cooperatively manage protected area sites and threats to biodiversity.

Much of the work for the first component of the project focused on building the capacity of CEPA and developing management policies and procedures. These included: a framework for systematic capacity development in protected areas; working out details of management arrangements with the various levels of government, including the proposed functioning of provincial protected area working groups; and processes for gazettal of new protected areas and transition of existing protected areas processes and format for management planning.

For the second component, the project was designed to work with partners and landholders to improve conservation efforts at three important conservation landscapes:

- Varirata National Park in Central Province
- YUS Conservation Area between Madang and Morobe Provinces
- The proposed Torricelli Mountain Range Conservation Area between East and West Sepik Provinces and led by the Tenkile Conservation Alliance.

GEF 6: Sustainable Financing of Papua New Guinea's Protected Area Network (2019-2025)

This project aims to reduce the funding gap for PNG's protected areas to improve their management effectiveness and the livelihoods of their customary landowners. A key outcome of this project is the establishment of a Biodiversity Fund for PNG. By the project's end, at least 12 protected areas across the protected area system of PNG will be receiving funds from the Biodiversity Fund, partly as grants and partly as loans when local revenue is expected as a result of the investments.

The project conducted a thorough review of biodiversity trust funds across the world and developed some guiding principles for how such a fund would work in PNG (Wildlife Conservation Society, 2020). Costing estimates for the network were developed and a Finance and Investment Plan (Koch et al., 2021) for PNG's protected areas was produced. Collaboration in the design phase has requested that the fund: be an independent institution, with Government involvement but not Government control, based in PNG, with safeguards to ensure independence; combine biodiversity and climate; and exhibit transparency, accountability, good governance and fiduciary responsibility.

Also as part of the GEF 6 project, the first Protected Areas Forum was conducted in 2021 with over 100 attendees from many PNG organizations (in person plus remote) (Protected Area Solutions, (2021)[56] and the second forum with a greater number

[54] UNDP in PNG (2011). See also useful reflections of the failures of the early programs in McCallum & Sekhran (1996).

[55] A draft offsets policy, training and toolkit have been developed, but still require negotiation and finalisation (Ms Patricia Kila, personal communication, 2022).

[56] The livestream recording of the Forum can be found at https://www.facebook.com/undpinpng and a snapshot on https://www.youtube.com/watch?v=0eEzJZb0r3M.

of attendants and a stronger emphasis on local initiatives was held in June 2022. These will support stronger partnerships and cooperation in protected area management. Due to Covid-19 delays, the field components of the GEF6 project only began in 2021 and are yet to show clear outcomes, but work in conjunction with WCS and other partners are being commenced in the Sepik Wetlands of East Sepik Province, the Mt Wilhelm area in Simbu Province and Kimbe Bay in West New Britain Province.

GEF Small Grants Programme (1994 and ongoing)

These grants aim to provide financial and technical support to projects that conserve and restore the environment while enhancing people's well-being and livelihoods. This facility was negotiated by CEPA and is managed by UNDP to screen and disburse small grants (up to US$50,000) to community-based organizations and NGOs that need support in their conservation initiatives. In addition to the programmes discussed above, the GEF Small Grants Programme has supported many protected area and biodiversity projects. These grants can be powerful incubators to enable community-based management to establish the necessary capacity to self-organize and then to apply for other funding. Examples of protected area-related small grants include publications produced for the community at Torricelli Ranges.

5.7.2 Other agencies and partners

Japanese government (JICA) Project for Biodiversity Conservation through Implementation of the PNG Policy on Protected Areas (2015-2020)

The JICA project was embedded in CEPA's protected area office for five years and assisted in many aspects of management. The goal of this project was to set up effective management of the Protected Areas Network by applying the models of protected areas management. Activities for this project focused on Varirata National Park and the surrounding Sogeri Plateau, and Bootless Bay marine area (Conservation and Environment Protection Authority, 2019). In 2020, the Government signed an agreement for the first "Conservation Easement" – that is, the conservation of mangroves and marine ecosystem estuary protection in Bootless Bay, a step towards the establishment of the area as a marine protected area (Kay Kalim, personal communication, 2021).

Lukautim Graun PNG Biodiversity Project[57] (partners include USAID, CI, TNC, CEPA, TKCA, CELCOR, WCS).

This large project funded by USAID is focused on the Bismarck Range Forest Corridor, a 200,000 ha corridor of intact forest along the Bismarck Range in the Eastern Highlands, Chimbu, Jiwaka and Madang provinces. However, the project is working across six provinces, with a wide range of partners and a wide range of activities supporting protected areas, livelihood improvement (including market chain work), biodiversity conservation, awareness-raising and gender equity. They are also working with provincial governments to ensure alignment with policies, including inviting them to activities and raising awareness of the community conservation activities.

Outcomes of this project to date have included (Maurice Knight pers. comm., 2022):[58]

- 250,000ha land protected (using conservation deeds)
- 214 people trained in community legal matters
- 283 people trained in community-based natural resource management
- 171 people trained in family-based businesses.

BIOPAMA (European Union)

The Biodiversity and Protected Areas Management Programme is financed by the European Union and jointly implemented by the International Union for Conservation of Nature (IUCN) and the Joint Research Centre of the European Commission. The project supports capacity development and also runs a small grants programme.

YUS Landscape (Tree Kangaroo Conservation Programme)

This is a partnership between the PNG Tree Kangaroo Conservation Association and Woodland Park Zoo. Tree Kangaroo Conservation Project (TKCP) works with local communities in the remote Huon Peninsula to protect the endangered Matschie's tree kangaroo and its habitat. The programme helped to establish the country's first Conservation Area and works with communities and government to address local needs including livelihoods, health, and education. An endowment fund provides a sustainable base to additional fundraising efforts.

Torricelli Mountain Range Proposed Conservation Area (Tenkile Conservation Alliance) (Funding from a range of donors including GEF, IUCN, UNDP, CEPA, Perth Zoo, Birdlife International, and European Union).

This programme began in an effort to save the Tenkile tree kangaroo from extinction and is now progressing towards the gazettal of a large area of rainforest. The team onsite works with more than 1,200 people from 50 villages. Work includes livelihood projects, training, cultural celebration, research and monitoring, and trialling alternative sources of protein to compensate for the moratorium on hunting tree kangaroos. Hunting moratoriums are negotiated for a number of threatened species: the Tenkile (CR), Weimang (CR) and Grizzled (V) tree kangaroos, the northern glider (CR) and the black spotted cuscus (CR).[59]

Managalas Conservation Area (assisted by Norwegian Rainforest Foundation)

This CA was gazetted in 2017 after a twenty-year effort to negotiate its protection with landholders and all levels of government. Community members and

[57] See also Facebook page.

[58] Maurice Knight, speaking at second PNG Protected Area Forum (2022).

[59] CR: critically endangered; V: vulnerable. For further explanation, see IUCN Red List.

other PNG experts led the work. This was supported in part by the Norwegian Rainforest Foundation.

Wanang proposed Conservation Area[60]

In this area, people associated with the Binatang Research Centre (BRC) have been working with communities for over 20 years. The first activity was to educate people about their environment and conservation, and subsequently nine clans signed a conservation agreement (later two clans withdrew and entered into logging agreements).

Critical Ecosystems Partnership Fund (CEPF)

CEPF works with people in biodiversity hotspots through small grants to civil society (community-based groups, non-governmental organizations, academic institutions and the private sector) for projects that contribute to biodiversity programmes. The eastern islands of PNG are part of the East Melanesian Islands Hotspot and communities have received funding for protected areas through this initiative.

World Wildlife Fund (WWF)

WWF actively works for the Kikori River Basin, a proposed WHA. A Conservation Blueprint was prepared using Marxan analysis to identify and prioritize areas of special conservation consideration and the cheapest options to manage protected areas in the region. WWF has worked with local communities on conservation programmes and community awareness in the basin to find the balance between development and conservation for many years.

Australian Government support to Kokoda and World Heritage Areas

Much of Australia's engagement to date has been through the Kokoda Initiative, in line with the PNG-Australia Joint Declaration on the Preservation of the Kokoda Track. A Road Map for Potential World Heritage Nomination: Kokoda Track and Owen Stanley Ranges was undertaken to assist the PNG Government to determine the arrangements, resources, information, consultation, operational context, and timeframe to attain the information required to make an informed decision on whether to pursue the option of World Heritage nomination, and the steps to be taken in the event that a nomination proceeds (Conservation and Environment Protection Authority, 2019). CEPA has undertaken extensive consultation with communities all along the Track and surrounding areas to determine the extent and character of the proposed protected area. An agreement was signed in 2019 between CEPA and the Queensland Parks and Wildlife Service, supported by UNDP, to assist in Varirata National Park and other localities with business planning and ranger training and mentoring.

Other ranger programmes

Known formal ranger programmes working both inside and outside formal protected areas include people working at Torricelli Mountain Range Proposed CA, YUS CA, Kokoda Trail, Pokili WMA, Torres Strait Treaty Villages, Piku Biodiversity Network (Kikori Basin), Varirata NP, Pirung WMA, WCS Wasman in Bismarck Range, and Wanang proposed CA.

5.8 Gaps in protected area programmes and risks of not improving the situation

Though a number of useful planning exercises have been undertaken, there has been little progress in expanding the protected area network to meet PNG's commitments under the CBD, with less than 5 percent of land declared as protected area, compared to the 2020 commitment of 17 percent of effectively managed protected areas. In the marine area, it is difficult to report, but figures of formal protected areas remain extremely low.

While some excellent initiatives are being implemented, management of protected areas needs to be improved across the entire network, or risks for biodiversity are dire, considering that these are places where protection should be guaranteed. Very high biodiversity values, combined with high development pressures, mean that failing to take action to implement the Policy on Protected Areas is a very high risk. There are also socio-economic risks, especially concerning those left behind, relating to the remote location of many existing and potential protected areas, linked with the lack of alternative opportunities for better livelihoods, infrastructure and facilities.

An additional risk of failing to act on establishment and ongoing management of protected areas is the progressive loss of community support and willingness to cooperate in conservation-oriented projects.

Much effort has been put into capacity building for CEPA staff, but numbers are still too low to be effective. There has been inadequate capacity building overall with provincial staff, management committees or rangers, who provide the on-site human resources for most protected areas.

5.9 Recommendations for protected areas

Recommendations and a programme for strengthening PNG's protected area network can be found in the Policy on Protected Areas (Independent State of Papua New Guinea, 2014), Protected Area Implementation Plan (CEPA, 2018), the action plan for capacity building (Peterson et al., 2019), an institutional and regulatory review (Bito, 2021) and recommendations from the management effectiveness study. In the report for the 2016-17 evaluation, recommendations from communities were collated and analysed for each of the evaluation topics, and the most common recommendations were:

[60] Information courtesy of Dr F. Diem at the 2021 Protected Area Forum (Protected Area Solutions, 2021)

- **Increase the input of all levels of government** in relation to funding and resourcing, while also encouraging other non-government sources and local income generating activities, including tourism;
- **Implement management actions**, including the development of management plans, establishing management committees, creating, training and appropriately resourcing an on-ground ranger workforce, clarifying boundaries and providing basic facilities and equipment;
- **Develop the skills and capacity** of the protected area managers (including committees, rangers and administrators) and develop and implement relevant awareness raising and education programmes that build support for the protected area;
- **Improve communication** among all relevant stakeholders including the customary landowners of the protected areas and all levels of government and non-government organizations; and
- **Improve protected area legislation** and improve enforcement capacity.

Since 2017, initiatives in all these areas have increased, but there is no 'quick fix' to bring PNG's protected area management up to a functioning level, nor to expand the network to meet targets. The context of geography and culture means that PNG's protected area network will be extremely time-consuming and expensive to establish, but the rewards of doing so will be great. A long-term, sustained effort needs to continue at many levels – national, provincial and local communities across the country, including in remote locations.

5.9.1 Finalize and implement the Protected Areas Bill

The Protected Areas Bill is key legislation for all types of protected areas, and it needs to be finalized along with regulations, forms, and other administrative mechanisms as listed in the Bill. Key features of the new legislation need to be explained in understandable language (in at least English and Tok Pisin) and widely promoted to groups including central government staff of all relevant agencies, provincial and local level governments and appropriate court personnel, industry groups and NGOs and CBOs, civil society, management committees and landowners.

5.9.2 Enhance partnerships and cooperation in protected areas

To capitalize on the good energy and intent from a wide range of organizations working in PNG's protected areas, better partnerships and coordination are needed among various levels of government, NGOS, aid agencies and communities. More needs to be done to better share lessons learned, avoid duplication, and lever off existing and planned projects. Government and development partners should continue to build on successes and support positive initiatives, to avoid the risk of successful projects becoming failures, as has been seen countless times in PNG when external support has been withdrawn.

The PNG Protected Area Forum offers a good opportunity to bring practitioners together to share stories and develop common ground. As CEPA has limited capacity to support this initiative, alternative ways of hosting it may be needed in the future, though involvement of CEPA staff and government officers is critical.

A compendium of grants and other sources of funding for protected area proposals and management would be helpful for communities.

5.9.3 Expand the protected area network and develop World Heritage site proposals

Guidelines for expanding the protected area network are included in the Policy on Protected Areas. Explanations of the proposed new protected area types, including processes for selection and designation, have been prepared as part of the GEF 5 project. In addition, solid work has been completed in identifying the most important areas for biodiversity and connectivity on land and sea (Adams et al., 2017). There have been recent advances with the gazettal of several new protected areas, involving the agreement to protect the marine area in Bootless Bay (Kay Kalim, personal communication, 2020). Processes are well underway for the establishment of several other significant protected areas, such as those in New Britain, the Torricelli Mountains, and the Kokoda Interim Protection Zone.

There is now a large backlog of protected area and WHA proposals that need to be further investigated and negotiated. This task is well beyond the current meagre resources of the SEP wing. In some areas, time-consuming social mapping or tenure clarification is needed, and all proposals need to be researched and documented, with mapping and boundary clarification. This endeavour needs further support from experts both within PNG and the international sphere. However, employing international consultants could be prohibitively expensive on the scale required. Possible avenues for support are to formally seek assistance from university students and staff, other research agencies, SPREP, NGOs, PNG conservation groups, and expert volunteers from IUCN World Commission on Protected Areas. Private enterprise may also be prepared to assist if this was appropriate. A cooperative working group could tackle the tasks under the direction of CEPA, so rapid progress could be made. Community negotiations, however, are best undertaken by CEPA and provincial government staff.

An important step in securing any kind of agreement is free, prior and informed consent of the landowners. More guidance on this matter is needed. Regular updates of maps and of statistics, including ecological representation, are required for reporting purposes, to better plan for reserve expansion.

5.9.4 Resource CEPA's protected area section and provincial government in protected area management

An enhanced workforce for the Sustainable Environment Programs (SEP) Wing of CEPA is

recommended to fulfil the statutory responsibilities under the Protected Areas Bill and international agreements. Functions which need allocated staff include management planning, direct consultation and liaison with provincial governments and protected area management committees, field operations, resource management, monitoring, enforcement and community education and awareness raising.

Recommended strengthening includes:

- Appointing more qualified staff with appropriate capacity;
- Prioritising capacity building of both existing and new staff;
- Proving essential support by supplying adequate infrastructure, equipment, systems and funding for basic operations;
- Developing procedures and plans – e.g., strategic plans, business plans to direct and motivate staff; and
- Appointing a minimum of two to four staff to be stationed in each geographic region of PNG (Highlands, Southern, Momase and Islands) to service the protected area needs of provinces.

5.9.5 Improve capacity for on-ground (and water) management through protected area management committees

If the community-based protected area model is to be effective, assisting communities in establishing or re-establishing and maintaining effective management committees is a critical mechanism for success. This needs to be done for all existing and proposed protected areas, and it would be desirable to have reliable base funding to bring all management committees up to a functioning level and to establish basic management operations.

Through CEPA and UNDP experiences in the GEF 4 and GEF 5 projects, recommendations were made outlining an approach to strengthen management committees (Leverington, Peterson, Peterson, et al., 2019). A six-step process was proposed to empower the management committees of the protected areas (Figure 34).

Management committee members are essentially leaders in conservation management, and this role requires the capacity and confidence to lead people, to engage with government bureaucracy and other outside organizations, obtain and manage finances and other resources, develop plans and communicate well. In some cases, committees will also be involved in managing paid staff.

> *"Free Prior Informed Consent (FPIC) is a critical requirement for working with communities. Land and resources are owned by the people and they must be properly consulted. Many different partners are applying FPIC. At a national level, we need to look at all of them and have standard FPIC process with basic elements of a step-by-step process, that can then be tailored to fit the local context."*
> *(L. Seri, Protected Area Forum, 2021)*

> *"It is important to have in place an empowerment programme for CBOs and committees. We need to have motivation for our communities, capacity building (technical and organizational frameworks) so they can participate meaningfully. We need to link CBOs to opportunities... We must develop pathways to link conservation to natural resource management to livelihood and gender."*
> *(Cosmas Apelis, TNC, Protected Area Forum, 2021)*

Figure 34: Process for empowering management committees

5.9.6 Undertake livelihood projects and other support

Livelihood projects that provide long-term support to protected area communities are essential in sustaining enthusiasm for ongoing conservation. GEF 4 and GEF 5 projects focused on trialling livelihood projects. Now, the challenge is to learn from these experiences (Modi, 2018). Key recommendations include:

- Review livelihood projects undertaken within protected areas and identify the key components of best practice that can underpin future investment in protected areas. Based on current information, this may include:
  - Work closely with protected area communities to prioritise projects
  - Engage fully with all groups within the protected area, including women, youth and special interest groups
  - Implement participatory planning, using results chains that clearly identify intended consequences and assumptions of proposed projects
  - Utilize local CBOs and NGOs to facilitate long-term engagement and support to build relationships and commitment within the community to conservation and possible expansion of their protected area
  - Support protected area management committee members to enable them to work collaboratively with all levels of government to raise awareness about individual protected area projects and ensure compatible planning outcomes that support rather than hinder conservation outcomes
  - Build capacity within the community to apply for, manage and report on grant funding for livelihood projects.
- Support communities to apply for grant funding. This will require increasing the capacity of the Small Grants programme to enable staff to raise awareness of the programme and provide relevant support.

More details about possible benefits from conservation are provided in Biodiversity, Section 4.8.8.

5.9.7 Build capacity of field staff in protected area management through additional employment, resourcing and training opportunities; and support the development of a national ranger network

Field staff including rangers are critical for implementation of protected area management in the field. Capacity development of this group of people is a high priority. As the number of Ranger and volunteer ranger programmes in PNG increase, interest is growing in establishing a stronger network of rangers, possibly linked to international ranger organizations.

5.9.8 Foster useful and relevant protected area management planning

With CEPA, support and train local organizations and management committees in protected area management planning. This process was started in 2019-2020 and needs to be continued to build on the training and experience of CEPA staff. The management planning process needs to be undertaken with full engagement of landowners and other local stakeholders and will be a productive mechanism to build commitment at local level.

Chapter 6.

Forests and forestry


UN
DP

6.1 Context for forests and forestry in Papua New Guinea

Papua New Guinea's (PNG's) forests are globally significant in terms of ecosystem structure, function and biodiversity; and essential for the many PNG residents who rely on forest products for subsistence and for income. However, the rate of forest clearing and degradation is of serious concern. Rising pressure from population increase, more threats from land-based activities and impacts of climate change are all driving the need to take steps to protect and conserve the nations' forests for current and future generations (Government of Papua New Guinea, 2015).

The forests of PNG are recognized as one of the most significant areas of intact forest in the world (CEPA and SPREP 2020). In addition to biodiversity, PNG's forests contribute to the world's carbon storage (Laurance et al., 2012; Makarieva and Gorshkov, 2015). Together with the forests of West Papua, they represent the third largest areas of intact tropical forest in the world and are globally and regionally significant for their role in absorbing greenhouse gases and regulating regional weather patterns (Steffen, 2015). While PNG's per capita emissions are low, its carbon-dense forests are its biggest contributor to the world's climate system. Tropical forests are the largest terrestrial carbon stores and active sinks globally (Dudley et al., 2010), and scientific research now estimates that natural forests have a more significant role in climate regulation than was previously considered: deforestation can trigger adverse climate impacts that will have local effects first and then possibly longer-ranging impacts (Makarieva and Gorshkov, 2015).

A number of methods have been used to categorise the forests of PNG and determine changes in forest cover (Bryan and Shearman, 2008, 2015; Shearman and Bryan, 2011). This report uses the nomenclature from the official government reports on land use change (PNG Forest Authority, 2019). While 14 types of forests are recognized in PNG (Figure 35, Table 26), three forest types are most widespread, constituting about 78 percent of all the forest. These are low altitude forest on plains and fans, low altitude forest on uplands, and lower montane forests (PNG Forest Authority, 2019).

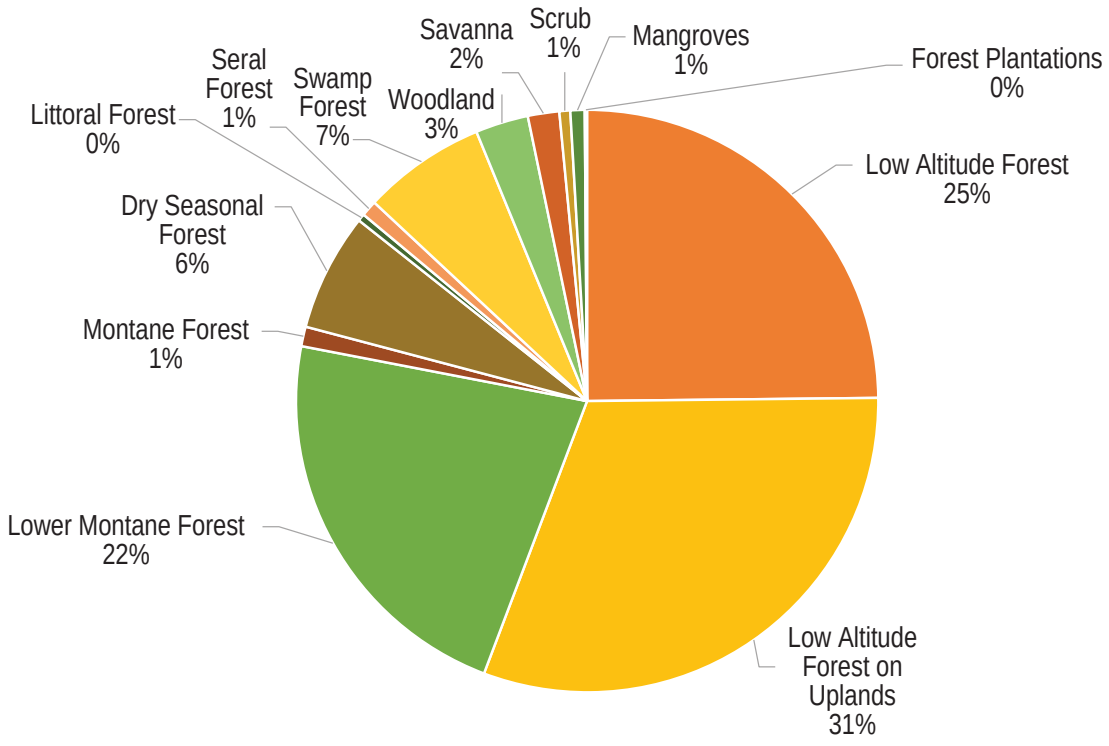


Figure 35: Percentage of forest types in Papua New Guinea
Source: (PNG Forest Authority, 2019)

Table 26: Forest classification in PNG and short description
Source: PNG Forest Authority, 2019

Vegetation Type	Short Description
Low Altitude Forest on plains and fans	Elevations <1,000 m with gentle slopes.
Low Altitude Forest on Uplands	Elevations <1,000 m with rough terrain.
Lower Montane Forest	From 1,000 – 3,000 m elevation.
Montane forest including montane coniferous forests	Elevations >3,000 m.
Dry Seasonal Forest	Restricted to southwest PNG in a low-rainfall area (1,800-2,500 mm).
Littoral Forest	Dry or inundated beach forest.
Seral Forest	River line, upper stream, river plains and volcano blast area.
Swamp Forest	Forest area inundated with freshwater either permanent or seasonal.
Woodland	Low and open tree layer.
Savana	Low (< 6 m) and open tree layer in low rainfall area with a marked dry season.
Scrub	Community of dense shrubs up to 6 m.
Mangroves	Along coastline and in the deltas of large rivers.
Forest Plantations	Planted forests are composed of trees established through planting or seeding by human intervention.

Forest clearing and degradation in PNG has been a matter of serious concern for decades, and PNG has now committed to phasing out all forest clearing by 2030.[61] This is part of its commitments to climate change action as well as to protecting biodiversity and landholders. For more information on how action on forest clearing is related to climate change, please see Chapter 7. The latest available data (Figure 38) shows that the rate of deforestation has now slowed but remains well above that experienced from 2000-2010. Similarly, information about degradation and logging exports indicate that this is slowing, but that logging rates are still very high, considering that the Government has committed to phasing out raw log exports by 2025 (see Section 6.3.2).

6.2 Legislation, agreements and government policies in forest management

Customary landowners own most forest land in PNG, with many areas inaccessible to formal forest management. Nationally significant legislation and policy relating to the broad context of environmental management including forestry is outlined in Chapter 2. The PNG Forest Authority (PNGFA) is the lead agency responsible for the planning and sustainable use of forestry resources in PNG. In addition to providing for the development and management of forest resources, the Forestry Act 1991 sets out the allocation of forest rights and responsibilities through Forest Management Agreements between customary landowners and the government.

The National Forest Plan details the national and provincial governments' intentions in management and utilization of forest resources. Though revisions have been proposed, the current official plan is dated 1996. The revised version (2013) was not approved.

[61] In 2021, PNG signed the Glasgow Leaders' Declaration on Forests and Land Use, which states that "'We therefore commit to working collectively to halt and reverse forest loss and land degradation by 2030 while delivering sustainable development and promoting an inclusive rural transformation" (127 signatories).

The legislation (Table 27), national policies and agreements, plans and strategies (Table 28) and international agreements (Table 29) for PNG with respect to forests and forestry are summarized below.

Table 27: Legislation in PNG with respect to forests and forestry

Legislation	Comments
Forestry Act 1991	Principal forestry legislation for PNG. Provides for the conservation, development and management of forest resources, and the allocation of forest rights and responsibilities through forest Management Agreements between customary landowners and the government. Requires the development of a National Forest Plan.
Environment Act 2000	Administrative mechanism for environmental impact assessments (EIAs) and guidelines to assess the impacts on the environment from the proposed use plans to determine project approval and permitting. The Act restricts the rights of landowners for projects of "national significance".
The International (Fauna and Flora) Trade Act 1978	Control of exploration and importation and introduction of flora and fauna from the sea, whether dead, alive, their by-products, parts or derivatives.
United Nations Paris Agreement (Implementation) Act 2016	Gives effect to implementing PNG's obligations under the Paris Agreement through the Nationally Determined Contribution and ensures REDD+ (and related activities) are enforceable.

Table 28: Policies and agreements with respect to forests and forestry

Policies and Agreements	Comments
National Forest Policy 1991	Covers the requirements of the forest industry, research needs, forest training and education, and forest organization and administration. Requires the Forest Authority to prepare a National Forest Plan to provide a detailed statement of how the national and provincial governments intend to manage and utilize the country's forest resources. Central to the policy are its concepts of environmental conservation and protection, the decentralization of decision-making, and the full recognition of the people's rights to their natural heritage.
National Forestry Development Guidelines 1993	Provided an implementation guide for elements under the Forestry Act 1991. It highlights sustainable production, domestic processing, forest revenue, training and localization, review of existing projects, forest resource acquisition and allocation and sustainable development.
National Forest Plan 1996	All forestry projects are expected to abide by the Plan. Provincial forest management plans are also required and must be prepared by Provincial Forest Management Committees. The NFP was developed (as required by the Forestry Act 1991) for the period 1996-2001. Since the Forestry Law and its subsequent amendments cover all aspects of PNG forest policy the NFP was not extended.
National Forest Development Program (1996-2001)	Required under the Forest Act but now expired.
Draft National Forest Plan 2013	Not approved to date. Requires improvement to address the lack of current data, prescriptions for bringing logging operations into line with the Logging Code of Practice, or restoration of logged areas. Consultations have been undertaken for the revisions of guidelines for provincial forest plans by PNGFA.
Forestry Regulations 1996 and 1998	Provide the legal status for the implementation of many of the requirements specified under the Forestry Act 1991 (as amended).
Logging Code of Practice 1996; Revised 2021	Guide to logging operations.
Forest Management Agreements under the Forestry Act 1991	FMAs are entered into between customary landowners and the government. Through these agreements landholders sell cutting rights to the PNGFA in exchange for timber royalties, and last for 50 years. FMAs require a complex 34 step process, including broad consultation, open and competitive bidding process, and approval that is dependent on the past reputation of the company seeking the timber permit.

Policies and Agreements	Comments
Forest Clearance Authority	Required to clear forests to make way for any agricultural or other land use development, including roads that will be greater than 12.5 km in length and/or where the amount of proposed clearance of natural forest for the project is greater than 50 hectares in total. Special Agricultural Business Leases that fall under FCAs are of particular concern.
Timber Rights Purchase (TRP) 1951	Introduced under the Forestry Ordinance in 1951 as a mechanism by which the State could purchase timber rights from customary landowners and then control the harvesting of timber through the issue of timber permits and licences to forest companies. The Forestry Act allowed TRPs and LFAs that were in existence in 1991 to continue in force. Significant areas are still logged under TRPs.
Local Forest Areas (1971)	Introduced in 1971 under the Forestry (Private Dealings) Act 1971 to give customary landowners the right to sell their timber direct to the forest industry, subject to the approval of the ForestryMinister. LFAs cover almost one million hectares and do not have expiry dates.
National Forest Stewardship Standard for PNG 2019	Sets principles, criteria, indicators and verifiers by which all forest operations in PNG can be judged. This standard is applicable to all forest operations seeking Forest Stewardship Council certification within PNG. The Forest Stewardship Council (FSC) is an international independent, not for profit, NGO established to support environmentally appropriate, socially beneficial, and economically viable management of the world's forests.
National Climate Compatible Development Management Policy (NCCDMP) 2013	National-level goals for carbon neutrality of 50% by 2030 and 100% by 2050. Includes mitigation and adaptation components. Mitigation focuses on: carbon neutrality by 2050; GHG emissions mitigated in the land use, land use change and forestry (LULUCF) sector; and, development that is climate-compatible through efficient, low greenhouse gas emitting infrastructure and technology. The policy identifies mitigation actions to be implemented in these key sectors and outlines the roles of national, provincial and local governments.
National REDD+ Strategy (2017-2027) and associated documentation	Outlines activities as priorities, including strengthening forest management and enforcement.
National strategies for downstream processing of forest produce 2020-2024	
National strategies for afforestation reforestation in PNG 2020-2024	

Table 29: International agreements related to forests and forestry

International agreements related to forests and forestry	Intent and Comments
United Nations Framework Convention on Climate Change (Non-annex I Party) and associated protocols (e.g., Kyoto Protocol, Paris Agreement)	Convention to combat desertification and mitigate the effects of drought through national action programmes that incorporate long-term strategies supported by international cooperation and partnership arrangements.
International Tropical Timber Agreement (2006)	Aims to promote the expansion and diversification of international trade in tropical timber from sustainably managed and legally harvested forests and to promote the sustainable management of tropical timber producing forests. Projects for the management for forests in PNG are funded through this mechanism.
Non-legally binding Instrument on all types of Forests	Series of policies and measures at the international and national levels to strengthen forest governance, technical and institutional capacity, policy and legal frameworks, forest sector investment and stakeholder participation, within the framework of national forest programmes.
The International Tropical Timber Organisation (ITTO)	PNG, as a member to the ITTO, recognizes the ITTO definition on illegal logging of timber and wood products trade.

6.3 Current status and progress towards forest goals

Goals specifically relating to forests and forestry are summarised in Table 30.

Table 30: International targets relating to forests and forestry

Source	Target/goal	Comment
Aichi Biodiversity Target 2: Biodiversity values are integrated	By 2020, at the latest, biodiversity values have been integrated into national and local development and poverty reduction strategies and planning processes and are being incorporated into national accounting, as appropriate, and reporting systems.	Status: Moving away from target (Conservation and Environment Protection Authority, 2019).
Aichi Biodiversity Target 4: Sustainable production and consumption	By 2020, at the latest, governments, business and stakeholders at all levels have taken steps to achieve or have implemented plans for sustainable production and consumption and have kept the impacts of use of natural resources well within safe ecological limits.	Status: Moving away from target (Conservation and Environment Protection Authority, 2019).
Aichi Biodiversity Target 5: Habitat loss halved or reduced	By 2020, the rate of loss of all natural habitats, including forests, is at least halved and where feasible brought close to zero, and degradation and fragmentation is significantly reduced.	Status: Moving away from the target (Conservation and Environment Protection Authority, 2019) Habitat loss is a serious concern but the rate of loss is slowing.
Aichi Biodiversity Target 7: Sustainable agriculture, aquaculture and forestry	By 2020 areas under agriculture, aquaculture and forestry are managed sustainably, ensuring conservation of biodiversity.	Status: Moving away from target (Conservation and Environment Protection Authority, 2019).
Proposed 2030 Biodiversity Target 10	Ensure all areas under agriculture, aquaculture and forestry are managed sustainably, in particular through the conservation and sustainable use of biodiversity, increasing the productivity and resilience of these production systems.	
Proposed 2030 Biodiversity Target 14	Fully integrate biodiversity values into policies, regulations, planning, development processes, poverty reduction strategies, accounts, and assessments of environmental impacts at all levels of government and across all sectors of the economy, ensuring that all activities and financial flows are aligned with biodiversity values.	
Proposed 2030 Biodiversity Target 2	Ensure that at least 20% of degraded freshwater, marine and terrestrial ecosystems are under restoration, ensuring connectivity among them and focusing on priority ecosystems.	
SDG Goal 15	Protect, restore and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification, and halt and reverse land degradation and halt biodiversity loss. By 2020, promote the implementation of sustainable management of all types of forests, halt deforestation, restore degraded forests and substantially increase afforestation and reforestation globally.	Forests are under pressure from a range of developments and from climate change effects. Since the dominant vegetation type in PNG is forest, both the macro and subsistence economies are reliant upon use and/or conversion to agriculture. The target is not being achieved (Conservation and Environment Protection Authority, 2019).

PNG has developed an accurate, reliable, cost-effective and transparent Monitoring and Measurement, Reporting and Verification system through a PNG Satellite Land Monitoring System that reports changes in forest degradation and deforestation (Conservation and Environment Protection Authority, 2019; PNG Forest Authority, 2019). The methodology (the National Forest Inventory) was documented and has been implemented (Conservation and Environment Protection Authority, 2019). Initial findings were published in a number of papers (11 at the time this report was prepared) in a peer-reviewed journal (University of California Press: Papua New Guinea's Forests – A Special Collection). However, the NFI is no longer funded. The NFI will continue when funds are available to complete the assessment (PNGFA, Personal Communication, 2020).

Lack of compliance, both monitoring and enforcement, within logging operations is recognized as an issue and CEPA has recommended a full review of forestry operations to determine the extent of illegal operations and the sustainability of current practices (Conservation and Environment Protection Authority, 2019).

As large-scale logging operations decrease and control on commercial operations is increased, there is a concern that small logging operations may become a greater threat to PNG's forests. This threat would be exacerbated by increased populations and demand for timber (Global Green Growth Institute & CCDA, 2021a).

6.3.1 Land use and forest clearing

Land use analysis showed that in 2015, 78 percent of PNG's land was classified as forest; nearly 11 percent crop land; 5 percent grassland; 4.6 percent wetlands, and less than 1 percent settlements (Figure 36) (Climate Change Development Authority, PNG, 2017; Gamoga et al., 2021; PNG Forest Authority, 2019). Provinces with the highest proportion of forests are Gulf (91.2 percent), West Sepik (90.6 percent), and West New Britain (85.3 percent). Provinces with higher population densities have a lower proportion of forests. The most comprehensive and interactive land use maps are available at PNG Climate Change and Forest Monitoring Web-portal.

Figures concerning the extent and causes of forest disturbance vary. This report uses the data up to 2017 from the PNG Forest Authority (Government of Papua New Guinea, 2022c), which is used as the basis for the reducing emissions from deforestation and forest degradation programme (REDD++)[62], and must be rigorous and consistent to meet international standards. Updates to 2019 are obtained from the Implementation Roadmap for the AFOLU Sector (Global Green Growth Institute & CCDA, 2021a).[63] Changes to forest cover distinguish between forest degradation (e.g., as a result of commercial logging), and forest deforestation where a forest is replaced by other land cover types (e.g., cropping, urban expansion) (Babon and Gowae, 2013). Special Agricultural Business Leases (SABLs) have forest clearance authorities so that they can be cleared for plantations (generally oil palm). However, these areas are often cleared for their timber and then left unplanted.

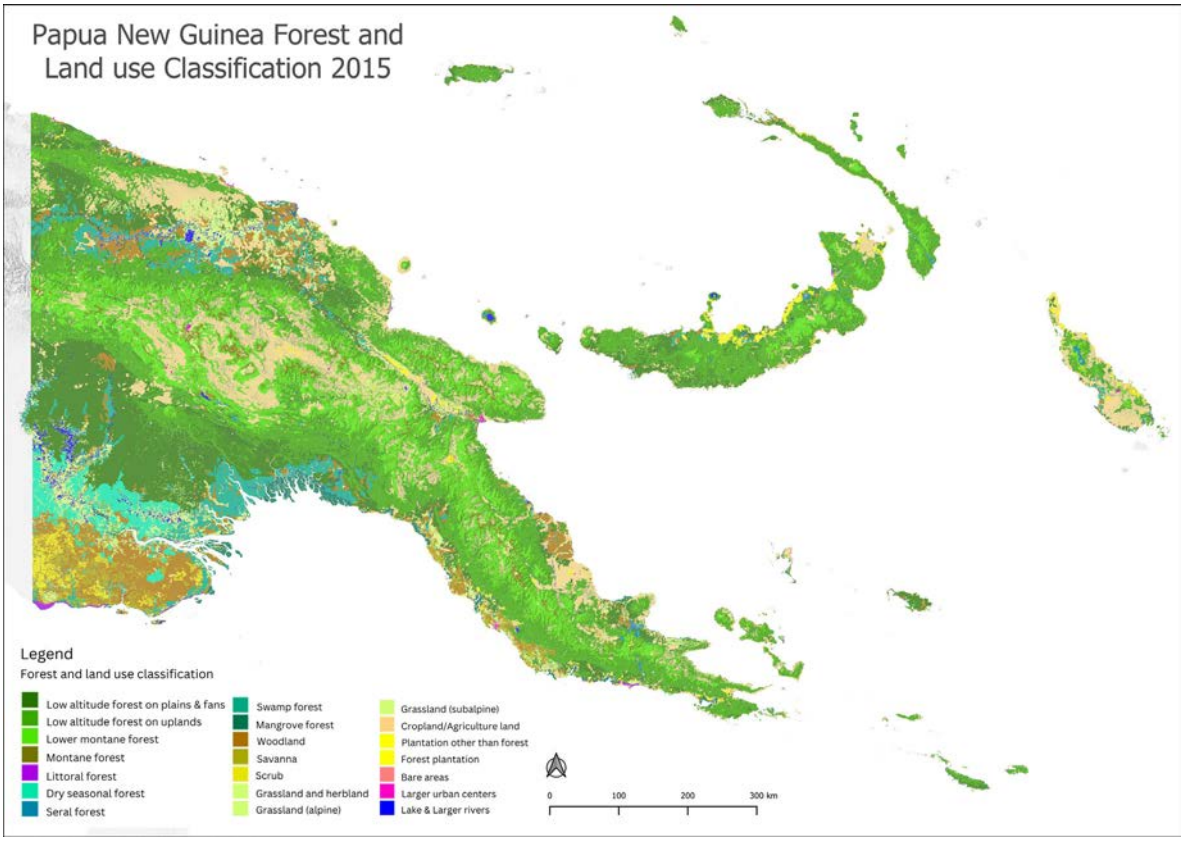


Figure 36: Forest and land use in Papua New Guinea 2015
Source: PNG Forest Authority (2019)

[62] REDD++ stands for reducing emissions from deforestation and forest degradation, as well as conservation, sustainable management of forests and enhancement of forest carbon stocks.

[63] While online sources show more recent statistics and data, this information has not been verified and should be interpreted with some care. However, sites such as the

Just over 76 percent of forests in PNG are mapped as having had no significant human disturbance (Figure 37). In spite of this, clearing of forests has been identified as the most serious direct threat to PNG's biodiversity, with selective logging ranked third (T. H. White et al., 2021).

Between 2000 and 2019, just over 350,000 ha of forest was cleared and converted to other uses (PNG Forest Authority, 2019). The average annual area of deforestation between 2011 and 2015 (30,700 ha), was significantly more than between 2001 and 2005 (PNG Forest Authority, 2019). This annual rate slowed to under 20,000 ha by 2019 (Global Green Growth Institute & CCDA, 2021a) (Figure 38). Almost all deforestation (99 percent) was due to land use conversion from forest land to cropland. Subsistence agriculture is reported to be the most significant driver of deforestation (responsible for over about two thirds), followed by oil palm plantation development (30 percent) (PNG Forest Authority, 2019). The highest rate of deforestation between 2011 and 2015 was in the West Sepik Province.

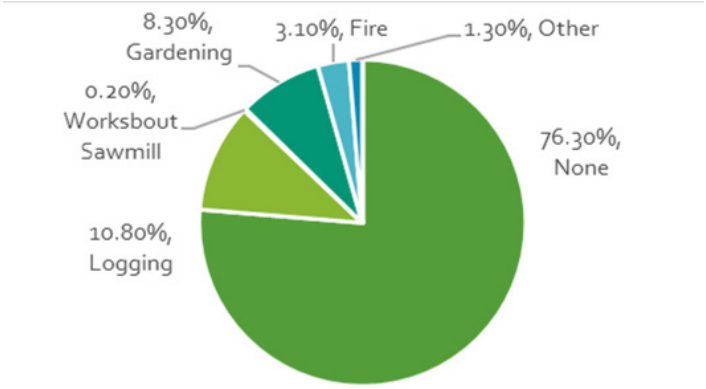


Figure 37: Human impact on forest land in Papua New Guinea

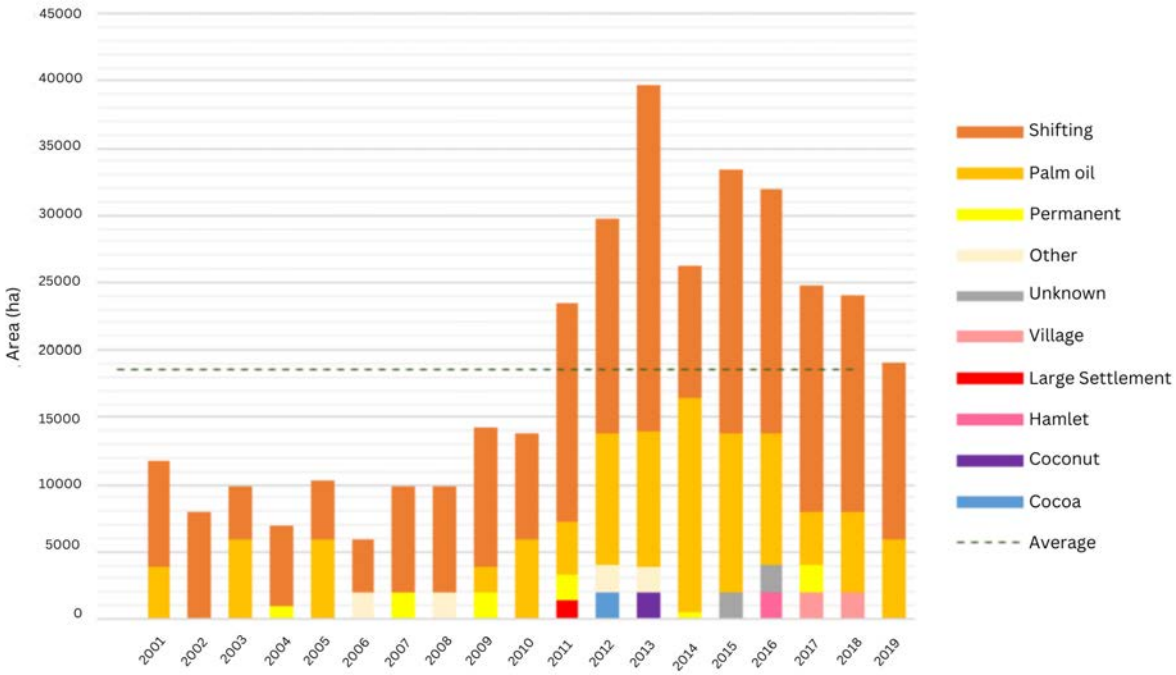


Figure 38: Estimated annual rates of deforestation in Papua New Guinea (2001-2019)
Source: (Global Green Growth Institute & CCDA, 2021a) from draft LULUCF Assessment, 2016-2019

6.3.2 Logging and forest degradation

Logging activities mostly occur in the low altitude forest on plains and fans, and low altitude forest on uplands, and are concentrated in forests in the 0-500 m altitude zone (CEPA and SPREP, in press; PNG Forest Authority, 2019). Most forest logging between 2000 and 2015 was in the provinces of Western, Gulf, West Sepik, West and East New Britain (PNG Forest Authority, 2019), while export licenses in 2021 were highest in West and East New Britain, New Ireland, and West Sepik (PNGi, 2022). In the official statistics, logging is regarded as degradation and clearing is mostly attributed to agricultural expansion. However, experts report that between 2002 and 2014, 81 percent of total forest change (deforestation and degradation) and 41 percent of total deforestation were caused by logging and occurred inside active logging operations (Bryan & Shearman, 2015).

Forest degradation occurs in a number of different concession types – Timber Resource Permits (52 percent); Forest Clearance Authorities (in SABLs as a supposed precursor to agricultural expansion) and Timber Authorities (16 percent); Forest Management Areas (25 percent), and Local Forest Areas (seven percent). Logging was responsible for 92 percent of the forest degradation. The annual area of forest degradation more than doubled from 2001 (87,600 ha) to its peak in 2011 (200,050 ha) (Global Green Growth Institute & CCDA, 2021a). Since its peak, the rate slowed to 100,000 ha in 2019 (Figure 39). Nearly 3 million ha of forest was mapped as becoming "degraded" between 2000 and 2019 (Global Green Growth Institute & CCDA, 2021a). This represents about 10 percent of the country's forests.

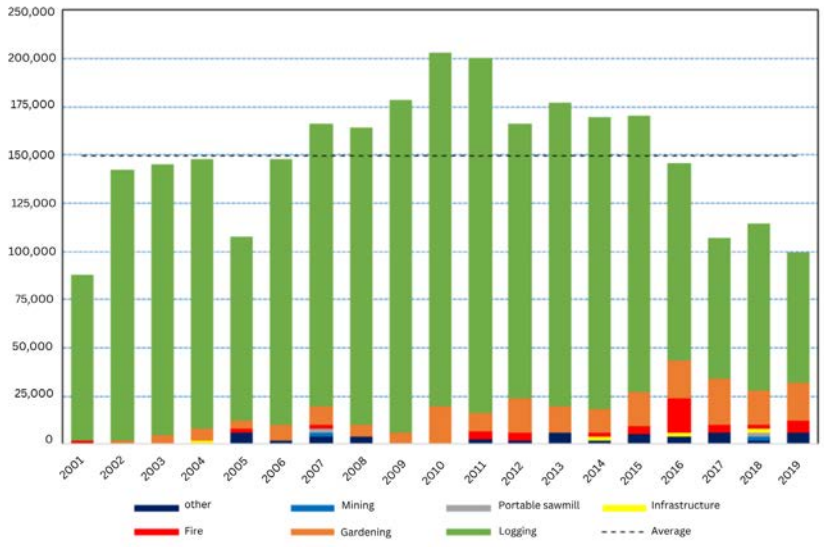


Figure 39: Annual rate of forest degradation in Papua New Guinea, 2001-2019 (area in ha)
Source: Global Green Growth Institute & CCDA, 2021a

Slowing rates of both degradation and deforestation are positive for biodiversity conservation and for PNG's progress towards a carbon-based economy, but experts warn that "it is important to understand that these gains and future progress are not permanent; nor is it inevitable that they will continue. They appear to have been driven by a range of policy and market forces, and these have the potential to fluctuate, as demand for land in PNG increases along with the domestic population and global demand for timber and agricultural products" (Global Green Growth Institute & CCDA, 2021a, p. 32).

Figure 40: Forest concessions and plots
Source: PNG Deforestation Alerts and Monitoring System (PNG FA, n.d.)

6.3.3 Timber harvest and exports

PNG is the largest exporter of tropical round logs in the world, exporting 84 percent of these logs to China (ITTO, 2021). The Government has committed to phasing this out by 2025, with two supporting policies: an end to new timber permits and permit renewals, and an end to new log export licenses for foreign owned logging companies. Logging volumes have declined since the peak in 2018 but are still high: 2021 levels were only 3.6 percent lower than 2020 (Figure 41). Forest clearance permits for agricultural leases (SABLs) were the source of 28 percent of these logs, including the largest export source which is from an oil palm concession in New Britain (PNGi, 2022).

Research by NGOs reveals several serious concerns about the capacity of PNG to meet its commitment to phase out round log exports (Act Now! for a better PNG, 2022):

1) Many timber permits and agreements granted in the past do not expire until well after 2025 (though information is difficult to obtain, it appears some permits apply until the 2050s)

2) Though the Government states that no new timber export licences have been granted since 2020, it is claimed that Log Export Monitoring data gathered for the PNGFA shows that new logging operations were responsible for over 20 percent of all unprocessed log exports in 2021.

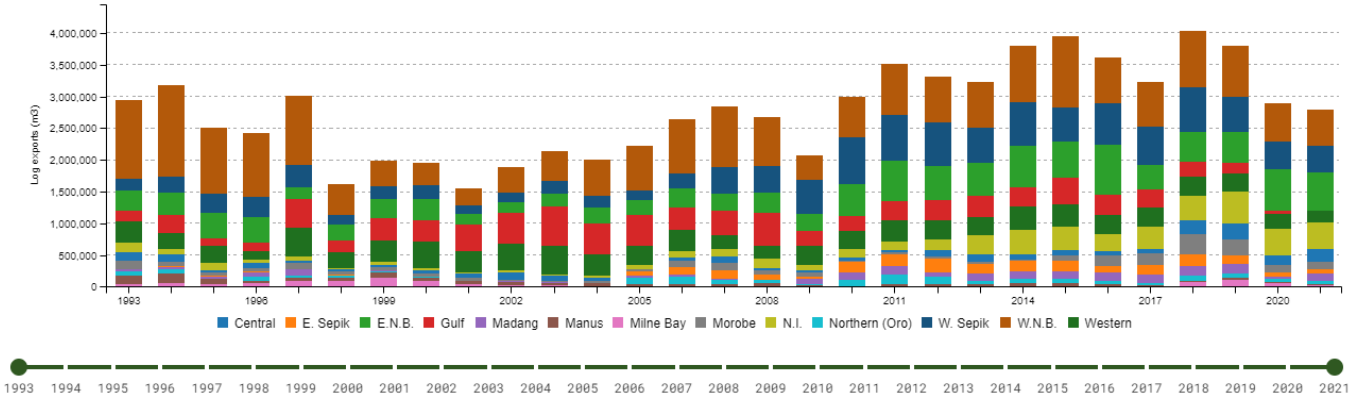


Figure 41: Exports of round logs from PNG, 1993 to 2021
Source: PNGi 2021

Logging in PNG is intended to use "selective harvesting", which removes only larger, saleable logs and leaves remaining trees standing. If practiced professionally over a long cycle, this harvesting aims to be sustainable. However, logging causes forest structural damage (10 to 80 percent) and canopy loss during selective harvesting of selected timber species. If the logging cycle is too frequent or small logs are harvested, the damage is greater. Fragmentation of understorey vegetation and disturbances to microclimate will occur. In addition, forest degradation and deforestation also cause soil damage and increases vulnerability to fire. Of concern are declines of sensitive species and the introduction of exotic species and pathogens.

Bryan and Shearman (2015) noted that repeat harvesting in shorter timeframes than the 35-year cutting cycle prescribed by the 1996 Logging Code of Practice had been widespread, with estimates that annual timber production in PNG needed to be at least 1.6 to 1.8 times lower than current production levels to be sustainable. Logging also facilitates forest invasion by human activities, logging roads, fires, hunting of wildlife and deforestation. Erosion, sedimentation and landslides are serious concerns.

Corruption and fraud have dogged the forest industry in PNG for decades and have been the subject of numerous investigations, court cases and reports (Davidson, 2021; Gabriel & Wood, 2015; Laurance et al., 2012; Lawson, 2014; Mousseau, 2017). These especially applied to the practice of logging within SABLs, and allegations were confirmed by a Government Commission of Inquiry (Numapo, 2013), which led to the cancellation of some of the licenses. Both environmental and social impacts, including greater violence and hardship for women, have been serious (Cannon, 2020). In 2021, the Chair of the PNGFA Board stated that "logging companies in PNG continue to blatantly disregard forest laws without fear of the repercussions" (Wokasup, 2021). Though Section 103 of the Forest Act requires a Public Register to be kept by PNGFA with critical information relating to the commercial use of forests, no register exists and no information on current logging operations is publicly available from the PNGFA (Act Now! for a better PNG, 2022).

Increasing timber legality is an identified action in the Roadmap for achieving PNG's climate goals (Section 6.3.5), and PNGFA is considering applying for Forest Stewardship Council (FSC) certification to ensure timber legality and sustainability (Abe Hitofumi, pers. comm., 2022).

6.3.4 Reducing Emissions from Deforestation and Forest Degradation (REDD+)

REDD+ is aimed at supporting countries to reduce or cease deforestation, which has huge benefits for reducing the emission of carbon into the atmosphere and for contributing to biodiversity conservation. The initiative is a financial mechanism and uses "a market-based approach to reducing greenhouse gas emissions from deforestation and forest degradation. The difference between the carbon stock of forests under historical deforestation and forest degradation rates and the actual C-stock achieved by forest conservation measures will be compensated financially. The difference in C-stocks is provided by a system of measurement, reporting and verification." (Köhl et al., 2020).

The REDD+ mechanism involved donors and recipients, with the structure of the partners shown in Figure 42 (Shin et al., 2022).

REDD+ is a critical mechanism in PNG to develop a structured national approach to tackle both direct and indirect drivers of forest change, and to "catalyse transformational change within the forest and land use sector towards a new responsible economy with lower GHG emissions, stronger long-term economic growth and community livelihoods and the effective conservation of biodiversity and ecosystem services". This can also ensure that forest resources are used in a sustainable and equitable manner (Government of Papua New Guinea, 2017).

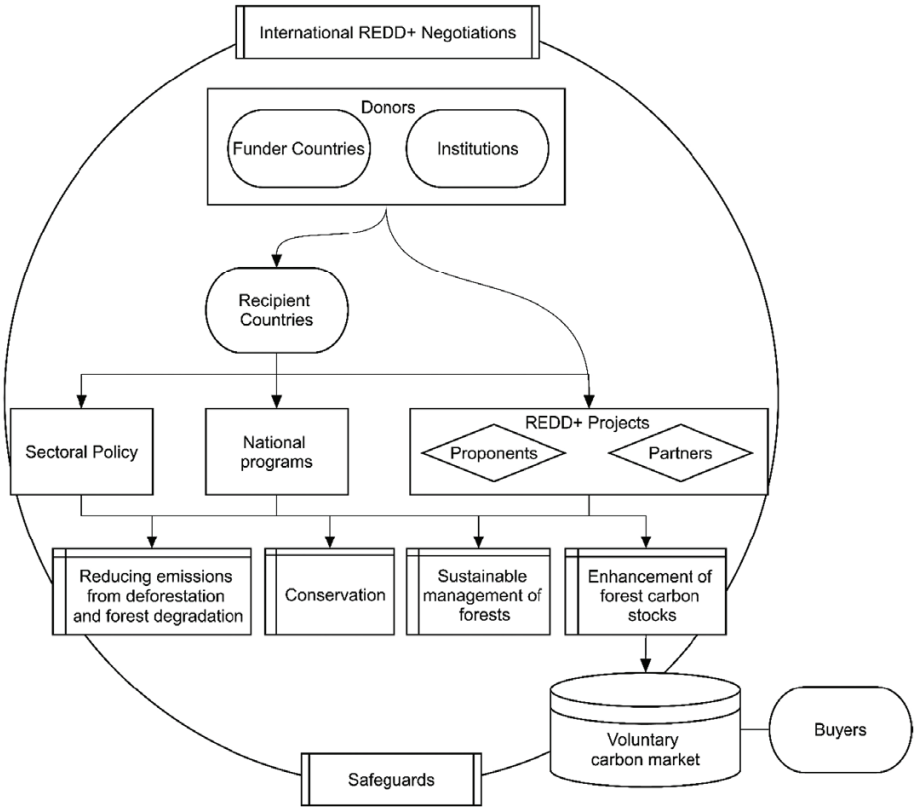


Figure 42: REDD+ architecture

Site-level pilot tests were undertaken for REDD projects, and learnings from these have been applied to develop the current government approach.[64] PNG has followed the Paris Agreement in moving away from site-based projects to a coordinated national approach that supports improved land use planning and management, national-level measurement and reporting, national policies and processes. These are implemented across all government sectors, subnational governments, civil society and the private sector (Government of Papua New Guinea, 2017). Details of the preparation for REDD+ are included in Section 7.3.3.

6.3.5 Climate action: forestry pathway[65]

The forestry sector is a very significant direct pathway in the reduction of greenhouse gas (GHG) emissions for PNG. The actions outlined in PNG's revised Nationally Determine Contributions (NDC) under the forestry pathway are estimated to delivery 54,000 GgCO2e in emissions reductions and removals by 2030 against 2015 levels (Global Green Growth Institute & CCDA, 2021a). These are based on targets and actions identified within the National REDD+ Strategy (Government of Papua New Guinea, 2017), REDD+ Implementation Plan as well as actions within the SDG13 Roadmap (Government of Papua New Guinea, 2020b) and NDC Implementation Plan (Climate Change and Development Authority, 2021) and key sector documents such as the National Reforestation Strategy 2020. The actions in this pathway are included in the recommendations for this chapter and their contribution is further discussed in Section 7.3.3. As well as the emissions reductions, these actions are likely to:

- Increase market access for PNG timber and price premiums for sustainably produced timber;
- Enhance production from planted forests and linked investment in downstream processing;
- Plant over 220,000 hectares of trees, including 60,000 hectares of environmental planting, 60,000 hectares of community planting and 100,000 hectares of commercial plantations;
- Create an estimated US$70 million in wood products within 10 years and a future asset worth of nearly US$2 billion if effectively maintained and harvested;
- Increase options for improved approaches to forest management and sustainable revenue generation from the sector; and

[64] See Section 7.3.3 for brief discussion of early issues with REDD.

[65] See Climate Change (Chapter 7) for more context.

- Reduce timber export levels by 30 percent against 2015 levels, leading to a fall in export taxes, levies and other royalty payments, some of which may be offset by changes in the tax regime (PNG's recent increases in export tax have offset the higher than proposed fall in export levels) as well as increases in export value of timber that is recognized as having higher production standards. (Global Green Growth Institute & CCDA, 2021a, p. 50)

6.4 Development partner projects and programmes in forests and forestry

6.4.1 Reducing Emissions from Deforestation and Forest Degradation (REDD+)

Details of development partner support for this programme are included in Climate Change Actions (Section 7.3.3), but are also highly relevant to forestry.

6.4.2 Sustainable forestry and legality

The PNG forest industry has been focused on harvesting natural forest for round log exports (NEPCon 2017). Logging of native forests has provided significant input into the PNG economy. In 2015, the forest industry contributed to around 9 percent of the GDP (PNG Forest Authority, 2018). Between 2009-2018, 34 million cubic metres of logs were exported. In 2016, domestic processing accounted for only 2 percent of export volume (Kama, 2019). (Further details on the economic impact of forestry in PNG will be found in the economic section of the CCA).

The latest available assessment of the legality risks for PNG in 2017 determined a Timber Risk Score for PNG of 3/100 (NEPCon, 2017). Key areas of concern relate to legal rights to harvest, taxes and fees, timber harvesting activities, third party rights, and transport and trade. This follows a number of allegations of malpractice, corruption, inadequate monitoring and poor enforcement within the forestry sector for a number of years (Laurance et al., 2012; Lawson, 2014; Mousseau, 2017). A recent report (Hoare, 2020) has suggested that PNG has made little progress in addressing these issues. The report identifies that an effective system for traceability and verification of legality is still not in place. Regulatory mechanisms are reported to be weak and there remains a lack of transparency in forest resource allocation and widespread corruption.

In the past, the PNG Government has promoted Special Agricultural Business Leases (SABLs) to allow the clear-felling logging to enable broadscale agriculture. It is reported that the clearing under SABLs enables illegal logging to take place, and that the customary landowners' consent for the issuing of the SABLs was frequently not provided, resulting in no residual rights for landowners (Bryan and Shearman, 2008; PNG Forest Authority, 2018).

While there has been a moratorium on issuing further SABLs, the existing leases are still in place. It is estimated that 4 million ha of closed canopy forests were available for harvesting under existing SABLs (Climate Change Development Authority, PNG, 2017). Recognizing that over 90 percent of the SABLs failed to realise the original intent of the lease, the PNG Government revoked a number of licences in 2017 (Department of National Planning and Monitoring, 2020).

Positive policy directions are undermined by some of the logging concessions under the Logging Code of Practice that prescribed repeat harvesting within the 35-year cutting cycle. A key priority for forest management in PNG is the re-entry of logging in too short a period (Bryan and Shearman, 2015). Annual timber production needs to be at least 1.6-1.8 times lower than current production levels to be sustainable (Bryan and Shearman, 2015).

In addition, it is reported that in the decade between 2009-2018, 55 percent of log exports came from the Timber Rights Purchase agreements and Local Forest Areas rather than under the Forest Management Areas. The Forest Management Areas are set up under the Forestry Act 1991 and were intended to provide full owner consent and engagement as well as sustainable harvesting levels (NEPCon, 2017).

While a ban on the commercial export of round logs was planned for 2020, this has been extended to 2025 (June 10, 2020: The National). Since 2014, proposals for such a ban have been in place (Climate Change Development Authority, PNG, 2017), with the expectation of timber processing within PNG to bolster the domestic timber industry. However, log export revenue is said to be an important source of revenue for the PNG Government, and there is pressure from the timber industry against the implementation of this policy.

Improved surveillance and compliance are required to improve sustainable use and a site-specific forest monitoring system for logging operations is recommended for verifying legality of operation annually (PNG Forest Authority, 2019).

As the CCDA summarized: Without interventions to address the current situation and provide viable alternatives to either continuation of a business-as-usual scenario or the closing down of commercial logging [,] the current situation will continue. There also remains the potential for a rapid increase in clearing as an unintended consequence of threats to cancel 'undeveloped' SABLs. (Climate Change Development Authority, PNG, 2017).

6.4.3 Community forest projects

The PNG Medium-Term Development Plan sets a goal to "build a forestry sector that is sustainable and highly profitable" (Department of National Planning and Monitoring, 2018). The importance of community forestry in achieving this goal is explicitly recognized through one of the nine sector strategies, namely to "promote community forestry activities with the view of empowering rural communities and alleviating poverty".

NGOs have initiated a number of projects to work with local communities to implement small-scale harvesting and processing with mobile sawmills (ACIAR, 2017). Further projects have been undertaken by the Australian Centre for International Agricultural Research (ACIAR) to understand the context and barriers to achieving community forestry.

The results of these projects have highlighted the need for multi-clan cooperation to address issues of scale and negotiations required to develop positive economic outcomes (ACIAR, 2017; Temple et al., 2016). In addition, the existing forestry legislation and policies do not consider the small-scale transactions involved with eco-forestry as opposed to large-scale commercial forestry (Holzknecht, 2017). It is understood that the review of the Forestry Act will take these issues into consideration (PNGFA, personal communication, 2022).

6.4.4 Reforestation

PNG has made commitments to revegetation projects. The Operation Painin Graun na Palanim Diwai (PNGFA) aims to plant 800,000 ha of trees for commercial, domestic, and conservation purposes by 2050. All PNG provinces are expected to contribute 1,100 ha of tree area per annum. The project aims to encourage customary landowners to secure land suitable for tree planting, including in and around their villages, or in previously abandoned areas such as logged over forests.

6.5 Effect of forest management on people especially those 'left behind'

Forests are a vital resource for local communities, particularly in the remote rural areas of PNG, providing food, fibre and building materials (CEPA and SPREP 2020). The foreign ownership of many of the SABLs has disenfranchised some of the clan groups, who have not been fully aware of their rights when negotiating agreements (PNG Forest Authority, 2018). Ownership of customary land, boundaries of different clan or family properties, and the right to speak for a group are often unclear and at times extremely controversial.

As outlined in other sections of this report, many rural people in PNG have rich natural resources but are cash poor. When development interests offer customary landowners with money and jobs in return for surrendering their land, people are faced with difficult decisions and may not be aware of the full range of options available to them and the consequences of their decisions. As few services are provided by the government, the need for cash may override the concern that people will be worse off in the long-term, when they have to purchase food and other commodities (Crane, 2015). People need to pay for health care and education services, and people often believe that these will be exchanged for the loss of the land and the subsequent loss of biodiversity and ecosystem services (Modi, 2018). Forest clearing, at least in some areas, has an additional negative impact on women, who lose access to vital resources of food and fuel. For example, in New Britain, women report an increase in tensions and gender-based violence due to forest clearing pressures, as women have traditionally been custodians of the land and are reluctant to see it cleared, while some of the men are more keen to see immediate cash (Cannon, 2020).

6.6 Development partners and programmes in Forestry

Strengthening capacity in the agriculture and land-use sectors for enhanced transparency in implementation and monitoring of Nationally Determined Contributions (NDCs) under the Paris Agreement in PNG (FAO/CCDA PNG) (2019-2021).

PNG prepares reports to the UNFCCC under the Paris Agreement Enhanced Transparency Framework (ETF) with strengthened agriculture and land use sector components including inventories of emissions by sources and sinks, and information necessary to track progress against priority actions identified in PNG's NDC for these sectors. Project outcomes included:

- Institutional arrangements for coordinating information and data from the agriculture and land use sectors into ETF processes and reports enhanced;
- Best practices on ETF reporting processes, information gathering, system infrastructure, and methodologies in the agriculture and land use sectors disseminated to relevant priority sectors;
- Reporting on inventories of emissions sources and sinks and emissions reduction activities from agriculture and land-use sectors strengthened; and
- Monitoring and reporting of selected NDC priority adaptation actions in the agriculture and land use sectors strengthened.

Enabling community forestry in PNG (PNGFA and ACIAR) 2017-2022

The project team are designing and testing tree-based livelihood systems for family-focused community-based reforestation and identifying the methods by which family-focused community-based reforestation can be scaled-out to a landscape level. The project will also identify and pilot test institutional arrangements – including policy recommendations which improve access to formal timber markets based on natural and secondary forests.

Enhancing value added products and environmental benefits from agroforestry systems in PNG and the Pacific (ACIAR) 2015-2021

Key outcomes for this project include:

- Improving financial status of: customary land holders, by providing access to the cash economy and a market for their products; women, by expanding opportunities to sell products and for paid work for fruit and nut processing; communities, by reducing crop losses from spoilage; processors, by building capacity in value-adding and producing products targeted to market needs; and regions, through import substitution;

- Increasing environmental benefits in areas where new agroforestry systems are replanted to reduce erosion and the impact of floods; and
- Creating greater capacity in market analysis and value-adding and enhanced public-private collaboration in partner countries.

Projects supported by the UN Food and Agriculture Organization, with partners, including:

Technical support to the PNGFA to implement a multi-purpose National Forest Inventory (EU/FAO)

From December 2014 to March 2019, the project supported the NFA in conducting the country's first Multi-purpose National Forest Inventory to estimate greenhouse gas emissions in Land Use and Land Use Change and Forestry. Methodologies for the inventory were developed, tested and documented. Numerous technical training sessions in various fields (including botany, zoology, soil survey, data management, and analysis) were conducted. The full-scale field assessment commenced in May 2017. A total of 160 plots in 43 clusters in seven provinces have been assessed by the end of 2019. A total of 8,803 trees were assessed, and 1,372 tree species were recorded, which is 41 percent of the total number of tree species ever reported in PNG. Over 16,000 plant specimens were collected, and 2,111 species were recorded, which is 19 percent of the total plant species recorded in PNG. A total of 408 bird species were recorded, which is 55 percent of bird species in PNG. A total of 248 species of ants, 1,108 species of moths, and 121 species of fruit fries were recorded (Turia et al., 2022).

Capacities for NFMS and FREL management and development in PNG (September 2018 to August 2020) (FCPF/FAO)

To strengthen sustainable forest management, FAO support is in building capacity in relevant stakeholders to advocate for and implement the essential elements of a sound timber legality assurance system; where necessary, it will support strengthening of technical capacities for research, policy and legislation review/reformulation. Operational and technical capacity building support may also be provided to facilitate forestry plantation development, to provide guidelines on responsible governance of land tenure, supporting acquisition and securing land for tree growing and forest plantation development.[66]

EU project: Our forests our future 2021-2027

The EU has begun a major investment in PNG over the time period 2021-2027. Of their three focus areas, the main investment will be in the forestry area, with strong links to climate change. The project documentation refers to the "Forestry, Climate change and Biodiversity nexus" (FCCB) and hopes to achieve "transformational change" in the sector (Table 31).

Table 31: Objectives and expected results for EU FCCB project

Objective	Expected results
1. An enabling evidence-based legal, regulatory and institutional framework for FCCB is in place, including through improved stakeholder participation and improved institutional coordination.	1) Increased availability of relevant digitalized data and information, 2) Improved environmental/forestry governance, legislative and regulatory frameworks and policy processes and 3) Enhanced protection and sustainable management of terrestrial ecosystems.
2. Improved FCCB awareness, knowledge, capacities and mobilization	1) Reinforced capacities of public, private and CSO sector actors in FCCB 2) FCCB included in the education sector 3) Improved outreach and awareness on FCCB issues among the PNG population 4) Green Deal Diplomacy intensified 5) Civil society voice and action in FCCB enhanced.
3. Increase public and private sector investment, sustainable growth and decent jobs in the FCCB space	1) Increasing use of sustainable, resilient and inclusive food systems and agribusiness options 2) Increased income opportunities in FCCB 3) Increased public and private sustainable sector investment in FCCB, including through innovative financing, digitalization, CO2 and biodiversity offsetting 4) Increased proportion of decarbonised, clean, affordable renewable energy 5) Increased climate proofing and energy/resource efficiency of relevant infrastructure.

[66] Please refer: http://www.fao.org/papua-new-guinea/programmes-and-projects/project-list/en/.

LEAF "Lowering Emissions by Accelerating Forest Finance" Coalition (Note: also relates to climate change portfolio).

This is a potential REDD+ results-based payment future project currently in preparation for funding application. Over US$100 million per year, for the period between 2022 and 2026 is required to support a range of activities to implement the REDD+ Finance and Investment Prospectus, which was prepared in 2021. A proposal submitted to LEAF[67] lists expected benefits of investing in protecting PNG's native forests as:

- 60 million tonnes of emission reductions;
- 6.5 million ha of forest under conservation;
- 470 threatened species for which habitat has been secured;
- 200,000 ha native forest planted; and
- US$75 million in sustainable forest products.

If approved and funded, the project will be implemented by CCDA with several agencies as potential financial intermediaries for LEAF. These include the Asian Development Bank, UNDP and FAO.

6.7 Recommendations for sustainable forest management

In the roadmap for reducing emissions from the AFOLU sector (Global Green Growth Institute & CCDA, 2021a, p. 51), key pathways include the 'forest' pathway which identifies five key actions:

- Strengthen forest information and monitoring systems;
- Pilot woodlot and plantation development in key locations;
- Pilot a transitional model for old timber permits;
- Establish an enhanced policy environment for forest governance;
- Regulate small-scale timber operations.

In the roadmap, indicators and targets are set for all actions, and the support from partner organizations is listed. The close relationship of forestry to other sectors is also recognized, with other key actions including development and effective management of protected areas, land use planning and sustainable agricultural development. Target jurisdictions for action include those listed in Table 32 (Global Green Growth Institute and CCDA, 2021, p. 48).

> *"The unique nature of land ownership in PNG, the high proportion of population living and relying on rural land for their livelihoods, and the importance of viewing landscapes as part of an integrated system mean it is crucial to link approaches to transitioning old concession areas with other action areas, namely those linked to protected area development, land use planning and those supporting agricultural development."*
>
> *Global Green Growth Institute and CCDA, 2021, p. 19*

Table 32: Target provinces for the period 2021-2026
Source: GGGI and CCDA (2021, p. 48)

Provinces	Reason for priority	Current activities	Support/actions needed
East and West New Britain	High levels of timber exports (degradation and forest clearance) High levels of oil palm production and new expansion	EF7 FOLUR, providing support to: - Enhance the capacity of provincial and subnational actors to undertake environmental monitoring - Test approaches to protected area designation in landscape and management support - Develop sustainable land use plans in two provinces, four districts and four LLGs - Action on land use planning - PACD, providing support to strengthen smallholder cocoa, coffee and livelihood diversification	Roll out of subnational land use planning across more districts and LLGs Transition from 'old' concessions
East and West Sepik	High levels of timber exports	GEF6 (Sustainable Finance of PNG's Protected Area Network), providing support to conservation work in Sepik Wetlands EU STREIT, providing support to agricultural value chain development for cocoa, coffee and vanilla in provinces Enhanced land use planning	Enhanced land use planning Concession monitoring Reforestation and plantation development

[67] The LEAF Coalition (n.d.)

Provinces	Reason for priority	Current activities	Support/actions needed
Enga	High levels of historic forest loss and degradation PCCC established and MoU on climate action signed	EU GCCA, providing support to land use planning, coffee value chain development, reforestation actions PACD, providing support to strengthening of smallholder cocoa, coffee and livelihood diversification	Protected area designation and management
Western and Eastern Highlands	Historic forest loss	GEF Landscape management project (under development) PACD, providing support to strengthening of smallholder cocoa, coffee and livelihood diversification	Enhanced land use planning Reforestation and plantation development Agricultural value chains Protected area designation and management

6.7.1 Strengthen timber legality through improved monitoring and surveillance and certification

Increasing timber legality is stressed in the AFOLU roadmap priorities as "Enhance monitoring and enforcement of timber legality standard", which has the targets of "50% concessions (including FCA timber) certified legal by 2025, 100% concession (including FCA timber) certified legal by 2030" (Global Green Growth Institute & CCDA, 2021a, p. 53). Third party verification is part of this action. The roadmap notes that "Having transparent systems will reduce the costs of applying further certification processes and empower other actors, such as buyers and NGOs, to be fully informed on the status of specific timber operations. This in turn, will help PNGFA enforce standards through selective purchasing, advocacy and awareness raising" (Global Green Growth Institute & CCDA, 2021b, p. 52).

Regular and independent monitoring of logging practices are required to ensure compliance with existing legislation and policies and to reduce opportunistic illegal logging.

6.7.2 Implement REDD+ to deliver benefits to PNG, and continue the National Forest Monitoring System and National Forest Inventory to support REDD+

REDD+ implementation phase, where payments can be received, can now be fully commenced and this is a high priority.

A reliable and transparent system of monitoring and reporting is critical to enable PNG to demonstrate its commitment to meeting targets associated with the Land Use, Land Use Change and Forestry sectors, and underlies the potential for receiving benefits from the REDD+ process. In addition, this work provides vital information to enable consistent and verifiable information for planning strategies and actions (see Section 7.3.3).

6.7.3 Improve governance and transparency in forest management and operations

Improving governance is a critical pillar to strengthen forest legality and ensure transparency and effective participation of stakeholders. In particular, the Government needs to develop and maintain the register of critical information, as required by Section 103 of the Forestry Act. This register is missing and would provide data for third parties to review progress in achieving the Government's stated aims (PNGi, 2022).

The review of the Forestry Act 1991 needs to be completed to harmonize with the National REDD+ Strategy 2017-2027 and to ensure equitable allocation and planning of resources. This task will include updating and implementing the National Forest Plan and Provincial Forest Plans.

There is a commitment to have a draft forest policy by 2023 and an updated forest policy by 2025 (Global Green Growth Institute & CCDA, 2021a).

6.7.4 Finalize details and implement the ban on round log exports, and review all timber concessions

This has been a PNG Government commitment over successive governments and there is a current commitment to implement this by 2025. Details of how a ban and increased on-shore processing would be implemented need to be finalized, with a clear pathway for dealing with existing permits and licences.

The ALOFU roadmap prioritizes an action to "establish a transition package for 'old' timber concessions", as the 47 percent of exports are from Timber Rights Purchase (TRP) – a type that predates the Forestry Act 1991[68], and these need to be transitioned into concessions with a more sustainable future (Global Green Growth Institute & CCDA, 2021a).

6.7.5 Engage with, and build the capacity of, customary landowners in understanding forestry operations

Better processes are needed to ensure that rights and proposed development agreements are understood by landowners. Women need to be fully involved in negotiations. Communities need a clear understanding of the trade-off between development benefits and the loss of forests and their values. Free, prior, and informed consent of customary landowners, and equitable benefit-sharing arrangements are necessary, ensuring that women are involved. Work is also required to ensure agreements include all legitimate landowners, and to audit that promised benefits are delivered in a timely manner.

6.7.6 Protect priority forests and implement land use plans

Priority forests should be protected through appropriate conservation measures, including through supporting landowners in a range of agreements including protected areas (Chapter 5) and protection of high importance areas within production forests. Land use planning and allocation needs to balance government commitments to increased development with the sustainable management and protection of forest resources, and protection of biodiversity. See Chapter 9 for more information on land use planning.

6.7.7 Update policy and information on small-scale (>500m^3) level forestry

Due to concerns that small-scale forestry operations may increase to become a significant threat to the environment, the AFOLU roadmap has recommended that legal requirements for small-scale forestry should be increased in the Forestry Act and that assessments should be conducted to determine the current extent of this activity. Capacity will need to be increased for provincial officers to implement the revised and updated law and to work with customary landholders to ensure operations are sustainable.

6.7.8 Increase plantations and reforestation

The AFOLU roadmap has identified as a priority action the need to enhance the supply of plantation timber and to embark on reforestation programmes. "National strategies for afforestation reforestation in PNG 2020-2024" have been released, but it is recognized that this will be expensive and will also face challenges with land tenure and market demand (Global Green Growth Institute & CCDA, 2021a).

[68] The Forestry Act 1991 was a response to the 1989 Commission of Inquiry into the Forestry Industry, which found widespread corruption and unsustainable forest management, and replaced TRPs with Forest Management Agreements in an attempt to introduce stronger controls and make forestry more sustainable (Act Now! for a better PNG, 2022).

Chapter 7.

Climate change and green energy


UN
DP

7.1 Context for climate change actions in Papua New Guinea

7.1.1 Climate change in PNG

Papua New Guinea's (PNG's) geophysical and climatic environment, the remoteness of many of its regions, and its economic circumstances combine to make it very vulnerable to natural disasters. The impacts of climate change – particularly more extreme weather events and sea-level rise – are increasing those vulnerabilities (UNDRR, 2019a).

Climate change is perceived as a threat across PNG's society, from the Prime Minister to local villagers. Climate change projections (summarised in Figure 43) already affect the environment, people, plants and animals and will have increasing impact in the future[69] (see Section 3.7 for more details). The threat and the level of impacts on people seem to be more real, urgent and serious in PNG than in many other countries, for a number of reasons, outlined below. A number of these changes most severely affect people who are 'left behind', including women, children and the elderly.

Many people are vulnerable to changes and to disasters

About 87 percent of people live in rural communities in PNG, and most of these depend on rain-fed freshwater, local agriculture and sustainable fisheries, making them very vulnerable to droughts, floods and changing seasonal weather patterns. PNG has a very high-risk rating for natural disasters, including floods, landslides and earthquakes, due to its geophysical and climatic environment (Chapter 12). The impacts of climate change – particularly more extreme weather events, sea-level rise, saltwater intrusion into freshwater resources such as wells, and changing sea currents – are increasing those vulnerabilities (UNDRR, 2019a). Cyclones and flood events are predicted to grow in intensity and frequency. Thus, climate change means that most of PNG's population is more likely to be affected by disasters.

Sea level rise is occurring rapidly

PNG's surrounding sea levels have risen by seven mm per year since 1993, more than double the global average (Papua New Guinea National Weather Service et al., 2015) (Figure 44). Projections indicate sea level rises will total by 40 to 80 centimetres by the end of this century. However, with ice cap melts this could be more than one metre (CMEP, 2018). Provinces expected to be most affected by sea level rise include Western, Gulf, West and East Sepik, Manus, New Ireland, Bougainville, and Milne Bay (Pilot Program for Climate Resilience, 2012).

Communities in low-lying coastal areas and lowlands are already being forced to leave their homelands or are finding their natural resources depleted and their crops failing due to sea level rise and saltwater intrusion. The Minister for Environment, Conservation and Climate Change remarked after he visited the remote Carteret Islands atoll that "every night the mothers quietly shed tears on their pillows as they ponder how they will feed their husbands and children. The crops fail because of the rise of saltwater".[70] UNDP field missions have recorded that already difficult conditions on remote islands have been greatly exacerbated, with lack of drinking water, decreased food security, malnutrition, and poor health obvious in many communities. This is due largely to rising sea levels, unpredictable seasons, and more frequent extreme weather events (John Poulsen, personal communication, 2021).

CLIMATE PREDICTIONS

Annual mean temperatures and extremely high daily temperatures continue to rise and warmer nights occur.

Average rainfall to increase, with more extreme rain events and droughts to decline in frequency.

- Sea level will continue to rise
- Ocean acidification affected area and severity to increase
- Sea surface temperature increase
- Coral bleaching to increase
- Along the northern coast,wave height and periods to decrease during December - March.

Tropical cyclones less frequent, but more intense.

Figure 43: Climate change projections for Papua New Guinea
Source: Papua New Guinea National Weather Service et al. 2015

[69] For example, see the recent review by the World Bank Group (2021), the PNG Climate Compatible Development Strategy (PNG Office of Climate Change and Development, 2014), the study on renewable energy by Global Green Growth Institute (2019) and a platform for all reports on the COP23 website https://cop23.com.fj/papuanewguinea/.

[70] The Hon. Wera Mori, Minister for Environment, Conservation and Climate Change at the Protected Area Forum, 2 June 2021.

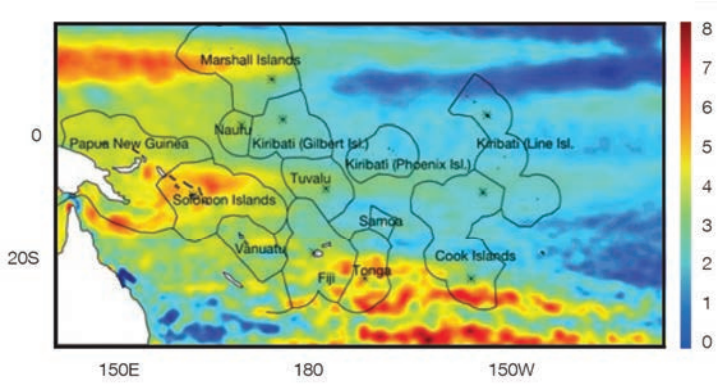
Rising sea levels will worsen the effect of coastal flooding, with salinization and flooding damaging fragile communities and cultures, potentially making these areas increasingly challenging to inhabit.

Heavy rain and flooding also threaten many communities. For the period to 2100, the global climate model projections and climate science findings (Australian Bureau of Meteorology and CSIRO, 2014) predict that average rainfall will increase in most areas (medium confidence). El Niño and La Niña events will continue to occur in the future (very high confidence), but there is little consensus on whether these events will change in intensity or frequency. Intensity and frequency of days of extreme rainfall are projected to increase (high confidence). Cyclones are expected to be less frequent but more intense. Heavy rainfall in PNG is associated with landslides (Robbins, 2016) and both inland and coastal flooding, which are among the most frequent disasters in the country.

Disease and scarcity are affecting the most vulnerable

Disease burdens and access to health care are already cause for serious concern in PNG. Health and food security issues arising from climate change are now emerging across the country, including changed patterns of diseases, additional challenges in producing crops, and more issues with reliable water supplies (United Nations in Papua New Guinea, 2019). Impacts are being experienced most severely by women and children, whose lives are already difficult and whose health is most impacted by the lack of clean water and reliable food.

Malaria has made a resurgence in PNG since 2014, and 750,000 cases were recorded in 2020. About 60 percent of the PNG's population lives in high-risk malaria regions, with the highlands above 1,600m generally regarded as being safe. However, more malaria has been reported in the highlands and the altitudinal barrier was rising with increased temperature by 2008 (Park et al., 2016). Additional rises in temperature will introduce malaria to more previously risk-free regions, and could worsen the impact of malaria for those living in low-risk zones.



Rate of sea-level rise from 1993 to 2017 (in mm per year) from satellite altimetry (Data source: Delayed Time, all-sat-merged Global Ocean Gridded SSALTO/DUACS Sea Surface Height L4 product, CLS,CNES).

Figure 44: Sea level rise in the Pacific islands 1993-2017
Source: CMEP (2018)

In December 2021, parts of Papua New Guinea (PNG) experienced a surge in king tides that flooded communities and displaced approximately 53,000 people. King tides are the highest predicted tides of the year and are reaching higher and farther as climate change causes sea levels to rise. For PNG – facing more than double the global average in annual sea level rise – the worst is yet to come.

In coastal and island communities in Bougainville, Manus Island, East Sepik, and the New Ireland provinces media reported how flooding submerged schools, homes, gardens, water catchments, and cemeteries, and that some homes were completely washed away.

Ron Knight, a resident of Manus Island and former member of parliament with experience coordinating emergency response to past flooding, told Human Rights Watch that flooding will have prolonged impacts on community members' ability to harvest food and that older people, children, and newborns are particularly at risk when essential food sources are adversely affected.

Human Rights Watch 2021

Biodiversity is threatened

PNG's biodiversity is very significant on a global scale. Many of the threats to biodiversity, including invasive species, increased human pressure, and inappropriate fire regimes are amplified by climate change (Note: these threats are discussed in Chapter 4). Many impacts of climate change interact with each other (for example, rainfall and temperature), and also interact with other threats.

For coastal people, projected effects on the marine environment are concerning. In addition to ocean acidification, coral bleaching from higher temperatures is expected to continue and become more severe (Australian Bureau of Meteorology and CSIRO, 2014). Coral reefs are also affected by increasing acidification of seawater (D'eath et al., 2009; Mollica et al., 2018). The loss of coral reefs would be devastating for many coastal communities, where people depend on marine life for their daily subsistence as well as for income. Inland and coastal flooding increases sedimentation, particularly where clearing has occurred. The extra mud and silt kill coral and can also cause the death of large areas of seagrass and mangroves. Loss of these marine systems would mean the natural barriers to waves and winds disappear and the effects of severe weather events are exacerbated.

Climate is less predictable

Both coastal and highland regions are sensitive to changed and less predictable climates, which result in more variability in agricultural yields. Sweet potato, coffee and cocoa are examples of climate-sensitive crops that Papua New Guineans are dependent on for food and livelihood. In the PNG protected area management effectiveness survey, climate change was the most frequently nominated threat, with communities perceiving impacts including sea level rise, unpredictability of seasons, rougher seas and more extreme temperatures. People reported that they didn't know when to plant their crops anymore, and that they were less able to travel by sea, as waves and winds were no longer predictable (Leverington et al., 2017a).

PNG's natural environment plays an important role, locally and globally

On the positive side, much of PNG is protected by its natural landscapes. As the Prime Minister wrote in 2020: "At present, we are protected from some of the worst impacts of climate change by our outstanding and unique natural capital. Mangroves have helped buffer the impacts of storm surges on coastal community. High levels of forest cover help maintain weather patterns and reduce soil loss and flash flooding. Our country acts as one of the most important global sinks for trapping and storing greenhouse gases, by reducing deforestation and promoting forest conservation and sustainable management of its forests through our National REDD+ Strategy. With increasing population and our need for economic development many of these protections are under threat" (Government of Papua New Guinea, 2020a, p. 2).

The vast natural forests of PNG play an important role in regulating climate and as a carbon sink (Makarieva and Gorshkov, 2015), and the clearing of these forests has a big impact on the country's emissions of greenhouse gases (GHGs) (Section 7.3.2). Further deforestation is also likely to cause a change in the water balance of PNG and may lead to lower long-term rainfall, severe droughts and flood events (Makarieva and Gorshkov, 2015). Chapter 6 provides information about the management of forests in PNG, rates of deforestation and logging, and the REDD+ initiatives aimed at reducing emissions from deforestation and forest degradation.

PNG's mangroves, seagrass and undisturbed coastal sediment absorb and store large amount of carbon, and the protection of this 'blue carbon' is also critical. Women, who are most severely impacted by climate change, can also play a very important role in the 'blue economy', for example through farming of seaweed.

7.1.2 Climate change, disasters and migration

Climate change will exacerbate the need for a more robust disaster risk management system in PNG (UNDRR, 2019a). Not only is investment in disaster resilient infrastructures and 'building back better in recovery' required, but the country also needs to explore long term strategies for relocating displaced populations, enhancing climate monitoring, forecasting capacity and dissemination of early warnings.

While disaster response and planning are often focused on big events, the accumulated impacts of many small and medium-sized events, such as local flooding, high waves and localised droughts can generate similar losses over time, as they affect more people. These events are more likely to involve housing, land, crops, livelihoods and local infrastructure, rather than major mortality or destruction of nationally-critical economic assets (Pacific Community, 2016). Some relocations have been and will be needed, but this is complicated because of the strong customary land tenure system and attachments to place and community, and the high costs of resettlement (Pilot Program for Climate Resilience, 2012).

The overlap between climate change adaptation and disaster management programmes (Figure 45) means that the two issues are closely related, with similar approaches needed to monitor, analyse, prepare for and respond to address climate and disaster risks (Pacific Community, 2016). Disaster response is discussed in Chapter 12.

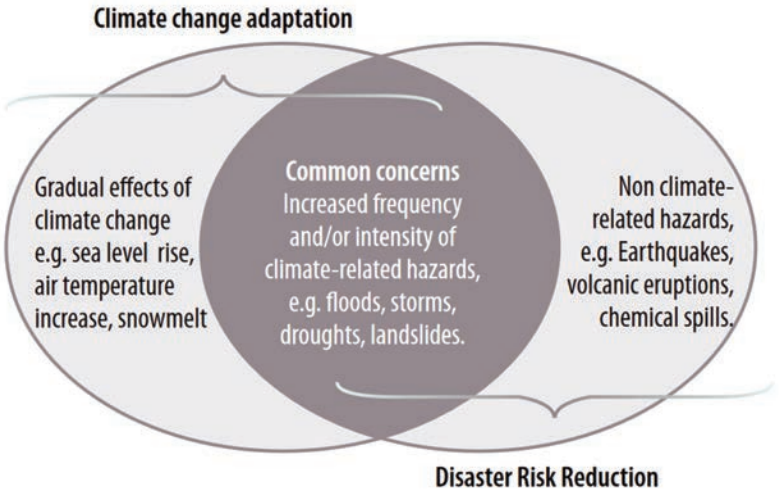


Figure 45: Overlap between climate change and disasters
Source: Framework for Resilient Development in the Pacific, p.7.

7.2 Legislation, policies and agreements relating to climate change

Several pieces of legislation (Table 33) and policies (Table 34) in PNG relate specifically to climate change.

Table 33: Legislation

Legislation	Intent
Climate Change (Management) Act 2015	Establishes the national Climate Change and Development Authority (CCDA) to coordinate research, analysis and policy and legislative frameworks for managing climate change.
Legislates the objectives of the national climate policy including national-level goals for carbon neutrality of 50% by 2030 and 100% by 2050.	
Provides overarching framework for regulating climate change activities including annual reporting and target-setting, and advocates consultations with relevant stakeholders.	
United Nations Paris Agreement (Implementation) Act 2016	Gives effect to implementing PNG's obligations under the Paris Agreement through the Nationally Determined Contribution and ensures REDD+ (and related activities) are enforceable.
Draft Minimum Energy Performance Standard and Labelling (MEPSL) regulation	Sets energy efficiency standards for heating, ventilation and air conditioning equipment and lighting.
Climate Change (Management) (Nationally Determined Contribution) Regulation 2021	Provides a legal framework for the implementation of PNG's Enhanced NDC under the Paris Agreement.

Table 34: Policies and strategies relating to climate change

Policy	Intent
National Climate Compatible Development Management Policy (NCCDMP) 2013	National-level goals for carbon neutrality of 50% by 2030 and 100% by 2050. Includes mitigation and adaptation components. Mitigation focuses on: · Carbon neutrality by 2050; · Greenhouse gas emissions mitigated in the land use, land use change and forestry (LULUCF) sector; and, · Development is climate-compatible through efficient, low greenhouse gas emitting infrastructure and technology. The policy identifies mitigation actions to be implemented in these key sectors and outlines the roles of national, provincial and local level governments.
National Energy Policy 2017-2027 (Department of Petroleum and Energy)	Broad policy encompassing energy production as well as generation and distribution and energy efficiency. Reflects the Vison 2050 goal of one hundred percent (100%) power supply from renewable and sustainable energy sources.
Geothermal Energy Policy (Department of Department of Mineral Policy and Geohazards Management and Mineral Resources Authority)	Fosters development of geothermal resources in PNG.
Strategy for Responsible Sustainable Development 2014 (STARS)	The National Strategy for Responsible Sustainable Development for PNG (StaRS) recognizes that previous planning documents, such as the PNG Development Strategic Plan 2010-2030, did not give the natural assets of PNG sufficient recognition. The strategy promotes cost-effective and resource efficient ways of responsible sustainable development and call for a paradigm shift towards a green economy based on the need to protect assets that are the basis of the country's wealth and future development. The strategy specifically discusses the need for government support for renewable energy.
Papua New Guinea's Sustainable Development Goal 13 Roadmap: 30 actions by 2030	Outlines a phased cross-sectoral approach to achieving 30 actions by 2030 relating to climate change and related SDG goals.

Policy	Intent
PNG Revised Nationally Determined Commitment under the UNFCCC Paris Agreement	The document and associated roadmaps are critical guides for PNG mitigation and adaptation strategies in ALOFU and Energy sectors.
National REDD+ Strategy 2017-2027 and associated documentation	Sets approach for integrating REDD+ (reducing emissions from deforestation and forest degradation) by: • Creating the enabling conditions for actions by government, civil society, and the private sector; • Mainstreaming REDD+ concepts and goals into the work of sectors and developing policies and measures that drive actions at national, provincial and local levels; • Initially focus on reporting emissions and removals related to reducing emissions from deforestation and forest degradation and the enhancement of forest stocks.

Key multilateral environmental agreements related to climate change are shown in Table 35.

Table 35: Key international conventions and agreements

Conventions	Intent
United Nations Framework Convention on Climate Change (UNFCCC) • Copenhagen Accord 2009 • Paris Agreement 2016	Seeks to reduce atmospheric concentrations of greenhouse gases, aiming to prevent dangerous anthropogenic interference with earth's climate system. Individual participating countries are required to commit to stabilizing greenhouse gas emissions.
Convention on Biological Diversity	Includes a goal related to climate change, and others affected by climate change.
Agreement on the Establishment of the Global Green Growth Institute	Establishment Agreement ratified by Member countries in 2012. Membership to GGGI is open to any member state of the United Nations that subscribes to the organization's goals and objectives. The mission is "global transition toward a model of green growth."

7.3 Progress and contributions towards climate change goals and targets

International goals and targets specifically relating to climate change are summarised in Table 36

Table 36: International targets relating to climate change

Source	Target/goal	Comment
SDG Goal 7	Ensure access to affordable, reliable, sustainable and modern energy for all Note: PNG government has established a target to provide electricity to 70% of households by 2030.	Less than 15% of the total population in PNG has access to electricity. Electricity access in rural areas is estimated to be under 3.7%.
SDG 13 Climate Action	Take urgent action to combat climate change.	High level of international engagement and commitments on climate change issues, but still lagging on actions. Current commitments in Enhanced NCD. Progress is now being made in reducing emissions from deforestation and forest degradation.
Aichi Biodiversity Target 10 Ecosystems vulnerable to climate change	By 2015, the multiple anthropogenic pressures on coral reefs, and other vulnerable ecosystems impacted by climate change or ocean acidification are minimized, so as to maintain their integrity and functioning.	Progress towards target but at an insufficient rate (Conservation and Environment Protection Authority, 2019).
Proposed post-2020 Biodiversity Target 8	Minimize the impact of climate change on biodiversity, contribute to mitigation and adaptation through ecosystem-based approaches, contributing at least 10 GtCO2e per year to global mitigation efforts, and ensure that all mitigation and adaptation efforts avoid negative impacts on biodiversity.	

7.3.1 PNG's response to climate change issues

PNG has been a world leader in pressing for action against climate change[71] and has made strong international commitments as well as policy statements including:

It has been an active party to the United Nations Framework Convention on Climate Change (UNFCCC) since 1992, and ratified the Convention in 1993. In 2009, PNG made a commitment to the UNFCCC to reduce greenhouse emissions by 50 percent by 2030 and to become carbon neutral by 2050. To comply with the reporting obligations under the UNFCCC, PNG prepared and submitted its First National Communication in 2002 and its Second National Communication (NC) in 2014. PNG adopted the Paris Agreement in 2015, then in 2016 submitted its Intended Nationally Determined Contribution (NDC) (Government of Papua New Guinea, 2016), which committed PNG to achieve 100 percent renewable energy by 2030. An enhanced NDC was finalised in 2020 (Government of Papua New Guinea, 2020a), changing the commitment to 78 percent renewables by 2030, and setting new targets for reducing forest degradation and deforestation. An implementation plan for the NDC was published in in 2021, and roadmaps for the Agriculture, Forestry, and Other Land Use (AFOLU) (Global Green Growth Institute & CCDA, 2021a) and the electricity sectors (Global Green Growth Institute & CCDA, 2021b) have also been developed. PNG will submit its National Adaptation Plan (NAP) to climate change to the UNFCCC in 2022.

The First Biennial Update Report (BUR1) (Government of Papua New Guinea, 2018a), containing figures of emissions up to 2015, was submitted to the UNFCCC in 2019, and the Second Biennial Update report was submitted in 2022 (Government of Papua New Guinea, 2022c), along with supplementary materials.

PNG is a member of the Small Island Developing States and is aligned with the Alliance of Small Island Developing States (SIDS) in the context of the UNFCCC. PNG is also the current Chair of the Coalition for Rainforest Nations which has engaged in negotiations under the UNFCCC for its 52 member countries. It is the current Chair of the Coalition for Rainforest Nations engaging in negotiations under the UNFCCC for its 52 member countries.

The PNG National Climate Compatible Development Management Policy (PNG Office of Climate Change & Development, 2014) was approved in 2014, and the Climate Change Management Act was passed in 2015.[72] Other policies also recognized the imperatives of climate change action, especially the National Strategy for Responsible Sustainable Development for PNG (StaRS), which calls for a paradigm shift towards a green economy, based on the need to protect assets that are the basis of the country's wealth and future development. As discussed in Section 6.4.1, PNG has also completed detailed work and published policies and procedures related to REDD+.

Current National Climate Targets

- *Work towards a carbon neutral energy industries sub-sector by 2030*
- *78% renewable energy by 2030 (Enhanced NDC)*
- *Annual deforestation and degradation reduced by 25% of the 2015 level by 2030 (equivalent to reduction of 8,300 ha of annual deforestation and 43,300ha of degradation) (Enhanced NDC)*
- *Halt and reverse forest loss and land degradation by 2030 (Glasgow Leaders' Declaration on Forest and Land Use)*

PNG's first NDC indicated that its main mitigation contribution would be to shift away from fossil fuels to renewable energy sources for electricity generation (Government of Papua New Guinea, 2018b). Other mitigation pathways identified in the first NDC were energy efficiency, energy efficient vehicles in the transport sector, reduction of oil and gas sector emissions and implementation of REDD+ activities. The updated NDC and implementation plan and the associated roadmaps commit to a wide range of targets and actions in both the LULUCF and energy sectors. Two types of actions are identified: direct action pathways and supporting activities.

In 2021, a delegation from PNG joined the Conference of Parties (CoP) to the UNFCCC, COP26, in Glasgow and supported the Glasgow Climate Pact. PNG also signed the 2021 Glasgow Leaders' Declaration on Forests and Land Use, which states that "'We therefore commit to working collectively to halt and reverse forest loss and land degradation by 2030 while delivering sustainable development and promoting an inclusive rural transformation". This declaration was signed by 127 countries. Although the declaration was endorsed outside the UNFCCC process and is not legally binding, the signatory countries govern around 90 percent of global tree coverage, so the declaration signifies important intent.

The challenge now is for PNG to implement its intentions and promises, while still enabling economic progress and a secure social environment. Progress in reducing deforestation is slow, with an increase in the rate of clearing and degradation after 2009 when the pledges were made to the UNFCCC. In a report

[71] For a more detailed history of PNG' involvement in the UNFCCC, see the enhanced NDC (Climate Change and Development Authority 2021, p.4).

[72] The Act is currently under review to ensure that it can effectively respond to the needs of and PNG's obligations under the Paris Agreement.

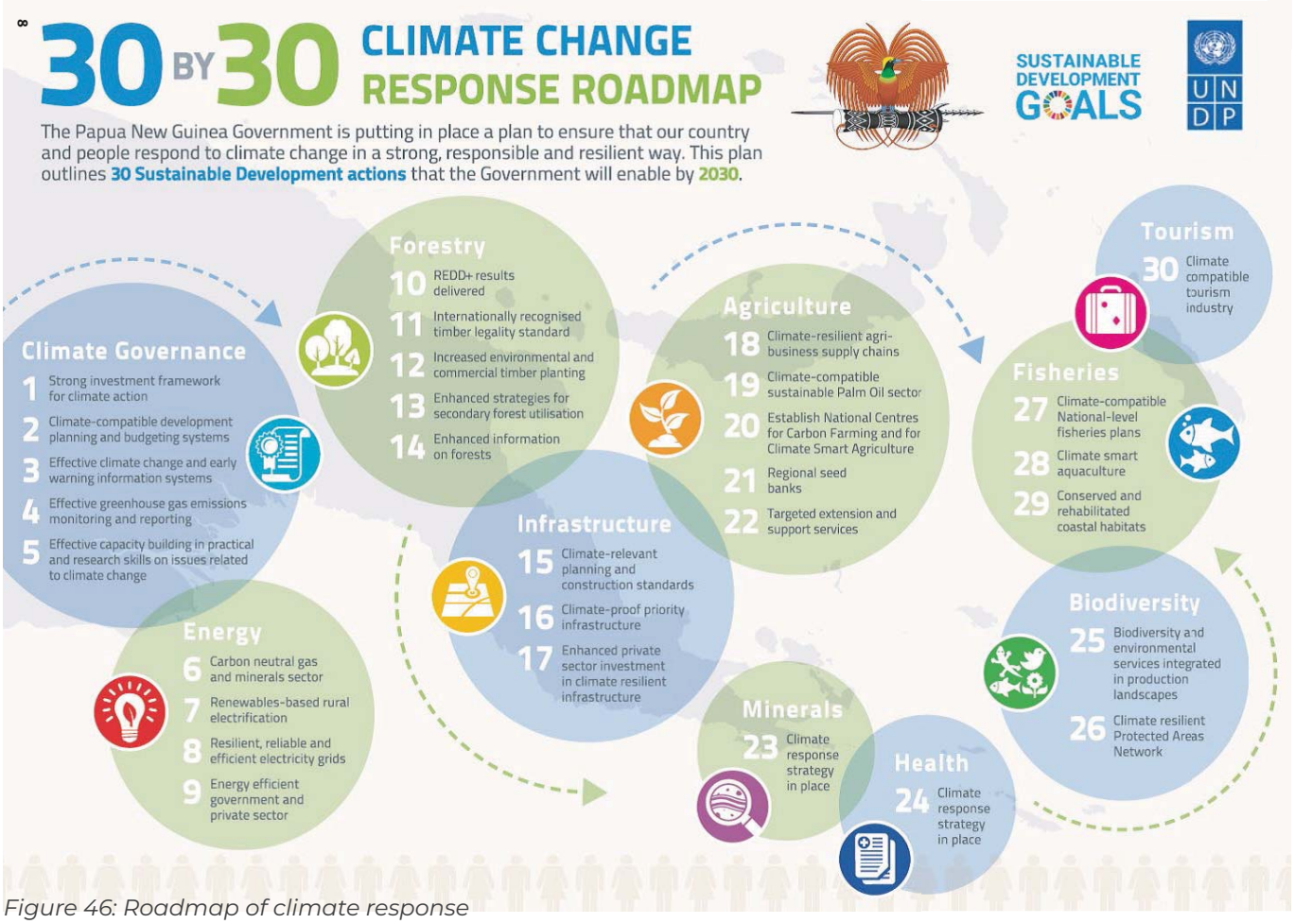


Figure 46: Roadmap of climate response
Source: Government of Papua New Guinea (2020b)

published in 2021, advocacy groups point out that while PNG leads on climate targets, it lags on action and outline major areas of continuing concern including: the need for drastic action and political will to reduce logging and increase revegetation; the lack of supervision, enforcement and transparency in the timber industry; barriers to uptake of renewable energy; and plans for new fossil fuel projects (Kuman & Jeong, 2021).[73]

Many organizations are assisting PNG in meeting its climate commitments and helping its people adapt to the climate challenges. UNDP is a key development partner, alongside other UN and intergovernmental agencies, governments including Australia, USA and New Zealand, the European Union and its member states, as well as a range of NGOs and other institutions. The second Biennial Update lists 26 partner projects, and estimates that more than US1 billion is needed over the next 10-year period to achieve the Enhanced NDC targets (Government of Papua New Guinea, 2022c).

A summary of the implications of climate change for all SDGs, and a roadmap of 30 actions across all sectors, was released in August 2020 (Figure 46) (Government of Papua New Guinea, 2020b).

7.3.2 Greenhouse gas inventory

The first biennial update report to the UNFCCC contains a national greenhouse gas inventory and describes trends in emissions from 2000 to 2015 (Government of Papua New Guinea, 2018a). The second biennial update report has been completed in 2022 (Government of Papua New Guinea, 2022b), along with the National Inventory Report for 2015-2017 (Government of Papua New Guinea, 2022a). Emissions are estimated according to Intergovernmental Panel on Climate Change (IPCC) 2006 guidelines using default IPCC emission factors.

PNG emissions grew significantly between 2010 and 2015, and the first biennial update report to

[73] According to this well-researched report, planned fossil fuel projects include Papua LNG, PNG LNG, P'nyang, Pasca A and a coal-fired power station in Lae. There is a concern that energy companies that can no longer profit from fossil fuels in other countries are turning their attention to PNG, which has pledged to rapidly increase its current low electrification rates.

As the chair of the Coalition of Rainforest Nations, The Prime Minister noted that PNG stands at "an important crossroad":

"We are a net remover of carbon from the atmosphere. The removal capacity from our forests is over 100 million tonnes per year. Our energy emissions are presently around 10 million tonnes annually.

Therefore, if the REDD+ (Reducing Emissions from Deforestation and forest Degradation and enhancing forest stocks) Mechanism delivers as it should, PNG can remain where every country needs to be by 2050 under the Paris Agreement – a net remover of carbon from the atmosphere.

The preservation and conservation plus sustainable harvest and use of forest resources can be our commitment to you all for the upkeep of earth heading the "red code for humanity" call by Secretary-General Guterres"

The Hon James Marape (2021) https://thediplomat.com/2021/10/pngs-prime-minister-wants-to-save-his-countrys-rainforest-he-cant-do-it-alone/ -

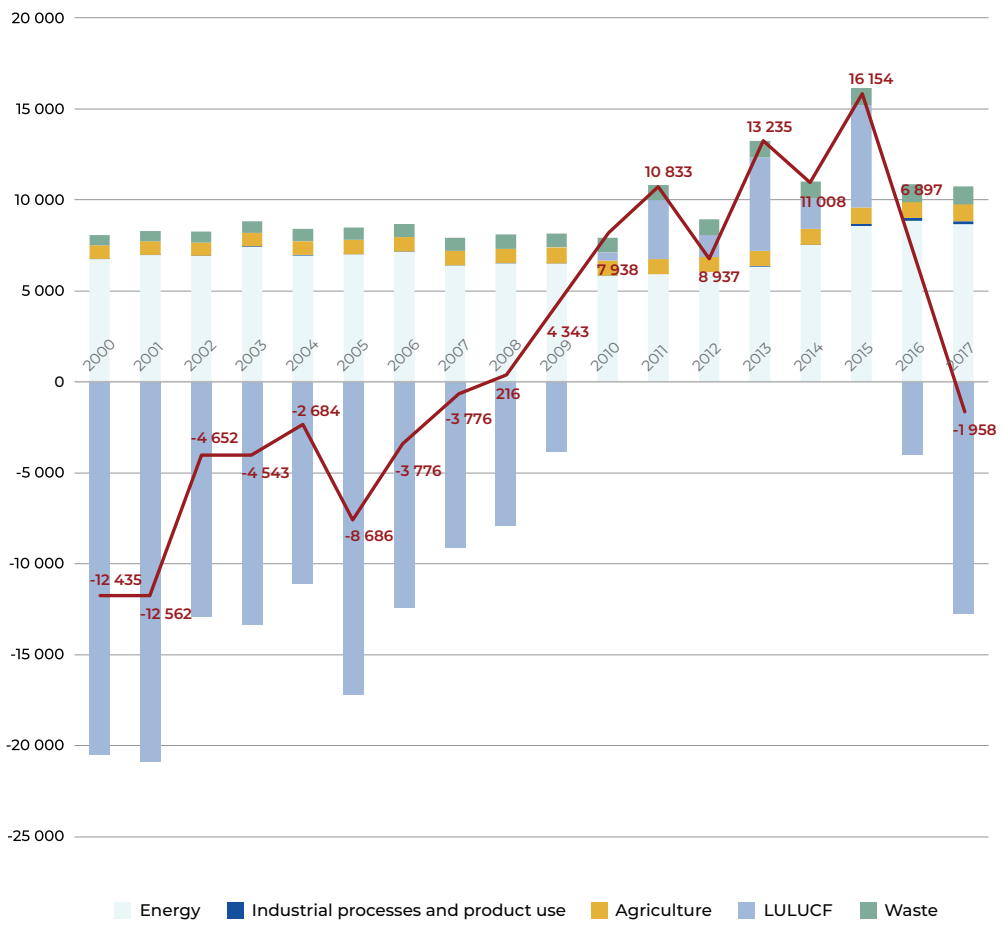


Figure 47: Total estimated emissions of greenhouse gases, 2001-2017, Papua New Guinea
Source: (Government of Papua New Guinea, 2022c, p. 12)

the UNFCCC (Government of Papua New Guinea, 2018a) indicated that PNG was no longer a net sink for greenhouse gases. There were significant increases between 2010 and 2015 in emissions from the land use, land use change and forestry (LULUCF) and energy sectors, driven by vegetation clearing and fugitive emissions from gas production. Total net emissions in 2015 were +15,193 gigagrams of carbon dioxide equivalents (Gg CO2 eq) compared to -14,179 Gg CO2 eq in 2000, but PNG returned to being a sink in 2017, with total net emissions of -1,958GgCo2eq (Figure 47). These trends closely follow the deforestation and degradation data shown in Section 6.3.

The second biennial report summarizes the trend of greenhouse gas emissions for each reported sector from 2000-2017 (Table 36) and this indicates that the net balance of the LULUCF sector was negative by 2017 (i.e., more carbon is stored than emitted). In a separate report, it is believed that rates of

Table 37: Trend of GHG emissions and removals (2000-2017)
Source: Government of Papua New Guinea, 2022c

Trend by sector — unit: kt-CO_2 eq

	2000	2001	2002	2003	2004	2005	2006	2007	2008
1.Energy	6,760	6,984	6,940	7,448	6,956	7,015	7,168	6,401	6,537
2.Industrial processes and Product Use	1	1	1	2	3	3	3	3	3
3.Agriculture	732	735	731	739	785	774	786	783	795
4.LULUCF	-20,488	-20,864	-12,929	-13,366	-11,087	-17,161	-12,441	-9,083	-7,879
5.Waste	560	582	605	634	659	683	708	733	760
total (with LULUCF)	-12,436	-12,562	-4,652	-4,544	-2,684	-8,687	-3,776	-1,164	216
total (without LULUCF)	8,052	8,301	8,277	8,822	8,403	8,474	8,665	7,920	8,095

	2009	2010	2011	2012	2013	2014	2015	2016	2017
1.Energy	6,531	5,844	5,919	6,035	6,352	7,553	8,551	8,846	8,673
2.Industrial processes and Product Use	3	3	3	3	2	2	142	161	153
3.Agriculture	845	838	821	842	865	865	896	894	935
4.LULUCF	-3,821	442	3,252	-1,190	5,124	1,668	5,617	-3,981	-12,725
5.Waste	785	811	838	867	892	920	948	977	1,006
total (with LULUCF)	4,342	7,937	10,833	6,557	13,236	11,009	16,153	6,897	-1,958
total (without LULUCF)	8,163	7,496	7,581	7,746	8,112	9,340	10,536	10,877	10,767

deforestation and degradation have continued to decline between 2017 and 2019, and this has resulted in early indications that PNG already achieved its Enhanced NDC target of a more than 10,000 GgCO2e reduction against 2020 levels (Global Green Growth Institute & CCDA, 2021a).

The top emitting single categories in 2017 (Table 38) were conversion of forest to cropland, and fuel consumption by manufacturing industries and construction, followed by road transport and settlements.

The Land Use, Land Use Change and Forestry (LULUCF) sector remains the biggest single gross source of emissions (Table 38), though this is balanced by the role of forest land as a 'sink'. Historically the sector acted as a net sink, but that role has declined over time due to forest degradation and deforestation, so for five years last decade it became a net source of emissions (Table 37). This was due to the high rate of clearing and degradation, which has now slowed, returning the sector to being a net source (see Chapter 6 for more details). The projected trend of emissions and removals of GHG by the LULUCF sector are shown in Figure 48.

Table 38: Key category assessment results including LULUCF in kTCo2eq
Note: only sectors emitting over 100 kTCO₂ equivalent are shown
Source: Government of Papua New Guinea, 2022a, p. 9

2006 IPCC code	category	Gas	2017 values	Absolute value of 2017 emissions	Level assessment	cumulative total
3.B.1	Forest land remaining forest land	CO_2	-23617.38	23,617.38	52.16%	52.16%
3.B.2.b	Land converted to cropland	CO_2	8493.36	8,493.36	18.76%	70.92%
1.A.2.	Manufacturing industries and construction	CO_2	3764.01	3,764.01	8.31%	79.23%
1.A.3.b	Road transportation	CO_2	1519.16	1,519.16	3.36%	82.59%
3.B.5	Settlements	CO_2	1058.52	1,058.52	2.34%	84.93%
3.B.2.a	Cropland remaining cropland	CO_2	904.46	904.46	2.00%	86.92%
1.B.2.a.2	Production	CH_4	855.57	855.57	1.89%	88.81%
1.A.1.c	Manufacture of solid fuels and other energy industries	CO_2	575.45	575.45	1.27%	90.09%
3.C.4	Direct N2O emission on managed soils	N_2O	528.79	528.79	1.17%	91.25%
5.D.1	Domestic wastewater	CH_4	503.40	503.40	1.11%	92.37%
1.A.3.a	Domestic aviation	CO_2	398.14	398.14	0.88%	93.24%
1.B.2.a.2	Production	CH_4	394.87	394.87	0.87%	94.12%
3.B.3	Grassland	CO_2	323.36	323.36	0.71%	94.83%
1.A.4.c	Agriculture/forestry/fishing	CO_2	313.20	313.20	0.69%	95.52%
5.A.1	Unmanaged waste disposal sites	CH_4	272.55	272.55	0.60%	96.12%
3.A.1	Enteric fermentation	CH_4	172.92	172.92	0.38%	96.51%
5.D.1	Domestic wastewater	N_2O	167.83	167.83	0.37%	96.88%
2.F.1	Refrigeration and air conditioning	HFC	150.62	150.62	0.33%	97.21%
3.A.2	Manure management	CH_4	144.28	144.28	0.32%	97.53%
1.A.1.a	Public electricity and heat production	CO_2	131.53	131.53	0.29%	97.82%
1.A.1.b	Petroleum refining	CO_2	122.46	122.46	0.27%	98.09%

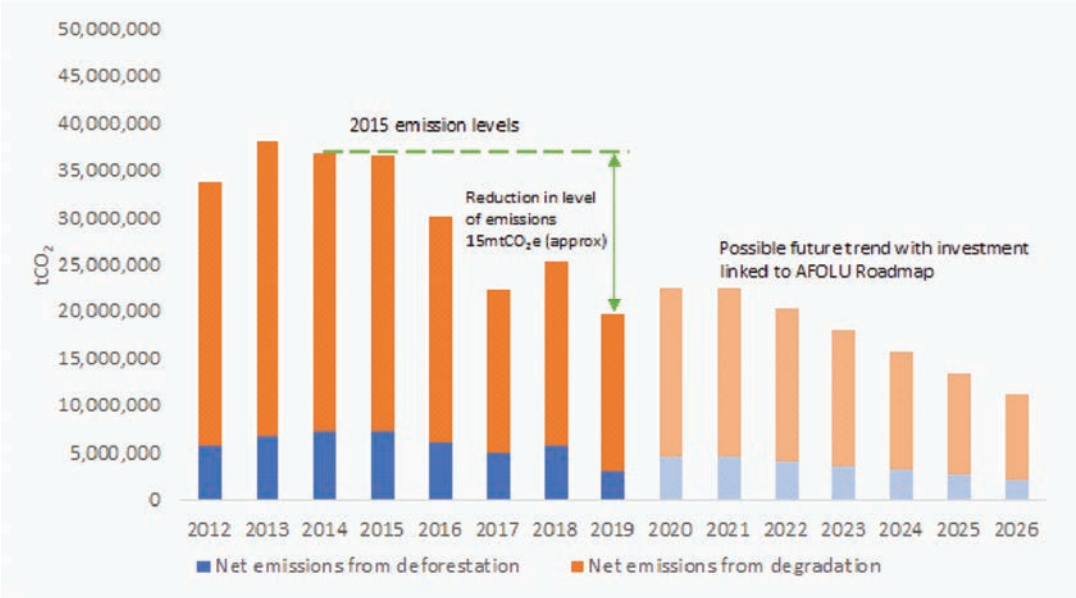


Figure 48: Projected trend of LULUCF sector emissions and removals (tCO2), Papua New Guinea
Source: (Global Green Growth Institute & CCDA, 2021a, p. 33)

Estimated emissions from the non-LULCF sectors increased by 45 percent from 2010 to 2016 and remained relatively stable in 2017 (Figure 49).

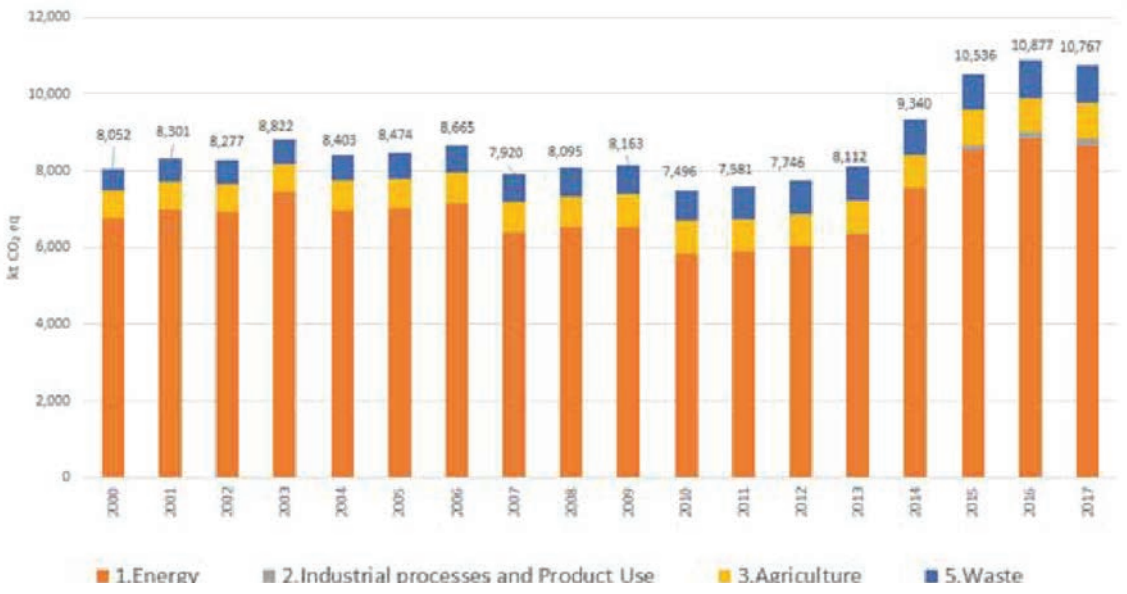


Figure 49: Emissions excluding the LULUCF sector 2000 to 2017, Papua New Guinea
Source: Government of Papua New Guinea, 2022a, p. 14

Of the non-LULUCF sectors, in 2017 the energy sector contributed 80 percent to total (non-LULUCF) greenhouse gas emissions, followed by the waste sector (9 percent), agriculture (9 percent), and industrial process and other product use (0.03 percent). Agricultural emissions are mostly from nitrogen oxide released from soils in croplands, and these have increased by 28 percent since 2000 (Government of Papua New Guinea, 2022a). Emissions from the waste sector have increased steadily and have almost doubled since 2000, due to increased population, consumption and development, as well as rural to urban drift (Government of Papua New Guinea, 2022a).

The energy sector was responsible for emissions of 8,673 kt CO_2 eq in 2017, an increase of 28 percent from 2000. Of this, liquid fuel combustion contributed 68 percent. Fugitive gases contributed methane (CH4) equivalent to 16 percent of the total and an additional one percent CO_2. The increase in GHG emissions from this sector from 2014 to 2017 is mainly due to increased demand for electricity and increased production of liquified natural gas (Government of Papua New Guinea, 2022a).

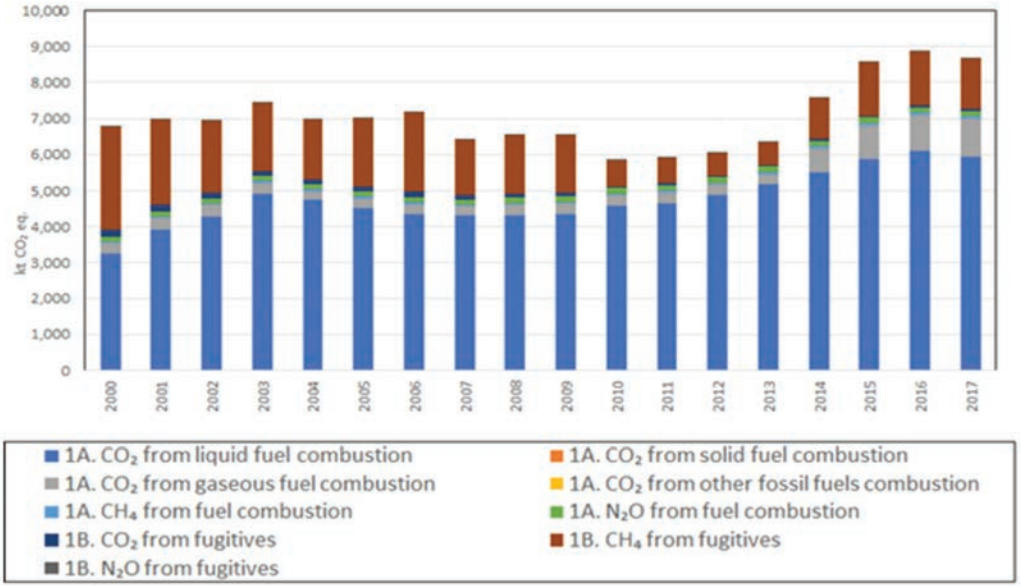


Figure 50: Trend of emissions from the energy sector, 2000-2017, Papua New Guinea
Source: Government of Papua New Guinea, 2022a, p. 15

7.3.3 Mitigation: LULUCF sector

The mitigation roadmap for the LULUCF sector (referred to in that report as the Agriculture, Forestry, and Other Land Use (AFOLU) Sector) includes both direct and supporting activities in four different 'pathways' (summarized in Figure 51). A number of these activities are discussed elsewhere in this report to achieve other targets, such as establishment and management of protected areas (Chapter 5), reduction in forest clearing and enhanced forestry management (Chapter 6), stronger environmental safeguards and functional land use planning (Chapter 10).

This section will focus on the important activities related to reducing deforestation and degradation,

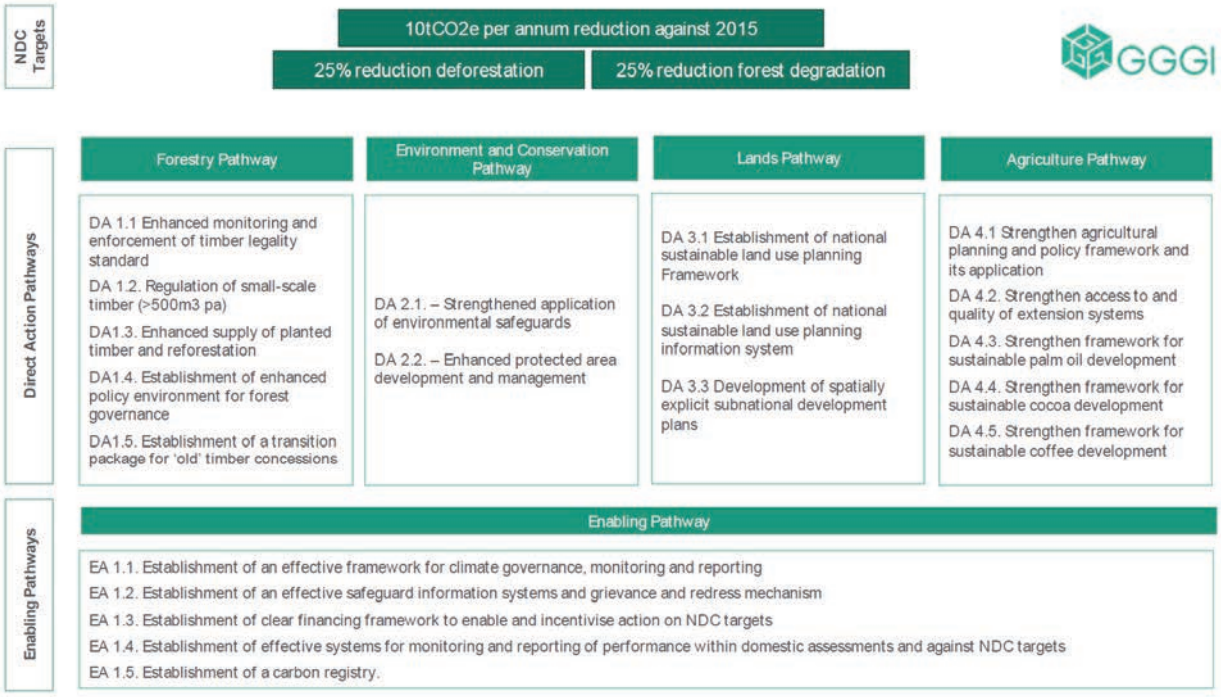


Figure 51: Proposed pathways for implementation of sector targets
Source: Global Green Growth Institute & CCDA, 2021a, p. 117

[74] According to some sources, the idea was from a businessman and close associate of Sir Michael Somare, Kevin Conrad, who is the executive chair of the Rainforest Coalition and has been Special Envoy and Ambassador for Environment and Climate Change for Papua New Guinea (Filer, 2011).

however other actions such as improving soil conservation are also very important. It is noted that women can play a major role in projects to reduce agricultural emissions, especially in regard to the improvement of farming practices.

Reducing Emissions from Deforestation and Forest Degradation (REDD+)

REDD+ is aimed at supporting countries to reduce or stop deforestation, which has huge benefits for reducing the emission of carbon into the atmosphere and contributing to biodiversity conservation (see also Chapter 7). The REDD+ mechanism is attributed to the late Sir Grand Chief Michael Somare - founding father of PNG[74]. The PNG Government (with Costa Rica) was instrumental in proposing the concept of REDD at the 11th Conference of the Parties to the United Nations Framework Convention on Climate Change (UNFCCC) in 2005 (Babon et al., 2014).

Reducing Emissions from Deforestation (REDD) strategies provide PNG with an opportunity to "catalyse transformational change within the forest and land use sector towards a new responsible economy with lower GHG emissions, stronger long term economic growth and community livelihoods and the effective conservation of biodiversity and ecosystem services". This can also ensure that forest resources are used in a sustainable and equitable manner (Government of Papua New Guinea, 2017). REDD+ will be a critical financial mechanism to support PNG to transition into a greener economic model.

To receive REDD+ support, countries need firstly to be able to clearly demonstrate that they can generate accurate data about their emissions, through reliable and transparent knowledge about the area of their forests and about current forestry conditions and activities. They also need supportive policies, legislation, and stakeholder involvement, with demonstrated processes to ensure full-prior and informed consent of landholders. The work to prepare for REDD+ (known as REDD+ readiness), is funded through the Readiness Fund. Once these criteria are met, the Carbon Fund can remunerate participant countries in accordance with their negotiated contracts for verifiable emission reductions.

In the early years after the REDD concept was approved, there were numerous issues with 'carbon cowboys' in PNG, trying to exploit village people by trading in (theoretical) carbon credits without gaining free, prior and informed consent, and it was alleged that corruption extended into high levels of government (Melick, 2010). The national government then took strong steps to stop the speculation in carbon credits and the voluntary carbon market (Filer, 2015). The early policy development for climate change actions and REDD development drew widespread criticism for 'being controlled by a small policy elite composed of select government officials and international consultants' (Babon & Gowae, 2013, p. 34). In 2014, an independent report revealed there had been little progress in meeting the conditions under which REDD would be successful (Brockhaus et al., 2015). However, policy reform has progressed considerably since then.

To date, PNG has prepared for REDD+ through several phases.

- UNDP supported the Office of Climate Change and Development (OCCD) and the PNG Forest Authority (PNGFA) to implement the country's UN-REDD programme from 2011
- Phase One of the UNDP REDD+ work[75] began in 2015 and overlapped with the completion of the UN-REDD project. The mid-term review in 2017 concluded that there was significant progress in the development of the approach to REDD+, and that given how much work remained to be done, the project should be extended with additional funding. At this stage there were still some issues with communication and cooperation and a concern about the need to stronger government commitment and ownership of the REDD+ work (UNDP in PNG, 2017)
- In Phase Two, the work was successfully completed and has supported the PNG Government to manage and implement the country's REDD+ readiness actions. This included strengthening capacities related to the National Forest Monitoring System, Forest Reference Emissions Level and safeguards, and increasing engagement with a range of stakeholders. Both projects were implemented by UNDP in conjunction with the lead implementing agencies: the Office of Climate Change and Development (OCCD) for the first phase and the Climate Change and Development Authority (CCDA) for the second phase, while PNG Forest Authority (PNGFA) acted as the responsible party. The Food and Agriculture Organization of the United Nations (FAO) was also a key implementation partner in REDD+ preparation, including the development of the National Forest Inventory, and is now assisting the government with this work into the future.

Outputs are all stored on the PNG REDD+ webpage and include:

- A National REDD+ Strategy developed through a highly participative, intersectoral and successful process, and endorsed by the National Executive Council (NEC) in May 2017. The national REDD+

[75] UN-Reducing Emissions from Deforestation and Forest Degradation work to enhance PNG's REDD+ Readiness. (FCPF I) 2015-2020 USD$4million Forest Carbon Partnership Trustee.

Strategy 2017-2027 was submitted to the UNFCCC in April 2018[76]

- A Forest Reference Emissions Level submitted to the UNFCCC in 2017, technically assessed by UNFCCC and resubmitted the same year (Climate Change Development Authority, PNG, 2017). It provided the basis for the development of a REDD+ annex to the First Biennial Update Report, which was submitted to the UNFCCC in 2019 (Government of Papua New Guinea, 2018a). The data and information provided in the annex, which covered the 2014-2015 period, has been deemed compliant by the UNFCCC. This allows PNG to be eligible for Results-based Payments under the Green Climate Fund (GCF). The Second Biennial Update Report was submitted in 2022 (Government of Papua New Guinea, 2022c), along with the National Inventory Report 2000-2017 (Government of Papua New Guinea, 2022a)
- A National Forest Monitoring System for which a web portal has been established. The portal provides the most comprehensive land use information in PNG. This will be strengthened in the future with new data from the National Forest Inventory and the re-measurement of Permanent Sampling Plots to improve accuracy of estimating GHG removal in degraded forests
- A Summary of information on safeguards, together with a National Safeguards Information System, which have been endorsed by the NEC in November 2020, as well as the guidelines for a Grievance and Redress Mechanism. REDD+ Benefit Sharing & Distribution Guidelines were finalised in 2022
- A draft REDD+ Finance and Investment Plan has been developed. This plan aims to support the delivery of REDD+ through climate finance (both grants and results based), development partner finance, philanthropy, government support and the private sector
- The first version of the PNG and the Green Climate Fund PNG project development manual is available to guide and inform national stakeholders on how to develop project proposals to access and utilise the GCF efficiently and effectively.

The implementation of the National REDD+ Strategy has resulted in a consistent and repeatable approach to monitor changes in forest cover, leading to better understanding of sustainable management of forests, as well as addressing climate change and mitigation. However, continuous capacity building is necessary for PNG to further sustain and build on the current dataset (PNG Forest Authority, 2019). REDD+ work has also resulted in a consistent definition of forests, and mapping of forested areas, filling a critical information gap on forests. This information is anticipated to contribute to national planning and policy formation for sustainable development for PNG (PNG Forest Authority, 2018). However, there remains uncertainty between the Forest Authority and the Climate Change and Development Authority regarding the jurisdiction of forests (Hoare, 2020). It appears that reviews of the Forestry Act to harmonize with the REDD+ policies have been put on hold at present. A review of the Forestry Act is underway with consultations occurring in 2020 (PNG FA, personal communication, 2020).

The REDD process and carbon market was dogged with allegations of 'carbon fraud' and corruption. This was especially so in the early phases when 'carbon cowboys' entered the marketplace, but to some extent the arguments continue (Gavara-Nanu, 2020). It is hoped that the safeguards now in place will protect landholders and the government against such problems in the future, but this will need constant vigilance and education programmes for village communities to ensure that free, prior and informed consent is given to any projects.

REDD+ has vast potential in PNG, but across the world it is noted that in 2022, this has "yet to translate into the provision of adequate and predictable financial support for developing Countries" (UN REDD Programme, 2022, p. 8). Lessons learned by the UN-REDD programme in relation to REDD+ funding have shown the need to leverage public funds to enhance access to private sector financing, as confirmed by the recent growth in carbon market investments in REDD+. An example of such a mechanism is the Lowering Emissions by Accelerating Forest Finance (LEAF) Coalition, an ambitious new public-private initiative designed to accelerate climate action by providing results-based finance (UN REDD Programme, 2022). PNG is currently preparing an application for LEAF support.

The report of lessons learned includes other notable points for working with public and private donor funds in REDD+(UN REDD Programme, 2022):

- The need for a high level of accountability and transparency in fund management and disbursement;
- Desire by donors for clear social safeguards and benefits;
- Burden and transaction costs for countries where they need to deal with multiple donors with different strict requirements and mechanisms, and the reluctance of some donors to support consolidated funds;
- In some countries, issues with internal agencies competing for position in administering REDD+ funding.

[76] Several development partners were involved in this process. "Between 2011 and 2017 PNG, with support from development partners including the UN-REDD Programme (implemented by UNDP, FAO and UNEP), JICA, GIZ, the EU and the FCPF Readiness Fund (implemented through UNDP), worked to increase capacity and understanding of REDD+ across key stakeholders within the country as part of the REDD+ Readiness Phase of REDD+ development. PNG has also assessed the drivers of forest cover change through partnership between CCDA and PNGFA as well as UNDP and FAO." https://pngreddplus.org/about/.

Overall Goal: Acheive 50 percent carbon neutrality by 2030 and full carbon neutrality by 2050

Energy Sector headline target: Carbon neutrality within the energy industries subsector

1. Non-GHG Quantitative Target

Enhance levels of renewables in the energy mix from 30% to 78% by 2030 for on-grid connection

2.Non-GHG Action-based targets

2.1 Reduce energy demand through the adoption and implementation of MEPSL
2.2 Establish a framework for fossil fuel emission offsetting
2.3 Enhance data collection capacities

Figure 52: Energy sector Goal and Targets
Source: Global Green Growth Institute and CCA (2021a, p.24)

7.3.4 Mitigation: Energy sector

The mitigation roadmap for the electricity sector aims to reach 50 percent carbon neutrality by 2030 and net zero by 2050, while also meeting the Government's target for 70 percent of households to have electricity by 2030 (Global Green Growth Institute & CCDA, 2021b) (Figure 52).

The country's mountainous terrain and geographically dispersed population compounds challenges to developing rural electrification infrastructure in the country. Less than 15 percent of the total population in PNG has access to electricity (UNDP, 2021)[77], and few settlements away from urban areas are connected to the electricity grid. Electricity access in rural areas is estimated to be under 3.7 percent, and PNG's rate of energy poverty is among the highest globally, comparable with countries in sub-Saharan Africa (Sharma et al., 2021). Remote and rural areas able to access electricity are often powered by high-cost diesel generators, which are unreliable and contribute to poor air quality and GHG emissions.

Generally, electricity supply from the grid is unreliable, with frequent blackouts. The state power utility (PPL) manages all on-grid generation, which is about 300 megawatts, mainly from hydropower and diesel generators. Other independent providers also supply power to PPL. Total generated capacity is about 580 megawatts, consisting of approximately 40 percent hydropower (230 MW or 37 percent diesel, 14 percent gas-fired and nine percent geothermal. Reform and institutional strengthening are underway to improve delivery. It is estimated that reaching the targets of 70 percent of households having access to electricity will require an additional 300 megawatts (Global Green Growth Institute & CCDA, 2021b).

Only about six percent of the country uses renewable energy (UNDP in PNG, n.d.). The Green Growth Potential Assessment concluded that PNG has a high potential for renewable energy from hydropower, solar, wind, biomass, and geothermal sources. Benefits are likely to include more cost-effective access to electricity to service greater numbers of rural and remote residents with associated improvements in agricultural productivity; increased fuel savings and reduced household expenditure on energy; reduced GHG emissions from the power generation sector; reduced risk of air pollution related illness; and job creation associated with constructing and maintaining renewable energy infrastructure (Global Green Growth Institute, 2019).

However, despite the benefits, a number of barriers need to be overcome to enable widespread adoption of renewable energy in PNG (Global Green Growth Institute, 2019). These include:

- A lack of an enabling policy environment, including a fixed national electricity tariff which is subsidized and does not cover the full cost of generation and distribution;
- A private sector which does not yet support renewable energy;
- A lack of reliable data about demand and supply; and
- Vandalism and theft of infrastructure.

Planned mitigation activities to increase renewable energy include creating an enabling environment and specific projects, some of which are already underway while others are longer term. The main source of renewable energy increase will be from

[77] Note these figures vary in different reports and databases, from 7-50 percentperent. What is certain is that theis the power supply is absent from many rural areas and is often unreliable.

hydropower, supported by solar and biomass. Wind and geothermal power are not included in the present plan, though they may play a role in the future (Global Green Growth Institute & CCDA, 2021b).

Off-grid and microgrids will play a part in the future energy mix, and two UNDP projects are underway to support this (Section 7.4.3). At present, many small stand-alone solar power systems are being installed, but some of these are substandard and at times dangerous, as there is no regulatory framework, many illegal salespeople, and little capacity to install or service systems properly (Karen Anawe, pers. comm., 2022). Work is underway to create a regulatory system to support microgrids, with a first step the recent development of the PNG Regulation for Small Power Systems, which provides for private and public investments in energy service products including power systems of less than one megawatt. This will allow for the involvement of communities, and will facilitate micro, small and medium enterprises to become energy service providers in remote areas of the country, bringing affordable energy services to rural villages (UNDP in PNG, 2022).

7.3.5 Adaptation plans and activities

National adaptation planning is underway with nine key focus areas (UNDP-UNEP, undated):

- Coastal flooding and sea level rise
- Inland flooding
- Food insecurity caused by crop failures due to droughts and inland frosts
- Cities and climate change
- Climate induced migration
- Damage to coral reefs
- Malaria and vector borne diseases
- Water and sanitation
- Landslides.

Training for this adaptation plan is being rolled out, and climate assessments, climate resilient plans and adaptation plans are being developed or have been completed for a number of provinces, including New Ireland, Enga, and Milne Bay.

7.4 Development partner projects and programmes

This section lists selected recent and current projects and programmes relevant to climate change and renewable energy underway in PNG, identified through internet searches and from information provided through UNDP. A list of development partners programmes, along with priorities for action, are also included in the Second Biennial Review, which state the priorities for assistance (Table 39).

Table 39: Technical and capacity building needs for each climate change action area
Source: Government of Papua New Guinea (2022c, p. 57)

Climate change action area	Technical and capacity building needs
Cross-cutting	▸ Development of sectoral policies to address climate change issues ▸ Monitoring and Evaluation knowledge and skills ▸ Technology needs assessment ▸ Financial needs analysis
Adaptation	▸ Vulnerability assessment knowledge and skills ▸ Climate-induced hazard modelling knowledge and skills
Mitigation	▸ Mitigation assessment ▸ development assessment ▸ Transformative change assessment ▸ Understanding of different tools used for mitigation assessment, sustainable development assessment and transformative change assessment
GHG inventory	▸ Enhanced understanding of 2006 IPPC guidelines and their 2019 refinement ▸ Data management skills ▸ Understanding of different tools used for GHG assessment ▸ Uncertainty analysis knowledge and skills ▸ Quality assurance and certification knowledge and skills

7.4.1 Publicity and advocacy

PNG is one of 120 countries where UNDP's "Climate promise" programme is helping governments and communities to deliver on their national climate goals, as expressed in their NDCs.

In June 2021, UNDP with partners supported the government, particularly CEPA and CCDA, to host a high-level National Environment and Climate Emergency Summit. This two-day event invited government and community members to come together with development partners to develop strong commitments to tackling climate change, and to prepare for the Glasgow meetings. The event was livestreamed on social media and is available to the public.

Later in 2021, UNDP ramped up publicity efforts to promote a wide range of voices leading up to and at the Glasgow Conference of Parties (COP26) of the UNFCCC. Social media was again used effectively to communicate messages.

Outputs of the advocacy work have included the Outcome statement from the National Environment and Climate Emergency Summit, which:

- "Called on all development partners and the private sector to orientate their investments to sustainable, climate-friendly actions and solutions to ensure the greening of PNG's economy
- Highlighted the need for the Government to take decisive action to better regulate against actions that may present harm to the environment, and in particular through policy and legislative directions in the extractives, agricultural, forestry and fisheries sectors
- Called on all the partners to enhance collaboration between stakeholders, coordination between departments and partnerships with the private sector
- Stressed the urgency of actions required, highlighting the overwhelming scientific evidence proving the catastrophic consequences of climate inaction using the real-life situation in the Autonomous Region of Bougainville (ARoB) as a case
- Called on all development partners, including the private sector, to support the more effective financing of the Sustainable Development Goals as a pathway to support all people of PNG address climate disruption, protect the environment and rise above poverty."

Cross-cutting programmes:

In 2020, the Government of PNG was supported by partners to develop its updated NDC, which was published in 2021. "In collaboration with other development partners, the UN supported GoPNG to enhance its NDC and work towards setting measurable targets to reduce greenhouse gas emissions under forestry, energy, and adaptation sectors within the second NDC (enhanced NDC). The NDC includes emissions reductions of more than 60 million tonnes of CO2 over the coming decade while delivering economic, social, and environmental co-benefits. Achievement of the action areas in the enhanced NDC will be critical in helping transform the livelihoods of PNG's rural communities and safeguard biodiversity" (United Nations in Papua New Guinea, 2020, p. 31).

Global Green Growth Institute (GGGI)

GGGI is an intergovernmental organization that works towards a 'green growth' model. Its objective in PNG 'is to support the ongoing effort of the Government in integrated planning for inclusive and climate-resilient green growth (CRGG) and in successful project implementation through mobilizing climate finance and green investments'.

The GGGI has given support to the government with its policy setting and nationally determined contribution. Two current projects are:

- The Pacific Green Entrepreneurs programme (funded by the Qatar Fund for Development), which supports 'green' business, including training in the 'Pacific Greenpreneurs Incubator Program'
- Climate-Resilient and Green Growth (CRGG) Project (2019-2022, funded by the Australian Government).

The project has produced a green growth strategy for the country (Global Green Growth Institute, 2019) and several specific strategies for provinces (GGGi, 2021a, 2021c, 2021b) with detailed possibilities developed by meetings of communities and experts for both mitigation and adaptation. A CRGG Phase II 2023-2027 is being designed.

7.4.2 Financing and capacity building

The Global Green Growth Institute has provided readiness and preparatory support to facilitate PNG accessing funds from the Green Climate Fund to assist the country in mitigating its contribution to climate change and adapting to the adverse impacts of climate change (Global Green Growth Institute, 2019).

7.4.3 Mitigation – REDD and green energy

To return PNG to its status as a 'sink' for greenhouse gases, the revised NDC stresses the need for attention to two main sectors: agriculture and forestry (especially land use and land use change, known as LULUCF); and energy. As a contribution to LULUCF, UNDP has supported the development of REDD+[78] as an important tool for avoiding deforestation and has also been working to assist more sustainable land use through land use planning projects (see Chapter 9). Two phases of the project "REDD+ Readiness" have been conducted.

[78] REDD+ stands for countries' efforts to reduce emissions from deforestation and forest degradation, and foster conservation, sustainable management of forests, and enhancement of forest carbon stocks. For more information, see https://www.forestcarbonpartnership.org/what-redd.

Relevant Projects

REDD+: "UNDP Forest Carbon Partnership Facility REDD+ Readiness Project Phase Two (FCPF II) (UNDP, 2020c) 2018-2020 US$5 million World Bank's Forest Carbon Partnership Facility Readiness Fund

The project supports the PNG Government to manage and implement the country's REDD+ readiness actions, including strengthening capacities related to the National Forest Monitoring System, Forest Reference Emissions Level and safeguards; and to increase engagement with a range of stakeholders. The anticipated results are:

- A five-year Finance and Investment Plan available to implement the National REDD+ Strategy;
- A national REDD+ communications strategy implemented at the national and sub-national levels;
- A Safeguards Information Systems developed and being implemented;
- Improving capacity in building initiatives and sector-based consultations for implementing the REDD+ Strategy;
- A national REDD+ Steering Committee and Technical Working Committees are established and functioning;
- Provincial stakeholder engagement plans for REDD+ implementation being implemented; and
- Strengthening of PNG's Forest Reference Level and National Forest Monitoring System, improving quality of forest data for accurate greenhouse gas reporting and monitoring of REDD+ safeguards, policies and measures.

Papua New Guinea: Renewable Biomass Project (Asian Development Bank, n.d.); (PNG Biomass, n.d.).

The proposed biomass project in Markham Valley, Morobe will be the first utility scale renewable biomass power generation project in PNG, providing up to 30 MW of power into the Ramu Grid. It will use wood chips from trees grown and harvested in surrounding plantations. The World Bank sponsored modelling and desk-top identification of 10 potential sites across PNG for wind-generation (Fae and Knight, 2015).

Pawarim Komuniti

As part of the PNG Electrification Partnership (PNG, Australia, Japan, New Zealand, the United States), Australia has allocated approximately AUD $20 million (2019-2022) for Pawarim Komuniti (PNGAus Partnership, 2020), an off-grid electrification programme to support access to clean energy in rural and remote communities. The programme provides grants to eligible companies or NGOs who will work with partners to establish clean energy systems generating less than 1 MW of power in areas that are beyond 10 km of existing power grids. Of 67 responses to the first call for proposals, six were shortlisted for consideration by the Australian delegate. Expressions of interest for the second grant round focused on mini-grids closed on 15 July 2020. A third call for proposals is likely to occur towards the end of 2020, focusing on solar home systems (Energy Wing, Department of Petroleum and Energy, 2020). The project is required to demonstrate gender inclusivity outcomes (PNGAus Partnership, 2020), and is likely to have significant benefits for women in terms of livelihoods, health and productivity.

UNDP Facilitating Renewable Energy and Energy Efficiency (FREAGER) UNDP/GEF, US$ (Global Environment Facility, 2017).

The FREAGER project seeks to enable the application of feasible renewable energy/energy efficiency technologies for achieving greenhouse gas emission reduction in PNG. It has four components focusing on:

1. Institutional development;
2. Technology applications;
3. Project financing; and
4. Awareness raising.

The project complements the national electrification plan, by assisting national agencies to develop the frameworks required for operating off-grid markets and mini-systems. An important output is the PNG Regulation for Small Power Systems, which has been handed over to the National Energy Authority (NEA) by to facilitate the promotion of access to affordable clean energy.

The project also supports the demonstration of relevant technologies to achieve widespread replication of micro and mini-hydro mini-grids, solar photovoltaic mini-grids, and township energy efficiency programmes. It aims to remove barriers to these technologies in the areas of policy and planning, technical and commercial viability, availability of financing, and information and awareness.

Support to Rural Entrepreneurship, Investment and Trade (STREIT)

STREIT is a large joint UN project funded by the EU and led by FAO, in which UNDP is a partner focusing on the renewable energy component. The overall project objective is "To increase sustainable and inclusive economic development of rural areas" through a combination of two integrated outcomes: (1) increasing the economic returns and opportunities from three selected value chains - cocoa, vanilla and fishery while; (2) strengthening and improving the efficiency of value chain enablers including the business environment and supporting sustainable, climate proof transport and energy infrastructure development.

This UNDP aspect of this programme is overseeing the installation of solar panels to generate renewable energy in select remote schools and health facilities

[79] The PPCR is part of the Strategic Climate Fund (SCF), a multi-donor Trust Fund within the Climate Investment Funds (CIF) and provides financing through the multilateral development banks to support programs in the selected pilot countries. The goal of the PPCR is to help countries transform to a climate resilient development path, consistent with national poverty reduction and sustainable development goals. The Government of PNG obtained a SCF-PPCR grant from the Asian Development Bank to implement the Building Resilience to Climate Change (BRCC) project, following it strategic plan for climate resilience (Papua New Guinea's Strategic Program for Climate Resilience, 2012).

in East and West Sepik Provinces. This is part of broader efforts to increase the use of solar energy to enhance agricultural value chains and improve production, particularly for women-led micro and small enterprises. Recent activities include training of solar technicians from PNG Power – an important step towards long-term sustainability of installations especially on public buildings.

7.4.4 Adaptation

Building Resilience to Climate Change in Papua New Guinea (BRCC)

Building Resilience to Climate Change (BRCC) in PNG is a major project supported by the Asian Development Bank through the Pilot Program for Climate Resilience (PPCR)[79] targeting vulnerable island and atoll communities in four provinces (East New Britain, Manus, Morobe and Milne Bay) and the ARoB. There are three components of the overall BRCC project.

1. Climate change vulnerability assessments and small sub-projects at island level: Many of the island communities in the four provinces are very vulnerable to sea level rise, with limited and decreasing freshwater access, food gardens threatened by saltwater, and receding coastlines. In addition, many are extremely isolated and difficult to reach, and have very little ability to communicate with the outside world. For example, of the approximately 140 inhabited islands in Milne Bay Province, only around 15 are in communication with the provincial government, so there is little ability for them to be warned about and assisted in disaster events.

   To better understand the needs of these communities, UNDP and its partners have undertaken major field work to visit and consult the people who live in these areas, and their local and provincial governments. Through the vulnerability assessments, the project conducted analyses and developed a summary of vulnerabilities and exposure of each island community to climate change and disasters, through a combination of climate change predictions for the area, and direct structured and gender sensitive/representative community consultations. The communities deliberated on possible appropriate solutions to enhance adaptation to the predicted climate change impacts and their priorities formed the basis for developing small-grant subproject investment proposals. Both the climate change vulnerability assessments and the subproject proposals were validated through workshops involving respective provincial and local government agencies. In this way, the projects are very 'bottom-up' and community-driven, but also fit well into the bigger picture in terms of local and provincial development plans. Ultimately, the subprojects will oversee the actual implementation of the individual subprojects on the islands/atolls.

   In addition, gender sensitive disaster response strategies and emergency response plans are being developed for each of the communities on the islands/atolls. This is complementing the ongoing establishment of early-warning systems. The project also conducts extensive awareness and training of relevant authorities and the communities and will ensure improved mainstreaming of climate change adaptation into local and provincial policies and planning.

2. Food security and fisheries in Manus, East New Britain and Milne Bay: UNDP is working to identify vulnerabilities and issues in food security due to climate change on home food gardens and marine food sources and options for improving food security. This will result in establishment of pilot home gardens as well as Locally Managed Marine Areas and improvements to watershed integrity, where appropriate. Detailed planning of this part of the project is currently underway.

3. Wharf development in Alotau – to be resilient to future sea level rise.

To date, outputs in relation to the vulnerability component of the project include climate change vulnerability assessments and investment plans, gender responsive disaster response strategies and emergency response plans for each of the island/atoll communities across the target areas (East New Britain, Manus, Morobe and Milne Bay provinces, and ARoB). Outputs for the food security and fisheries component are planned for the first half of 2022.

Advancing PNG's National Adaptation Plan Feb 2020 – August 2021 US$1.74 million Green Climate Fund (UNDP, 2020e).

This project aims to mainstream climate change into regulatory and policy frameworks to address climate change adaptation and to increase climate change adaptation awareness amongst key stakeholders at national and sub-national levels. Anticipated results include:

- Regulatory and policy frameworks are reviewed and reforms are initiated;
- At least 200 stakeholders are sensitised to climate change adaptation;
- Adaptation priorities are integrated into national and four sectoral policies;
- Stronger mechanisms for regularly updating and reviewing adaptation are fed into iterative adaptation planning processes;
- A system for economic analysis and appraisal of adaptation plans is established; and
- A National Adaptation Plan financing and investment strategy are completed.

Early warning systems and climate monitoring systems have been upgraded. More details are available in the vulnerability to disaster section (UNDRR, 2019a).

UNDP Building Resilience to Climate Change (UNDP, 2020a), 2019—21. US$3 million Asian Development Bank through the Strategic Climate Fund.

This project's objective is to increase resilience to the impacts of climate vulnerability and climate change and improve capacities of government agencies, civil society, and communities in vulnerable atolls and islands, to plan and to respond to the impacts

of climate change. It focuses on 21 sites in the Autonomous Region of Bougainville (AROB), and the four participating provinces of East New Britain, Manus, Milne Bay and Morobe. Anticipated outputs include local level:

- Climate change and vulnerability assessments;
- Awareness raising campaigns/community consultations;
- Investment priority plans are developed and collected from communities;
- Gender-responsive disaster response strategies; and
- Trained disaster management committees.

The Pacific Resilience Partnership is the umbrella implementation mechanism for the Framework for Resilience Development in the Pacific, which provides high level strategic guidance to different stakeholder groups on how to enhance resilience to climate change and disasters in ways that contribute to and are embedded in sustainable development.

PACRES (Intra-ACP Global Climate Change Alliance Plus Pacific Adaptation to Climate Change and Resilience Building) aims to ensure better regional and national adaptation and mitigation responses to climate change challenges faced by Pacific ACP countries. The PACRES programme was admitted into the CCDA list of Agencies in 2020 focusing on implementing adaptation/mitigation projects in PNG. PACRES focuses on scaling up of two CCDA identified climate affected communities that have undergone project implementation by CCDA project partners, which are Karama community of the Kerema Central, Gulf province and Keapara community of Rigo, Central Province.

Climate change and disaster resilience US$107 million, 2016-present, Australian Government (Department of Foreign Affairs and Trade, undated).

Current projects include:

- The Climate Resilient Green Growth Project (US$6 million, 2018-2022), which helps PNG's government, businesses, and communities to pursue climate resilient, low-carbon development pathways;
- Non-Government Organisation Climate Change Grants Program (US$2 million, 2018-2020), helping civil society organizations support PNG communities to increase their resilience to climate change and disasters;
- Placement of an Australian climate change advisor in the PNG CCDA to support policy development and bilateral links;
- Constructing roads/bridges to accommodate more extreme weather through the Transport Sector Support Program;
- Incorporating renewables into energy sector projects for both off-grid and on-grid electrification;
- The Climate and Oceans Support Program in the Pacific Phase 2 (US$23.3 million, 2018-2022) works with the PNG National Meteorological Service to provide seasonal forecasts that help farmers plan for harvesting, and weather warnings to alert people about disasters; and,
- The Pacific Resilience and Governance Program (US$10 million, 2019-2022) supports governments across the region to include climate change and disaster risk factors in their planning, budgeting, and implementation to ensure they are building resilience into government initiatives across a range of sectors.

Climate Smart Agriculture project (Australian government) is scheduled to end in 2024. ACAIR with the PNG Department of Agriculture and Livestock, CCDA, University of Goroka and the CSIRO.

7.5 Risks of not managing climate change

PNG has clear targets and policies for managing climate change. A key challenge is resourcing implementation, with financial resources, expert and technical advice, government systems and community capacity all needed. For example, investments in adaptation and resilience have yet to have widespread impact at the community level. The majority of the population remains vulnerable to the impact of natural disaster, with these impacts likely to increase over time.

A national adaptation plan is being finalized, which will set the framework for adaptation activities. Inevitably this project will only be the beginning of the work required to adapt to climate change across PNG. Adaptation and resilience activities need to be developed with local communities and tailored to local conditions as there are substantial differences in likely geophysical and socioeconomic impacts of climate change across geographical regions (UNDRR, 2019a).

The voluntary carbon market has been problematic, and from March 2022 there has been a moratorium on these activities in PNG. More work is needed on regulatory framework – and corruption-free enforcement – to enable carbon markets to function properly (Donald, 2022).

Without taking action to adapt to climate change, PNG will face more extreme impacts associated with:

- Low-lying and coastal communities affected by flooding and sea level rise;
- Malaria, dengue and other mosquito borne diseases;
- Inland flooding and landslides;
- Loss of and changes to terrestrial and marine ecosystems and biodiversity;
- Challenges to food security stemming from climate driven changes to agricultural and native harvested yields; and
- Displacement of communities.

The impacts of global climate change are driving vulnerabilities associated with more extreme weather events, sea level rise, and potential changes

to biodiversity and loss of livelihoods. Investments in adaptation and resilience have yet to have widespread impact at the community level. The majority of the population remains vulnerable to the impact of natural disaster, with these impacts likely to increase over time.

7.6 Recommendations

PNG is currently working to finalize roadmaps and adaptation plans to meet the commitments in its NDC. The most important recommendation is that these actions are supported, implemented and evaluated. Work on conservation measures such as forest and marine conservation, and increasing and managing protected areas, also contributes to both mitigation and adaptation activities.

7.6.1 Support development and maintenance of data and reporting of emissions and climate change actions to meet required verification standards and drive improvement

PNG's greenhouse measurement, reporting and verification system can be supported by financing, establishing and maintaining:

- A comprehensive national GHG inventory based on IPCC methodologies to estimate and report anthropogenic emissions by sources and removals by sinks, consistent with the requirements identified in the National Inventory Improvement Plan and advice from the UNFCCC (Climate Change Development Authority, PNG, 2020)
- The CCDA resources required to apply Part IV of Climate Change (Management) Act 2015, which provides for regulated sectors to report annually. Prioritise mandatory reporting by high-emitting subsectors, including land use change and forestry, energy industries, and fugitive gas emissions
- Establish web-based platforms that enable industry reporting, and for information about emissions trends and compliance to be publicly reported. For example, the PNG REDD+ and Forest Monitoring Web-Portal to share information (domestically and internationally) on all forest and REDD+ related issues, to allow stakeholders to participate and to ensure that implementation of REDD+ policies and measures including safeguards are results-based.

7.6.2 Continue and expand mitigation efforts through all relevant sectors

Implement mitigation measures in the Revised Nationally Determined Contributions and the Roadmaps for the AFOLU and Energy sectors, to significantly reduce and/or offset greenhouse gas emissions, including actions to:

- Implement mitigation actions for the transport sector identified in the Revised Nationally Determined Contribution (NDC)
- Reduce emissions from the Agriculture Sector through improved agricultural practices as identified in the Revised Nationally Determined Contribution and AFOLU roadmap
- Reduce emissions in the Industrial Process and Product Use and Waste sectors by implementing actions identified in the Revised NDC, including creating a node of industrial sustainability that minimizes waste, enhances inter-industry cooperation, and more effectively and efficiently utilizes local resources
- Reduce emissions from LULUCF sector including effectively implementing the national REDD+ Strategy 2017-2027 and reducing the impacts of commercial logging, subsistence agriculture and oil palm plantations
- Work towards the transition to 100 percent power generation from renewable sources by 2050 through actions identified in the Revised NDC and the Energy Sector Roadmap. Accelerate implementation of energy efficiency initiatives, including through off-grid mechanisms. Require the oil and gas sector to reduce their overall emissions.

7.6.3 Continue and expand climate adaptation planning and implementation in all sectors and all parts of the country

See also Vulnerability to Disaster (Chapter 12).

The National Adaptation Plan needs to be completed and implemented. Adaptation activities can efficiently be integrated with other local-level programmes such as building disaster resilience; water, sanitation and hygiene projects; energy efficiency and off-grid power generation; conservation rangers.

Note that adaptation and resilience activities need to be developed with local communities and tailored to local conditions as there are substantial differences in likely geophysical and socioeconomic impacts of climate change across geographical regions (UNDRR, 2019b).

Those most impacted by climate change, such as women and children and those in the most vulnerable communities, should be a focus of urgent actions.

Chapter 8.

Marine conservation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DP

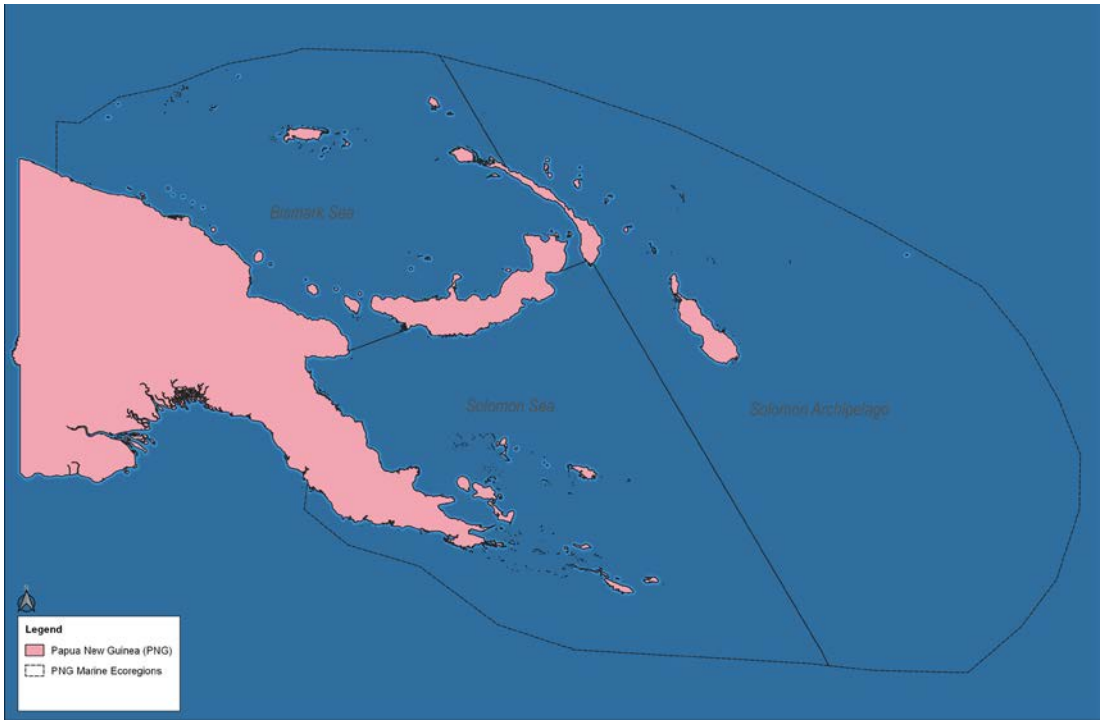

Figure 53: Papua New Guinea's marine bioregions
Source: Green et al. (2014).

8.1 Context for marine conservation in Papua New Guinea

Papua New Guinea's (PNG's) marine environment is vast and diverse, globally significant in terms of its ecosystem structure, function and biodiversity, and locally significant for the many residents who rely on its products for subsistence and for income. Increasing pressure from a growing population, increased threats from land-based activities, and impacts of climate change are all challenging sustainable productivity of the marine systems.

PNG's marine environment (excluding the Torres Strait) lies within the Coral Triangle, an area shared with Indonesia, Philippines, Malaysia, Solomon Islands, and Timor-Leste, which scientists identified as the epicentre of marine biodiversity (Veron et al., 2009).

PNG has the highest marine biodiversity richness of the Pacific Ocean countries (Conservation and Environment Protection Authority, 2019). Marine environments include inshore lagoons, fringing and barrier reef systems, and shallow banks, and extend into very deep offshore areas encompassing slope, abyssal plain, trenches and ridges, seamounts and deep ocean vents (Adams et al., 2017). There are extensive mangroves and seagrass beds. PNG lies on the West Pacific flyway of seabirds and its waters are on migratory paths for cetaceans, turtles and tuna (Conservation and Environment Protection Authority, 2019).

PNG's Exclusive Economic Zone (EEZ) is large: while quoted figures vary, the Oceans Policy states that it is 3.12 million km2 (Department of Justice & Attorney General, 2020, p. 10).[80] Its marine and coastal areas support at least 500 species of stony corals, 1,635 reef-associated fish species, 43 mangrove species, and seven seagrass species (CEPA and SPREP 2020). The EEZ has 21 shelf sea bioregions located within five large-scale marine and coastal ecoregions (Green et al., 2014). Two of the large ecoregions - the Bismarck Sea and Solomon Sea – lie fully within PNG's national jurisdiction. The other three ecoregions – the Pacific Warm Pool, the Coral Sea, and the Arafura Sea – extend into other national jurisdictions (Green et al., 2014).

Most of PNG's threatened and highly biodiverse marine and coastal ecosystems and species are not well protected, leaving them potentially vulnerable to conflicting resource use and over-exploitation. However, because such a large proportion of PNG's marine areas are remote and difficult to access, many have been spared the degradation associated with densely populated settlements. Closer to shore about 850,000 people (eight percent of the population) live within one km of the sea. They are dispersed among 4,000 rural coastal communities throughout 14 provinces.

Communities vary in the extent to which they harvest marine products from estuarine, coral reef, mangrove and sea-grass habitats (CEPA and SPREP, 2020). These coastal populations are expanding rapidly, placing pressure on coastal and marine resources that are essential for income, food, medicines, cultural values and physical protection from severe weather

[80] A commonly cited figure is 1,673,759 km2

(e.g., mangrove forests and fringing coral reefs). Some coastal communities are facing more regular crop failure due to effects of climate change, so their reliance on marine resources for food is increasing (Busilacchi et al., 2018; Butler et al., 2020). In many instances, marine resources are the main source of cash income, which is needed for health services and education (Simard et al., 2019). Other pressures on marine and coastal areas include changing and intensifying weather patterns, rising sea levels and other effects of climate change; impacts from land-based activities including a loss of foraging and breeding grounds; invasive species; overfishing, with destructive fishing practices in some areas; illegal, unreported and unregulated fishing; and increased frequency of crown-of-thorn starfish (COTS) outbreaks (CEPA and SPREP 2020). Increased foreign investment in fishing may further deplete fish stocks (A. Smith, 2020). The impacts of mine waste and resultant pollution have been severe (Busilacchi, Curth-Bibb, et al., 2020). This occurs from accidental discharge and spills as well as legal discharge of tailings into rivers and the submarine environment (Kwong et al., 2019).

In recent years, uncertainty about the impacts on the marine environments by offshore deep seabed exploration and mining for minerals by foreign companies has raised community concern (Department of Justice and Attorney General, 2020). Sandmining has also become a recent concern for some coastal communities.

Some of PNG's marine ecosystems are of international significance. The Milne Bay Seascape situated within the Solomon Sea bioregion is part of a tentative world heritage site (Hitchcock and Gabriel, 2015). Another two areas identified by experts as ecologically or biologically significant marine areas in the international context (EBSAs) are partially or totally under the jurisdiction of the PNG Government (Secretariat of the Convention on Biological Diversity, 2014). These are the PNG portion of the EBSA Remetau Group: South-west Caroline Islands and Northern PNG and the New Britain Trench Region.

8.2 Legislation, policies and agreements relating to marine conservation

The Conservation and Environment Protection Authority (CEPA) is responsible for the design and implementation of marine conservation and planning initiatives. CEPA works closely with provincial and local level governments, civil society and international and national research organizations, as well as other PNG agencies including the Department of Minerals and Geohazards, the Coastal Fisheries Development Agency and the National Fisheries Authority (NFA).

A number of Acts of Parliament, Multilateral Environmental Agreements (MEAs), plans, strategies and policies are of relevance to marine sanctuaries and regional protected areas including Locally Managed Marine Areas (LMMAs). PNG's Policy on Protected Areas sets directions for the establishment of protected areas, including national marine resource use and conservation. The institutional framework within the Organic Law on Provincial and Local-Level Governments 1998 provides a strong basis for local community-based management of marine and coastal areas. Management and planning of marine resources must work within the Organic Law and other relevant acts of parliament, and enable and support government processes (CEPA & SPREP, 2020; Government of Papua New Guinea, 2015). Refer to Chapter 2 for a more general list of instruments relating to environmental management.

8.2.1 Legislation

The most relevant legislation relating to marine conservation is summarized in Table 40.

Table 40: Legislation relevant to marine conservation

Legislation	Scope
Marine Pollution (Preparedness and Response) Act 2013	Relates to oil/other substances; gives effect to relevant international conventions.
Quarantine Act 1953 **Quarantine Regulations 1956**	Biosecurity for international trade.
The International (Fauna and Flora) Trade Act 1978	Control of exploration, importation and introduction of flora and fauna from the sea, whether dead, alive, their by-products, parts or derivatives.
Fauna (Protection and Control) Act 1966	Provides for the conservation and management of PNG fauna, particularly through the establishment of Wildlife Management Areas (WMAs), administered by local interest groups through a Wildlife Management Committee. Provides for the protection of fauna through the declaration of protected fauna (dugong and leatherback turtles). It does not provide protection against development, or provide for threatened species, and needs revision.

Legislation	Scope
Fisheries Management Act 1998 (FMA) and Regulation	Provides for and gives effect to the National Goals and Directive Principles and in particular to promote the management and sustainable development of fisheries, and for related purposes.
Environment Act 2000	Provides for the protection of the environment; regulates the environmental impacts of development activities by safeguarding the life-supporting capacity of air, water, soil and ecosystems; and the management of national water resources and the responsibility for their management.
PNG Maritime Zones (Amendment) Act 2015	Provides for delimitation of maritime zones of PNG and the rights of Papua New Guineans in those zones; incorporates provisions of the UN Convention on the Law of the Sea; regulates marine scientific research in waters of PNG; and makes provisions in regard to marine environmental protection and underwater cultural heritage.

In addition, the following legislation is of relevance:

- Crocodile (Trade and Protection) Act 1978 and Regulation;
- Conservation and Environment Protection Authority Act 2014;
- Dumping of Wastes at Sea Act 1979 and Regulation (DOWASA);
- Prevention of Pollution at Sea Act 1979 (POPASA) and Regulation;
- Maritime Zones Act 2015;
- National Maritime Safety Authority Act 2003;
- Merchant Shipping Act 1975; and
- Oil and Gas Act 1998.

8.2.2 National policies

There are several national level plans, strategies and policies related to marine conservation (Table 14).

Table 41: National policies and strategies relating to marine conservation

Policies and strategies	Comments
National Oceans Policy 2020-2030	Designed to provide a framework to improve ocean governance and management. The vision is a healthy ocean that achieves responsible sustainable development outcomes and aspirations for PNG, whilst addressing and mitigating impacts of climate change, natural disasters, anthropogenic waste, and land-based sources of pollution. Aims to provide the strategic direction for planning, resource allocation – to promote sustainable management and use of ocean resources within and beyond PNG's national jurisdiction. Reaffirms the recognition of Indigenous and local community ownership regimes of any ocean space and natural resources within PNG's national jurisdiction, recognizes the need for ecosystem-based management and sustainable use, promotes marine protected areas, and requires environmental impact statements using a precautionary approach for any likely impact. Established five principles: 1. Transparent, accountable and integrated governance and management; including the development and implementation of a comprehensive ocean policy strategy; 2. Improving understanding of PNG's marine resources through science and research; 3. Protecting and maintaining the health of the ocean and coastal environment; 4. Sustainable development and management of the use of ocean resources; and 5. Promoting and enhancing the peaceful use of the oceans (Department of Justice and Attorney General, 2020).
Policy on Protected Areas	See Chapter 5.
The National Marine Plan of Action 2019-2023	Provides an overarching framework for managing PNG's marine environment, including targets and goals for establishment of the marine protected area network. Currently being updated (new draft developed).
National Plan of Action for Sharks and Rays, 2021-2024	Covers all species in the class Chondrichtyes (sharks, skates, rays and chimeras). The Plan addresses global concerns about the management of sharks and addresses conservation, management and sustainable use, coordination and control between NFA and CEPA and encourages LMMAs to protect and manage critical habitats.

Other significant national plans and policies include: National beche-de-mer fishery management plan, National tuna fishery management 2014, National lobster fishery management plan, National mudcrab management plan, and National fish aggregating device management policy.

8.2.3 Multilateral Environmental Agreements (MEAs)

Table 42: Multilateral Environmental Agreements

MEA	Comments
United Nations Convention on the Law of the Sea (UNCLOS) including Conservation and Management of Straddling Fish Stocks and Highly Migratory Fish Stocks (2001)	Ratified in 1994, UNCLOS provides a comprehensive regime of law and order in the world's oceans and seas establishing rules governing all uses of the oceans and their resources. It enshrines the notion that all problems of ocean space are closely interrelated and need to be addressed as a whole. States should cooperate to ensure conservation and promote sustainability of fish stocks both within and beyond the exclusive economic zone.
South Pacific offshore fisheries management agreements	South Pacific offshore fisheries are managed through a regional ocean governance framework of organizations including the Pacific Community (SPC), the Pacific Islands Forum Fisheries Agency (FFA), the Secretariat of the Pacific Regional Environment Programme (SPREP), and the Pacific Islands Forum (PIF). Regional Fisheries Management Organizations are critical for tuna fisheries management (Karcher et al., 2020). Parties to the Nauru Agreement (PNA) control the world's largest sustainable tuna purse seine fishery.
International Convention for the Prevention of Pollution from Ships (MARPOL)	Includes regulations aimed to prevent accidental pollution and pollution from routine vessel operations.
1. Memorandum of Understanding on the Conservation and Management of Marine Turtles and their Habitats of the Indian Ocean and South-East Asia; **2. Memorandum of Understanding on the Conservation and Management of Dugongs (Dugong dugon) and their Habitats throughout their Range; and** **3. Memorandum of Understanding for the Conservation of Cetaceans and their Habitats in the Pacific Islands Region.**	1. Establishes a framework through which States, territories and other stakeholders work together to conserve marine turtle populations and their habitats, for which they share responsibility. There are four sub-regions; species covered include loggerhead, Olive Ridley, green, Hawksbill, leatherback and flatback. 2 Aims to promote internationally coordinated actions to ensure the long-term survival of dugongs and their seagrass habitats throughout their range. Signed by 27 States. 3. Provides an international framework for coordinated conservation efforts to improve the conservation status of the Pacific Islands cetaceans. Incudes 22 range States.
Coral Triangle Initiative on Coral Reefs, Fisheries and Food Security	Multilateral partnership between the governments of Indonesia, Malaysia, PNG, Philippines, Solomon Islands, and Timor-Leste (Coral Triangle Initiative, 2017).
Torres Strait Treaty	Between Australia and PNG (1985), to acknowledge and protect the traditional way of life and livelihood of traditional inhabitants allowing for their traditional fishing and free movement between the two countries. The Treaty enables sustainable commercial fishing activities through binding agreements on Total Allowable Catch and other resource-sharing strategies for six fisheries.

8.3 Current status and progress towards marine conservation goals

Source	Target/ goal	Comment
SDG14: Conserve and sustainably use the oceans, seas and marine resources for sustainable development	SDG 14.2 By 2020, sustainably manage and protect marine and coastal ecosystems to avoid significant adverse impacts and take action to achieve healthy and productive oceans. SDG 14.7 By 2030, increase economic benefits through sustainable management of fisheries, aquaculture and tourism.	Status: progress towards target. · National Oceans Policy in place to facilitate the blue economy processes
Aichi Target 6: Sustainable management of aquatic living resources	By 2020 all fish and invertebrate stocks and aquatic plants are managed and harvested sustainably, legally and applying ecosystem-based approaches, so that overfishing is avoided, recovery plans and measures are in place for all depleted species, fisheries have no significant adverse impacts on threatened species and vulnerable ecosystems and the impacts of fisheries on stocks, species and ecosystems are within safe ecological limits.	Status: progress towards target but at an insufficient rate · National management plans and policies in place for selected species

Source	Target/ goal	Comment
Aichi Target 11: Marine protection	By 2020, at least 17% of terrestrial and inland water, and 10% of coastal and marine areas, especially areas of particular importance for biodiversity and ecosystem services, are conserved through effectively and equitably managed, ecologically representative and well-connected systems of protected areas and other effective area-based conservation measures, and integrated into the wider landscapes and seascapes.	Status: slow progress • 0.21% of coastal and marine areas within the EEZ are protected • New additions will only increase to 2.2%
Coral Triangle Initiative goals	Goal 1. Priority seascapes designated and effectively managed; Goal 2. Ecosystem approach to management of fisheries and other marine resources fully applied; Goal 3. Marine protected areas established and effectively managed; Goal 4. Climate change adaptation measured achieved; and Goal 5. Threatened species status improving (Coral Triangle Initiative, 2017).	Status: some progress • Milne Bay Seascape (Solomon Sea ecoregion) is part of a tentative World Heritage site • South-west Caroline Islands and Northern PNG – critically important for streaked shearwaters, fish and coral • New Britain Trench – productive fisheries
Policy on Protected Areas	10 percent of territorial waters and the coastline within a variety of marine protected areas by 2025. 2.5 percent of territorial waters under a combination of no-take zones and zones which allow fishing only by customary landowners for subsistence use by 2025. 10 percent of offshore areas outside territorial waters but within the EEZ will be included in national marine sanctuaries by 2025.	Status: slow progress • Refer Achi Target 11

Most of PNG's threatened and highly biodiverse marine and coastal ecosystems and species are poorly protected, and are vulnerable to conflicting resource use and over-exploitation (Department of Justice and Attorney General, 2020). Without reduction in international fishing effort, populations of pelagic species remain under threat (Pinheiro et al., 2019).

8.3.1 Marine protected areas

PNG has 123 marine protected areas (MPAs) with at least 29 designated, 20 voluntary and 25 proposed marine MPAs, which when gazetted would still only comprise two percent of the EEZ (CEPA pers.comm., 2022). High priority marine areas for conservation actions have been identified and prioritised using available information and according to specific conservation principles - comprehensiveness, adequacy, representation and resilience (CARR) (Adams et al., 2017; Government of Papua New Guinea, 2015; Tulloch et al., 2021). This reserve planning work integrated marine areas with connected landscapes. In August 2020, part of Bootless Bay including the Bautama Central Papua Conference (CPC) land for the Seventh-day Adventist church was declared a marine protected area. This has been achieved through a conservation easement agreement signed between CPC and CEPA for the conservation of mangroves in Bautama, which further strengthens the Bootless Bay MPA (Keamo, 2020).

The Protected Areas Bill may eventually recognize over 1,000 LMMAs, and other places set aside by communities, and provide the platform to create a comprehensive marine protected area network in line with IUCN categories, management and governance arrangements (Leverington, 2019). Once the Bill is passed, any LMMA recognized under any local or provincial law will be recognizeon the official national register and statistics. The proposed legislation will also recognize areas already protected under any other legislation, including current MPAs under the Maritime Zones Act and the Law of the Sea. Conservation deeds are being used as an interim protection mechanism for marine areas (Booth, 2021).

Major barriers against the implementation of MPAs across PNG's coastal waters are the chronic lack of resources and personnel for effective management (Department of Environment and Conservation, 2019). This issue is likely to be resolved through the Biodiversity and Climate Fund that is currently in development.

LMMAs have been agreed to throughout the country, with varying levels of implementation and support. Legal mechanisms have been created to support these in several local government areas (Booth, 2021). Most had support from NGOs at some stage during their formation, but have not had consistent support since, and have faced many challenges. For example, a cluster of LMMAS was established in Kimbe Bay, West New Britain. In the 1990s and 2000s, several local communities, government and NGOs in Kimbe Bay worked together to establish LMMAs where special rules (e.g., 'tambu' reserves, no-take zones, harvest limits) would be managed by local community resource owners. The main goal was to enhance food security while maintaining biodiversity conservation, but most were not actively managed after the withdrawal of The Nature Conservancy (Butler et al., 2017). The design of the LMMAs was based on principles of reef resilience and habitat

connectivity; locally-agreed harvesting restrictions and management plans; legislation developed under local level government by-laws; long-term efforts to build awareness and capacity; and user fees and fines as the financing mechanisms. In 2013, a review of these LMMAs revealed that although there have been some ecosystem improvements, the LMMAs were not actively managed and the financing mechanisms were not working (Wise et al., 2016). However, in recent times there has been a renewed commitment to the LMMAs from landowners, the provincial government and supporting agencies, including CEPA and UNDP. The landowners are also taking control and are keen on driving the direction of future development.

The PNG Centre for Locally Managed Areas (PNGCLMA) was established in 2009 to coordinate the LMMA Network for communities and practitioners. This NGO also houses the secretariat of a Learning and Training Network (LTN) which comprises PNG's marine resource management organizations in partnership with the Coral Triangle Initiative (CTI) Secretariat within CEPA (SPREP, 2020c).

8.3.2 Special species

The following PNG marine species are subject to international trade controls under CITES (Convention on International Trade in Endangered Species of Wild Fauna and Flora CITES, 2017):

- Sawfish species (Appendix 1);[81]
- Estuarine crocodile (Crocodylus porosus) (Appendix 2);
- Black and Acropora coral species (Appendix 2);
- Bigeye Tuna (Thunnus obsesus) (Appendix 2);
- Wedge fish (Rhynchobatus spp.) (Appendix 2);
- Leatherback turtle (Dermochelys coriacea) (Appendix 1);
- Dugong (Dugong dugong) (Appendix 2);
- All shark and ray species (Appendix 2);
- Giant clam (Tridacna giga) (Appendix 2);
- Sea turtles (Cheloniidae spp.): green, loggerhead, hawksbill, olive ridley and hawksbill; and,
- Dolphins and whales (Cetacea), excluding blue whales and humpback whales (snubfin and humpback freshwater dolphins are listed as vulnerable on the IUCN Red List);
- Guitarfish (Appendix 2);
- Sea cucumber (black teatfish and white teatfish sea cucumber) (Appendix 2).

Seven of the world's eight species of giant clam shell species are found in PNG, and most are under threat, mainly from overfishing, poaching by foreign boats, and climate change. Of the total seven marine turtle species found in the world, six of them occur in PNG. Three are listed as critically endangered, one near threatened and one vulnerable.

Marine turtle conservation

PNG is a Party to three regional arrangements for marine turtle conservation and sustainable management i.e., the Regional Marine Turtle Action Plan under SPREP, IOSEA arrangement, and the Regional Plan of Action under the CTI. However, these are largely not implemented, and turtle conservation programmes underway focus on nesting turtle tagging and protection of nesting beaches. They do not extend to halting turtle hunting and sale of marine turtle products (Opu, 2018).

8.3.3 Fisheries

Local fishers target finfish and invertebrates for subsistence, local sale or export, and have exclusive rights to traditional fishing grounds within a 3-12 nautical mile zone from the coast. Although PNG's coastal environment and fish stocks are relatively healthy, there has been depletion of some fisheries (CEPA and SPREP 2020). However, significant loss of coastal fisheries is evident along PNG's coastline. Marine resources in provinces that have depended heavily on them to sustain livelihoods have come under increasing stress because of fish catches that exceed sustainable levels, destructive fishing methods, and use of outboard engine-powered crafts to access distant or protected fishing grounds (Conservation and Environment Protection Authority, 2019).

Beche-de-mer

The collapse of the lucrative village-based beche-de-mer fishery due to overexploitation led to a temporary closure (five years then a further three years) by the National Fisheries Authority in 2010. During a brief re-opening for a few months in 2017, villagers in New Ireland were able to generate enough income to make a significant financial contribution to their local economy (Hair et al., 2019). In other coastal areas, illegal fishing and trading of beche-de-mer occurs. A full stock assessment was conducted in 2018-19 to validate the stock and the fishery was opened in September 2020, based on the non-detrimental findings of the assessment (i.e., only for the white teat fish and the black teat fish) (Vagi Rei, personal communication, 2022).

Customary fisheries

The customary fisheries of PNG are extremely important. The Fisheries Management Act 1988 defines "customary fishing" as fishing by indigenous inhabitants, in waters where they are entitled by custom to fish, where the fish are taken in a manner that is substantially in accordance with their customary traditions and the fish are taken for household consumption, barter or customary social or ceremonial purposes. The customary fisheries of

[81] Appendix I: species threatened with extinction. Trade in specimens of these species is permitted only in exceptional circumstances; Appendix II: species not necessarily threatened with extinction, but in which trade must be controlled in order to avoid utilization incompatible with their survival.

PNG exploit a wide variety of species, most of which are located on the reef, nearshore marine areas, in inter-tidal mangrove areas, and in the extensive bodies of freshwater. Finfish, various gastropods, giant clam, lobster, and aquatic plants are the major groups exploited by the customary fisheries.

Although there is no specific government articulation of objectives in the management of customary fisheries, it is generally understood that safeguarding the fisheries' resources is the key objective to enable these resources to contribute to the food supply of villagers. The Fisheries Management Act 1988 addresses the management of customary fisheries in a number of provisions[82] and allows customary fishing rights' holders to manage the exploitation of resources in areas under customary jurisdiction. The specific management measures vary from area to area and can involve resource or area ownership in which community leaders restrict access by outsiders, as well as various kinds of harvest bans for residents. Reducing fishing effort to prevent over-exploitation of resources is often, but not always, the intent of these measures.

Customary management works reasonably well in the PNG context, with the measures implemented being able to protect village fishery food supplies from major threats, as they have been doing for many centuries. Given the limitations in government funding and capacity there are few viable alternatives to customary management. The major difficulty encountered with customary fisheries management in the PNG concerns threats that cannot be addressed at the site level, such as the downstream effects of logging. Other problems experienced in many places are the breakdown of traditional authority, increasing commercialization of fisheries, and lack of demarcation of many customary fishing areas. With the very large number of customary management systems in PNG, many may not be oriented to achieving any of the Government's established goals.

Enforcement of customary management is generally carried out by the residents of the management area concerned. The enforcement is often more effective when directed at outsiders, as opposed to residents of the area. As customary management arises from within the communities, it is sensitive to local stakeholders' concerns. The degree of direct stakeholder input into management decisions can vary considerably between communities. Generally, information for management is acquired by direct observation of the abundance of the species concerned. In many cases the village fishers have harvested the important fishery resources for several generations and are well aware of changes in abundance.

Small-scale commercial fisheries

The major types of resources exploited by the small-scale commercial fisheries of PNG are finfish, rock lobsters, and the sedentary species: beche-de-mer, pearl oyster, trochus, and green snail. Over 300 species of finfish have been recorded from PNG's coastal fisheries. Panulirus ornatus, or ornate rock lobster forms most of the catch in the lobster fishery. The commercial beche-de-mer fishery takes about 20 species. The main pearl oyster species are the blacklip pearl oyster (*Pinctada margaritifera*), goldlip pearl oyster (*P. maxima*), and the brownlip pearl oyster (*Pteria penguin*). Trochus fishing and green snail fishing each target a single species. Except for the rock lobster fishery, which is covered by a bi-lateral arrangement with Australia, all the other components of PNG's small-scale commercial fisheries are managed on a national basis.

As there is no recognized "management system" for the country's small-scale fisheries, the Government has not specifically articulated management goals. General objectives, however, can be inferred from the Fisheries Management Act. Some local areas have management plans, although the strategies applied to attain the objectives vary considerably across PNG. In general, the approach in recent years has been to formulate fishery management plans, which are required to: identify the fishery and its characteristics, including its current state of exploitation; specify the objectives to be achieved in the management of the fishery; identify any possible adverse environmental effects of the operation of fishing activities in the fishery; and identify where appropriate any relevant customary fishing rights or practices.

This general strategy is complicated somewhat by the relationship between the national Government and lower levels of government. Under the Fisheries Management Act, responsibility for management of PNG's fisheries lies with the NFA. However, the Organic Law on Provincial Governments and Local-Level Governments gives these lower levels of government vaguely defined rights in regard to the development and management of their natural resources, including fisheries. This can overshadow the Fisheries Management Act, which empowers NFA to manage, control and regulate all of PNG's fishery resources, whether inland, coastal or offshore. Although the Act recognizes and allows for customary uses, rights and traditional resource ownership, it does not in itself empower provincial or lower-level governments to manage fisheries in what they may consider to be their areas of jurisdiction.

Large-scale commercial fisheries

Around 18 percent of the global tuna stock is found in PNG's largest macro-economic fishery (the northern EEZ tuna fishery). Between 2012 and 2014, the sector averaged an estimated 500,000 tonnes landed catch – around 11 percent of the global catch. The industry is under threat from potential over-exploitation of yellowfin and bigeye tuna (a vulnerable species) (CEPA and SPREP 2020). PNG is a major tuna breeding ground, however, rising global temperatures may result in a shift of tuna out of PNG waters

[82] One of the 10 members of the National Fisheries Board must be a person nominated by fisheries resource owners; fisheries management plans must recognize and respect the rights of the customary owners of fisheries resources and fishing rights in all transactions affecting the resource or the area in which the right operates and must identify, where appropriate, any relevant customary fishing rights or practices.

altogether by 2050 (Pilling et al., 2015). By-catch from offshore commercial fishing threatens many IUCN listed species such as sharks and turtles. Illegal international fishing may be rife in offshore areas and has been reported closer to shore around Daru, Milne Bay, Manus and New Island (CEPA and SPREP 2020).

In recent years, the increased number of observers, improved auditing, and development of a sustainability programme have led to better commercial fisheries management. Recent successes in the management of the offshore fishing industry also include the establishment of the Parties to the Nauru Agreement, the introduction of the 'Fishing Days Scheme', and membership in the Western and Central Pacific Fisheries Commission (WCFPC) (CEPA and SPREP 2020).

The 2017 bêche-de-mer fishing season made a significant financial contribution to coastal villages in New Ireland and can do so in future with opportunities for mariculture and improved fisheries management (Hair et al., 2019). A new Memorandum of Agreement (July 2020) between the Morobe Provincial Government and the National Fisheries Authority ensures that bêche-de-mer harvesting is exclusively reserved for indigenous Papua New Guineans. This will help the PNG Government reach its KPI of increasing revenue by 30 percent (Gware, 2020).

In May 2020 the PNG Fishing Industry Association (comprising 32 purse-seine vessels belonging to PNG, and another 32 owned by the Philippines but based in PNG) won a Marine Stewardship Council (MSC) certification for tuna harvesting and processing. Certification covers 10 criteria - seven relate to reducing environmental impact, and three focus on fisheries management. MSC-certified may provide a competitive edge for selling tuna to the US and other countries (Heath, 2020).

The PEUMP programme with assistance from WWF and WCS has supported development of the National Plan of Action for Sharks and Rays. This plan "explores conservation and management options that could be used to locally protect some of the most vulnerable species of sharks and rays whilst at the same time allow for sustainable use of other species to generate income in the commercial and artisanal fisheries sectors". Completion of this plan is a requirement of managing the utilization of sharks within national waters in accordance with the Regional Plan of Action on Sharks.

Shark fin fishing

Shark fin fishing is thought to be increasing throughout the EEZ, but accurate fishing effort estimates are difficult to obtain due to suspected high numbers of national and international illegal fishers (CEPA and SPREP, 2020). The first detailed examination of species composition using DNA barcoding of sharks from an artisanal fishery in the Milne Bay Province of PNG identified 20 species of sharks from 623 fins. Of these, 21 percent were threatened species (vulnerable or endangered), with 8 percent taken from the endangered scalloped hammerhead shark. Importantly, most fins were from juveniles (Appleyard et al., 2018). Scalloped hammerhead sharks also occur in PNG's northern waters, however, there is very little information on fishing effort for this species in these waters. Adult females are thought to regularly migrate north from Australia to Indonesia and PNG (Chin et al., 2017). Shark fishing activities in the Louisiade Archipelago of the Milne Bay Province were expected to increase substantially since the closure of the beche-de-mer fishery in 2009. However, one study showed that quarterly dried fin production was actually higher while the beche-de-mer fishery operated, possibly due to falling shark fin prices, a decline in market access since the beche-de-mer fishery closed, and the impact of rising fuel costs (Vieira et al., 2017).

Prawn, barramundi and lobster fisheries

The PNG prawn fishery comprises 19 prawn trawlers: 15 in the Gulf of Papua, one in the Orangerie Bay and three in the Torres Strait. All operate without by-catch reduction devices. By-catch includes several species of sharks and rays, and possibly other species e.g., turtles and dolphins. The peak season from April to July coincides with the migratory routes of some prawn species moving from the Great Barrier Reef to the Gulf of Papua. A barramundi fishery operates in Western Province along the southern PNG coastline, but there is a lack of data to calculate fishing effort. Lobsters are caught in the Gulf and Western Provinces, mainly for the export market, and in other provinces lobsters are caught and sold for local markets and hotels. The only legal way to catch lobsters is by hand-held spear gun. In the past, trawling produced large catches of lobsters, but this has been banned since 1984 (CEPA and SPREP 2020).

Mud crab fishery

Mud crabs are found in the mangrove and estuarine habitats throughout the coastal provinces in PNG and include four species (Scylla paramamosain, S. olivacea, S. serrata and S. tranquabarica). The National Mud Crab Fishery Management Plan 2019 aims to sustainably manage the mud crab fishery for the long-term livelihood benefit of the resource owners, and maintain populations at a biologically sustainable level. Mud crabs are an important food source and are consumed in large quantities by local coastal communities and some communities are heavily dependent on mud crabs for both food and income generation (Government of PNG, 2019). Mud crabs are caught by a variety of methods including by hand, pulled from holes using a forked stick, baited traps or nets, and gillnets. Prices of mud crabs vary among the provinces but are highly priced especially in urban markets (e.g., from PGK 5-50 per crab). Prices in Port Moresby are normally higher than other provinces, partly due to the high demand and easy accessibility to urban markets, restaurants, hotels and other business houses. There is no industrial harvesting of mud crabs. However, mud crabs have been recorded as by-catch in the Gulf of Papua prawn fishery.

The NFA has been conducting annual stock assessments in several maritime provinces since 2017.[83] Mud crabs have been exported from PNG since 1994, albeit in small volumes. Since 2015, these exports have grown exponentially, reaching a peak in 2019 with 807 tonnes and declining in following years, in part due to the restricted movements imposed by the Covid-19 pandemic (Government of PNG, 2019).

8.3.4 Respect and support tradition, tambu systems and local practices for conservation

Alternative sources of food and cash are urgently needed to reduce fishing pressure and to maintain ecosystem services and food security in coastal PNG. These can be partly realised with careful guidance and help through local, national and international partnerships. Together with the revival and application of traditional knowledge such as 'gwala', which sustained the Milne Bay's island communities for centuries, strong partnerships can help build resilience in coastal communities, and sustain marine resources well into the future. Through the practice of gwala, which protected healthy coral reefs and clam gardens, people on the island of Wiyaloki survived food scarcities during recent droughts such as El Nino (1997) that harmed livelihoods over large parts of coastal PNG. Since then, other marine resources including fish species have returned in healthy numbers, providing important protein for the islanders (CEPA and SPREP, 2020; Conservation International, 2020).

8.3.5 Inshore Fish Aggregating Devices deployed in maritime provinces

The NFA has deployed Inshore Fish Aggregating Devices (IFAD) into maritime provinces to provide food security, generate income and alleviate poverty for overpopulated small islands and coastal provinces under pressure. Subsequently, the IFAD will be used as a conservation and management tool to enhance the sustainability of fisheries resources, especially in reef environments. Submerged IFAD are now being deployed to counter vandalism.

8.3.6 Support marine tourism

Tourism is often perceived as a sustainable alternative to extractive industries such as mining and fishing, bringing many positive benefits including poverty alleviation, reliable income and much needed services and infrastructure. Marine tourism includes boating, cruising, fishing, snorkelling, diving, surfing and land-based activities on the coastal fringe. Surfing is a growing industry with the surf season officially running from November to April when surf conditions are at their best. Up to half the breaks are offshore. Surfing operations currently take place in Vanimo (West Sepik), Tupira (Ulingan Bay, Madang), New Island (e.g., Nusa Island), and the Admiralty Islands. However, there are numerous challenges to the establishment of a viable sustainable industry with benefits accruing to locals and visitors. Barriers include difficult physical access to sites of interest; relatively high costs of accommodation, tours, meals and airfares; international travel warnings; perceptions of safety; political instability; negative media publicity; access to health services; potential conflict between visitors and residents for limited resources; capacity-building of locals to sustain an influx of curious visitors (Sumba, 2020) and the lack of a nationally focused tourism plan and promotional activities.

It is proposed that the best prospects for wildlife tourism in PNG lie with birds; marine wildlife such as dolphins, turtles, fishes, coral reef species and crocodiles; and some terrestrial species (Markwell, 2018). To date, PNG wildlife tours focus mainly on terrestrial birds, although there are several diving resorts where tourists hire dive or snorkelling gear to visit nearby coral reefs Although dolphins of various species are frequently seen, there is only one 'dolphin-watch' tour, currently on Duke of York Island, East New Britain. There is potential for small-scale nature tourism based on nesting leatherback turtles in the Labu Tali WMA in Morobe Province (Markwell, 2018).

8.3.7 Blue carbon and 'sustainable blue economy' enterprises

Blue carbon is the carbon stored in coastal and marine ecosystems, estimated to be 83 percent of the earth's carbon stocks. Coastal ecosystems including mangroves and seagrasses sequester and store large quantities of carbon in the plants but mostly in the sediments below. Coastal ecosystems sequester carbon at a much faster rate than forests and at a greater amount per unit area, and when these systems are disturbed, carbon is released into the atmosphere (E. McLeod et al., 2011). Recognition of the important role of coastal and marine ecosystems in climate mitigation has created opportunities for funding of 'blue economy' projects supporting sustainable coastal management.

8.4 Threats to marine conservation and use

Threats to biodiversity and resource management generally are outlined in Chapter 3, and many of these have implications for the marine as well as terrestrial environments.

8.4.1 Overexploitation of marine resources

In PNG, research has shown that species diversity for both fished and non-fished species decreases as the size of the local human population increases, and this relationship is stronger in species that are fished (Drew et al., 2015). Thus, as coastal populations increase, there is an expected decline in abundance of reef fishes, possibly leading to over-exploitation of some species.

[83] Refer to National Mud Crab Fishery Management Plan 2019 for further information.

Because some marine resources such as bêche-de-mer and hard corals occur in shallow coastal waters, they are readily accessible to local residents, and can become vulnerable to over-exploitation. For some fisheries (e.g., bêche-de-mer fishery), fishers often exceed the total allowable catch despite sound stock monitoring in many provinces (Conservation and Environment Protection Authority, 2019). Further, as coastal populations continue to increase, more pressure is placed on inshore fisheries (CEPA and SPREP, 2020).

Increased foreign investment in fisheries operations may bring local employment, but could deplete fish stocks and create more local hardship (A. Smith, 2020).

8.4.2 Illegal harvest of marine animals

For many coastal residents the only way to earn cash is through the selling of high value marine products such as beche-de-mer or shark fin illegally (Busilacchi et al., 2018; Moran, 2020; Vieira et al., 2017). There are reports of illegal fishing within the PNG EEZ by foreign vessels (Conservation and Environment Protection Authority, 2019; SPREP, 2020d).

Dugong hunting is banned from the Dugong Sanctuary in Western Torres Strait. It is illegal to sell the meat of dugong or turtle species in the Australian communities; the sale of dugong meat is also banned in the 13 PNG Treaty villages and Daru, the capital of the South Fly district of the Western Province of PNG. The sale of turtle meat is also banned in Daru (but not in the Treaty villages). 15 Australian communities in the Torres Strait have developed turtle and dugong hunting management plans, which provide an important means of maintaining and revitalising culture. However, there is unregulated harvesting of these species in the 13 Treaty Villages along the PNG coast and Daru, despite the ban on the sale of meat (Hariharan et al., 2016). A management plan setting out objectives and management arrangements for this region of PNG has been under development for several years in response to concerns about: the large numbers of dugongs and green turtles caught by Treaty villagers using long mesh nets; overharvest leading to the illegal sale of dugong meat in the Daru market; and disturbance from large commercial vessels anchoring in channels adjacent to the feeding grounds in Bistow and Daru Islands (Hagihara et al., 2016).

8.4.3 Marine pollution

There are major concerns about the impact of marine mine waste disposal on shallow and deep marine biodiversity and ecosystem processes (CEPA & SPREP, 2020; Kwong et al., 2019; Mudd et al., 2020). Negative impacts from the nickel refinery and the tuna cannery on protected areas in the Madang Lagoon include local communities reporting fish kills, algal blooms and declines in water quality (Leverington et al., 2017). In 2019, Ramu Nickel accidentally spilled an estimated 200,000 litres of toxic slurry into a bay, turning the water bright red and staining the shore (Harriman, 2019). It is reported that the toxic slurry has killed marine mammals and large tuna, and caused health impacts among local people (Robinson-Drawbridge, 2019). Over the years, the Ok Tedi mine has polluted the extensive Fly River system forcing villagers (who were previously wealthy in terms of natural resources and subsistence living) to migrate to Daru (Busilacchi, Curth-Bibb, et al., 2020).

There are significant concerns about the number of shipping lanes that passes through PNG's waters and the potential for shipping accidents, including oil spills (Conservation and Environment Protection Authority, 2019).

8.4.4 Sedimentation

Rugged mountainous terrain, exceptionally heavy rainfall, tectonic activity and the rapid growth of both human populations and commercial activities have combined to create some of the highest soil-erosion rates in the world (Standish, 2019). One study modelling the effects of increased sediment and nutrient loads on inshore reefs due to oil palm development predicted that almost 60 percent of coastal ecosystems could be very degraded after five years if all suitable land was converted to oil palm. Limiting plantings to hill slopes below 15° would substantially reduce sediment load (Tulloch et al., 2016).

8.4.5 Deep sea mining

Deep sea mining is potentially very harmful to the marine environment (Childs, 2019). Mining, particularly of hydrothermal vents, can release methane and sequestered carbon contributing to greenhouse gas emissions (Department of Justice and Attorney General, 2020) (refer Table 59).

8.5 Effect on people especially those 'left behind'

Coastal residents have few opportunities to earn cash for essential human services such as clothing, education, some types of food and health. Access to healthcare, clean water and sanitation is limited, with few services provided by governments at all levels (Busilacchi et al., 2018; J. R. A. Butler et al., 2020; Moran, 2020; World Bank, 2019). For some, the only way to earn cash is through the selling of high value marine products such as beche-de-mer or shark fin to overseas markets (Moran, 2020; Vieira et al., 2017).

Climate change impacts pose huge challenges to marine and coastal ecosystem health and biodiversity and subsequently to the people who rely on these systems. Climate change impacts on coastal lands and islands include threats to ecosystem services; increased displacement and unmanaged human mobility; and loss of land to erosion or sea inundation, which can lead to loss of livelihoods and homes, community instability and forced displacement (See Section 7.1.2). In addition, disasters such as cyclones, chemical and pollution spills, can critically damage marine and coastal ecosystems.

Any plans to effectively manage marine resources must include viable pathways for the health and wellbeing of coastal communities, including easy access to basic human services such as health care and education, well into the future.

8.6 Development partner projects and programmes

Pacific-European Union Marine Partnership Programme (PEUMP)

This is the flagship initiative under the European Union (EU) cooperation and development regional programme to promote a healthy Pacific Ocean and strong governance of marine and coastal resources (European Union, 2018). This major Pacific-wide programme aims to address some of the most serious challenges faced by Pacific countries, including: the increasing depletion of coastal fisheries resources; the threats to marine biodiversity, including negative impacts of climate change and disasters; the uneven contribution of oceanic fisheries to national economic development; the need for improved education and training; and the need to mainstream a rights-based approach and to promote greater recognition of gender issues to ensure inclusiveness and positive changes for Pacific island people. The five-year PEUMP programme is funded by the EU (EUR 35 million) and the Government of Sweden (EUR 10 million). It is implemented by the Pacific Community (SPC), the Forum Fisheries Agency (FFA), the Secretariat of the Pacific Regional Environment Programme (SPREP) and the University of the South Pacific (USP) in close collaboration with NGOs and the national authorities. Six key result areas have been identified (Table 43).

Table 43: Key result areas
Source: European Union (2018)

Theme	KRA	Meaning
Oceanic Fisheries	KRA 1	High quality scientific and management advice for oceanic fisheries provided and utilised at regional and national level
	KRA 2	Inclusive economic benefits from sustainable tuna fishing increased through supporting competent authorities and strengthening private sector capacities to create decent employment
Coastal Fisheries	KRA 3	Sustainable management of coastal fisheries resources and ecosystems improved through better quality scientific information, legal advice, support, mentoring and empowerment at community level
Coastal and Oceanic fisheries	KRA 4	IUU fishing reduced through enhanced monitoring control and surveillance of both oceanic and coastal fisheries, improved legislation, access to information, and effective marine area management
	KRA 5	Sustainable utilization of the coastal and marine biodiversity promoted through improving marine special planning, increasing climate change resilience, enhancing conservation/ mitigation and rehabilitation measures
Capacity development	KRA 6	Capacity built through education, training and research and development for key stakeholder groups in fisheries and marine resources management. Gender issues and a rights-based approach will be mainstreamed throughout the programme

Activities conducted by the Wildlife Conservation Society are to provide support to coastal communities and stakeholders, in order to increase and improve community-based fisheries management approaches in New Ireland Province. The ultimate aim is to increase the spread of coastal fisheries management measures – and means for communication among stakeholders – to at least 80 percent of the communities in New Ireland Province (Booth, 2020). [84]

Investing in Coral Reefs and the Blue Economy: BE-EIF, also known as 'Gutpla solwara, gutpla bisnis' (Good oceans, good business)

UNDP is in the early stages of a new joint project to support local 'blue enterprises', leverage local skills and ultimately unlock private capital from domestic and international sources by demonstrating the viability of reef-first enterprise models. The project is supported by the Global Fund for Coral Reefs and the

[84] Please see Wildlife Conservation Society annual report.

UN Capital Development Fund. The joint programme will establish a Blue Economy Enterprise Incubation Facility (BE-EIF) to accelerate sustainable livelihoods' opportunities linked to the marine environment in Kimbe Bay, New Britain and Louisiade Archipelago, Milne Bay.

Through its technical assistance and finance facilities, the BE-EIF will provide cradle to exit support for blue enterprise development, crowd-in private capital through partnerships with domestic financial institutions and provide incentives for the long-term conservation of key marine ecosystems. The project is initially focusing on Kimbe Bay (West New Britain) and Milne Bay, Louisiade Archipelago. Both sites are high in biodiversity and encompass significant areas of coral reefs. Businesses and projects to be supported could include marine ecotourism, coral reef restoration and sustainable aquaculture, mud crab and seaweed farming. This approach can lead to sustainable impact investments to provide long-term resourcing for environmentally sustainable natural resource use. The project also has important implications for harnessing the contribution of the marine environment to climate change mitigation.

Kikori River Programme

The Kikori River delta in Gulf Province is home to two species of inshore dolphins, the Australian Snubfin and the Australian Humpback dolphins. This is the only area in PNG where these species are recorded and the only site outside of Australia for both species. The Piku Biodiversity Network (PBN) in partnership with the Pidu (Dolphin/Dugong) Project ,with funding from SPREP through the BIEM Initiative and PEUMP, with support from the CEPA, are investigating dolphin by-catch in the Kikori delta. The project is working closely with Kikori coastal villages. Three recorders have been trained to collect scientific data for dolphins. They monitor and record information on dolphin sightings, strandings or by-catch within their area. This information helps to provide scientific information on dolphin death rates and causes, informs the community and relevant stakeholders on the status of dolphins and assists in developing plans for community-based dolphin conservation and management.[85]

Implementation of the Arafura and Timor Seas Regional and National Strategic Action Programs

This includes the Second Phase of the Arafura Timor Seas Ecosystem Action Program (ATSEA-2), and the UN Partnership for Development Framework (UNPDF)/Country Programme (PNG 2018-2022: Outcome 3). The programmes focus on sustainable management of natural resources, biodiversity conservation, strengthened climate, and disaster resilience. By 2022, PNG should demonstrate improved performance in managing environmental resources and risks emanating from climate change and disasters.

Pacific Resilience Partnership (PRP)

The PRP short courses aim to build the capacity of climate change and resilience practitioners. This initiative is supported by the Australian Government through the grant supporting implementation of the PRP, and the EU through the Intra-ACP GCCA+ Pacific Adaptation to Climate Change and Resilience Building (PACRES) and Pacific-EU Marine Partnership (PEUMP) programme.[86] The short course training on grant writing attracted 200 participants from around the region.

USAID PACAM (2014-2020)

Through USAID's support, Mahonia Na Dari, a local NGO, trained nearly 300 primary school teachers to teach the Marine Environmental Education Program (MEEP) curriculum to more than 6,000 primary students in 24 Kimbe Bay schools. Youth participants were trained to plant mangroves and start their own mangrove nurseries as part of their MEEP training which helped them understand the Kimbe Bay's unique biodiversity across a range of marine ecosystems, including shoreline, mangroves, sea grasses, coral reefs, and the open ocean.[87]

Marine managed areas

In the YUS Conservation Area Landscape (Marine Component Area), the objective is to conserve and sustainably manage the YUS marine component area through on-going community involvement. The Milne Bay Eco-custodians are working to conserve and sustainably manage Milne Bay's marine and island resources area through on-going community involvement (e.g., Gwala Rising). Ailan Awareness in New Ireland Province is a CBO using a traditional approach to sustainably manage marine resources through community involvement (e.g., Vala North). The Centre for Locally Managed Marine Areas (PNGCLMA) is the secretariat to the PNG Marine Program National Learning and Training Network (LTN).

The Conflict Islands Conservation Initiative is a NGO with close links to Australia, working to "protect, conserve and enhance the natural environment, habitats and species of the Coral Sea with a particular

[85] Please see: https://www.facebook.com/Piku-Biodiversity-Network-Inc-298817660756783

[86] Please see: 2 Mu50artchp 1a1tf sr09i7:5d8; and https://bit.ly/3K92iaq.

[87] Please see: 2217 SNopvo8eombuer 2f00mi19.

emphasis on the area within and around the Conflict Islands region of Papua New Guinea (PNG), and the roles this region plays in its connectedness to the Great Barrier Reef (GBR) through our joint sharing of the Coral Sea, and to conduct research and education". The programme is also supporting 'reef guardians' of local LMMAs.

Mangoro Market Meri Project

Women-led participatory value chain analysis of mud crabs – a joint project with TNC and CSIRO centred on mangrove conservation and livelihood alternatives in Milne Bay and Manus Island (see Section 13.5.3).

Sea Women of Melanesia Programme

This programme, supported by the Coral Sea Foundation, empowers indigenous women with scuba diving and marine science skills so they can take an active role in creating and monitoring marine protected areas on their own coral reefs.

8.7 Gaps and risks in marine conservation

Additional conservation areas are needed to meet SDG 14 and Aichi Target 11. In particular, there is an urgent need to protect and manage deep water habitats and reefs, and to adequately protect spawning aggregations, turtles, seabirds and cetaceans. Further there is a need to undertake a prioritization of potential marine conservation areas at a local scale, rather than at the level of the whole EEZ. Prioritization of marine conservation should be based on specified conservation values, and account for the range of human uses of marine resources (Department of National Planning and Monitoring, 2015a). Many of the actions relating to protected areas are also applicable to marine conservation, including those dealing with resourcing, capacity and livelihood projects (See Section 5.9.).

8.8 Recommendations for marine conservation

8.8.1 Establish and manage marine protected areas

Though PNG has committed to increasing the coverage of marine protected areas, achievements so far have been limited and action needs to be accelerated. In the off-shore areas, the Government needs to act decisively to establish large-scale marine protected areas, reflecting the importance of the seascape concept in the Coral Triangle, and the priorities set in planning exercises (Adams et al., 2017).

LMMAs can only be established on the initiative of local communities, but support for these communities is important. LMMA communities need modest but sustainable support and can then do great work, so there is a big 'multiplier effect' on investment. A productive investment would be to support the PNG Centre for Locally Managed Areas PNG, which helps to promote LMMAs and share learnings and information among the scattered communities on coasts and islands.

8.8.2 Implement a programme of marine species conservation

There is a need for better habitat protection of marine species listed as critically endangered, threatened or vulnerable, as well as those subject to international trade controls under CITES. Habitat areas need to be patrolled to ensure that illegal harvesting does not occur. Management agencies require much stronger capacity to prohibit illegal sale of marine products including shark fin, beche-de-mer, lobsters and fish bladders. Management agencies should actively work with commercial fishers to reduce by-catch, such as through mandatory turtle-exclusion devices.

Communities and management agencies also need to enforce:

- Total allowable catch for targeted species, e.g., bêche-de-mer fishery, clam shell species, sharks, turtle, dugong, some finfish, trochus, crab, and tuna;
- Regulated harvesting of turtle and dugong (i.e., to end illegal harvesting);
- Dugong hunting bans in Western Torres Strait;
- Sale of dugong meat in 13 PNG Treaty villages and Daru; and
- Sale of turtle meat in Daru.

Dugong and marine turtle conservation

Recommendation: Review the National Marine Turtle Conservation Program and carry out an intensive awareness programme (Opu, 2018).

Support communities to progressively co-develop and implement local-level turtle and dugong hunting management plans in all coastal areas where they are hunted, which specify hunting methods, total allowable catch, where meat may be sold, protection of feeding and breeding grounds.

Sharks and rays

Recommendation: Implement and enforce the management plan for sharks and rays. WCS will implement a Shark Conservation Foundation project to amend national-level species protection legislation to include sawfish and rhino rays; update and amend the Shark and Ray National Plan of Action to include sawfish and rhino specific management recommendations; enact the first sawfish and rhino ray protection rules in PNG at two MPAs; and develop plans for new spatial management areas in key sawfish and rhino ray population strongholds in the Gulf of Papua.

8.8.3 Further explore and expand a range of 'blue carbon' and blue economy programmes

Apply the learnings from the current blue economy pilot programme (Section 8.6) and pilot programmes on seaweed farming, marine ecotourism and mangrove rehabilitation to other areas throughout the country.

8.8.4 Improve livelihoods for coastal residents

Any plans to effectively manage marine resources should include viable pathways for improving the health and wellbeing of coastal communities. Investigate and establish viable and sustainable opportunities for mariculture and improved fisheries management, especially in relation to beche-de-mer trading (Busilacchi, Murphy, et al., 2020; Hair et al., 2019).[88] For further information on livelihood and compensation projects, see Biodiversity, section 3.8.8 and Protected Areas, section 4.9.6.

8.8.5 Develop partnerships to support sustainable fisheries

The PNG Development Strategy Plan 2010-2030 outlines ways in which the Government can partner with large funding bodies to help coastal communities establish fishing cooperatives for sustainably selling local catch. Joint ventures could be established to facilitate the construction of critical infrastructure such as ports and jetties; cold storage and onshore processing facilities; and vital equipment including boats for co-op members. The onshore processing of fish such as tuna for domestic and international markets will add to PNG's manufacturing capacity (Department of National Planning and Monitoring, 2010).

8.8.6 Support coastal and marine ecotourism

In PNG's coastal areas, tourism may be a viable, sustainable addition to other livelihood options. There are potential gains in creating tourism opportunities for coastal communities, e.g., crocodile viewing, dolphin watch tours, leatherback turtles, coral and fish viewing (snorkelling, diving), and surfing. However, such initiatives have to be locally led to be successful. Capacity building of locals who may be potentially involved in tourism is crucial. Specific training in relation to nature interpretation, dive instruction, establishing and running tourist lodges and associated enterprises are all essential ingredients for success (Markwell, 2018).

[88] Improved management could occur with strengthened collaboration between Melanesian Spearhead Group (MSG) countries (Fiji, PNG, Solomon Islands and Vanuatu) and neighbours such as Indonesia and Australia; and with support from The Pacific Community (SPC) and donors such as the World Bank (Australian Centre for International Agricultural Research (ACIAR), 2019; Govern, 2018; Karcher et al., 2020).

Chapter 9.

Sustainable Land Use Planning


UN
DP

9.1 Context for land use planning in Papua New Guinea

Effective land use planning (LUP) is a cross-cutting issue that provides an essential basis for ensuring more sustainable natural resource management (NRM) and improved community well-being and livelihoods. Papua New Guinea (PNG) faces pressures from expanding community gardens, commercial agriculture and logging, a rapidly increasing population and internal migration, and a changing climate. Customary landowners, governments and commercial interests in PNG have a substantial role to play in ensuring more sustainable use of natural resources, including protection of forests, arable land, biodiversity, catchments, and ultimately food security. This is difficult to achieve in PNG with poor and sometimes non-existent LUP at all levels of government and the community.

This chapter addresses the role of land (and sea) use planning in relation to better protection of biodiversity and providing enhanced socio-economic and cultural outcomes for PNG and its people. Integrated and sustainable LUP are needed to underpin future development and improve the well-being of PNG's citizens. There have been many small steps on the path to achieving effective LUP, with many plans, policies and recommendations made but the outcomes have been limited.

9.1.1 Key elements of land use planning

LUP is a process whereby land is allocated between a range of uses in an environmentally sound way to ensure sustainable outcomes for the people, their environment and economy. It is an integrated process that helps to meet basic social/human needs, within the context of the available resources and technical knowledge (Thomas, 2001). LUP often takes place within a legal context and articulates the roles and responsibilities of the responsible agencies, and relevant procedures to be followed in the development planning process. The law often provides remedies for people affected by planning and development decisions/actions and penalties for those who fail to comply.

Land use policies and plans are effective only if they are implemented and consistently and fairly enforced. Thus, development control plays an important role in LUP, to ensure that developments are appropriately sited (e.g., do not impact on sensitive environments), have the necessary infrastructure and facilities, comply with relevant codes, and are safe and supportive of relevant communities. However, at times, political interference and corruption can influence the location of development and impact communities and long-term sustainability.

Effective land use policies and plans help to: (a) anticipate development needs in relation to housing, agriculture, education, transport, basic services and economic development; (b) identify opportunities and constraints to a range of developments; (c) identify areas suitable/unsuitable for different types of development; (d) propose how an area should develop over time; and (e) establish policies and standards to guide development. For example, LUP helps to ensure that housing and settlement areas are allocated in suitable areas (and not areas subject to inundation, natural disasters, or of high biodiversity value), with appropriate infrastructure and service provision, and similarly that commercial agriculture does not take place on steep land or important forest areas.

In PNG plans can be prepared country-wide, for regions, provinces, local level governments (LLGs) and smaller local areas/communities or vulnerable areas (e.g., a coastal zone plan or a catchment plan). In the absence of plans and policies, there is no framework upon which to base and justify decisions related to land use and development. The process can become open to misuse and corruption, such as the location of industrial areas in a politician's electorate or the leasing of agricultural land by foreign entities at the expense of local communities. In such circumstances the process can be seen as arbitrary, questionable, inconsistent and uncertain. In PNG, "often, plans are short-sighted and seek to bring quick financial benefits, sacrificing natural resources and traditional rights in the process" (World Wildlife Fund, 2020).

9.1.2 Land tenure and rights

It is useful to think about land tenure rights as 'bundles of rights' (Table 44), as this approach has implications for the administrative processes and registration systems related to land,[89] and how women's land rights are defined and their security of tenure is addressed. For example, administrative records often only identify the person or groups who have the formal, legal rights to the land and rarely assign different rights to various people in a group, especially women (refer s1.3.7, where issues related to land tenure in PNG were introduced).

[89] Land administration is the way in which the rules of land tenure are applied and made operational. This includes land rights (e.g. allocation of rights, delimitation of boundaries, transfer, dispute resolution); land use regulation (e.g. land use planning, enforcement and adjudication of land use conflicts); and land valuation and taxation (e.g. collecting revenues through land valuation and taxation and adjudication of land valuation and taxation disputes).

Table 44: Meaning of land tenure rights
Source: Doss and Meinzen-Dick (2020)

Land tenure right	Meaning - Rights to:
Usus	Use - including access and withdrawal rights
Abusus	Change the land - including management and transformation rights
Fructus	Make profit and loss
Exclusion	Prevent others from using a resource
Transfer	Transfer the land, whether temporarily or permanently
Future interests	Inherit or realise other rights at some future point

In PNG, formalization of the administration of land rights is often promoted as a prerequisite for economic development with perceived benefits including tenure security and access to credit, with a formal administration able to facilitate a land market (Department of National Planning and Monitoring, 2010; Government of Papua New Guinea, 2022b). These claims have been disputed (Anderson, 2009; Augustinus, 2008; Kaiku, 2020) and hence land reform remains a contentious issue. "When you talk about land and a policy on land, it involves people's lives, and we are touching on a very sensitive area" (Interviewee, personal communication, 2021).

The flawed design and implementation of land formalization can result in reduced tenure security, by concentrating rights to land in the hands of one or a few individuals and neglecting the claims of others, particularly women and other vulnerable groups, who may hold partial or common rights (e.g., to gather forest products, obtain water). Also, it may not provide access to credit, as banks may not accept agricultural land as collateral against loans (Food and Agriculture Organization of the United Nations, 2012).

Land use planning in PNG

In PNG LUP is a broad term that applies mainly to regional planning settings or lands outside of towns and cities, while physical planning refers specifically to urban settings (DLPP, personal communication, 2022). In this chapter LUP incorporates planning undertaken across PNG, i.e., within urban and regional settings.

Customary land tenure underpins the land system and land use planning in PNG and operates on unwritten laws, customs and practices whereby kinship groups own lands and seas and recognize and enforce a system of ownership and rights, including access to natural resources.[90] Much land tenure information is held within a community through collective memory. Exclusive individual landownership and inheritance are limited and this impacts on the way that LUP operates and the way that land is opened for development.

> *"Land, its custodianship and management by clans is central to the subsistence, hunting, gathering livelihoods and wellbeing of the majority of rural villages that make up PNG … Within the boundaries of the clan's land and seas the attributes of the land/sea are described by the language group of the peoples that live there…The clans identify areas suitable for gardens in wet times, in drought and for different crop types, depending on the stage of forest fallow regrowth within the swidden slash and burn cycle" (Mitchell, 2020).*

The land tenure system ensures that the customary landowners can make decisions to exploit the resources on their land and seas and gain benefit from this use. Important areas from which food, medicine and building materials are taken are known, along with hunting/fishing sites, customary closures and tambu areas (restricted places). This knowledge continues to some extent within the current generations.

At independence in 1975, the Constitution and later the Organic Law on Provincial Government and Local-Level Government (Organic Law) recognized customary land tenure. At this time about 97 percent of land in PNG (i.e. 47 million hectares) was in customary ownership (i.e., land is owned under traditional or customary title by nationals), and three percent (i.e. 1.2 million hectares) was alienated, with titles belonging to the Government (2.5 percent, with some granted as long term, 99-year leases) or freehold (0.5 percent) (Fletcher & Mousseau, 2019; Manning & Highes, 2008).[91] Recorded land titles are rare, and PNG law does not allow for the permanent alienation of customary land, and customary landowners in the main do not agree with land being alienated (B. Allen, 2009).

During the mid-1970s land reform was a major concern and two mechanisms were used to reduce customary land ownership (by about 12 percent):

[90] The rights to land may be held by a group, or parts of a group; and the rights to occupy this land may be determined by kinship or historical circumstances based on agreed histories that describe how the person or group came to occupy the land. Hence, determining rights to land within landowning groups varies from place to place and group to group and is rarely based on generalised principles of right holding (B. Allen, 2009).

[91] Note however, that in 1988 the Department of Lands estimated that alienated land had fallen to 1.3% (Government of Papua New Guinea, 2007; Filer, 2014).

1) Incorporated Land Groups (ILGs), established in 1974[92], allow customary owners to create a corporate body to 'hold, manage and deal with their customary land' and undertake small scale economic activities. This resulted in consent for large-scale resource extraction (mainly logging). The system is based on the establishment of ILGs and registration of customary land. An ILG can be a clan, tribe or other social unit. The incorporation process is administered by the ILG Division of Department of Lands and Physical Planning (DLPP) under the Land Group Incorporation Amendment Act 2009. This process is part of the Voluntary Customary Land Registration (VCLR) system in PNG, whereby landowners can register their land, or a portion of the land, and bring it onto the formal land market as a means to engage in legal transactions (Nao, 2019). The effect of registration means that the land is no longer customary land and custom ceases to apply on the land. After registration, any transfer, subdivision or selling is subject to the approval of the Minister for Lands and Physical Planning under s128 of the Act (Serowa, 2018). This system resulted in consent for large-scale resource extraction (mainly logging).

2) Special Agricultural Business Leases (SABLs) initiated in 1979, allow landowner groups to lease customary land for agricultural purposes. From 2003 to 2012, about 12 percent of PNG's land area came under SABL mechanisms, largely in the hands of national and foreign corporate entities (Fletcher & Mousseau, 2019) with long-term corporate leases,[93] many of which resulted in large-scale logging. The Commission of Inquiry into SABLs found 58 of 75 SABLs were subleased to developers for 99 years and left no residual rights to the landowners, and that the sublease agreements contained provisions that were grossly unfair to the landowners, making it almost impossible for customary landowners to reclaim the leased/subleased land (Gabriel et al., 2017; Numapo, 2013). This process of commercialising customary land in effect transfers clan rights to one or more individuals, who may not be clan leaders, but are supported by a developer who has a close connection with elected politicians or government officials (Gabriel et al. 2017). Global Witness described this large-scale acquisition of land in PNG as "the largest land grab in modern history", with about 5.6 million hectares of customary land (12 percent of PNG) converted to SABLs (Fletcher & Mousseau, 2019). The SABL process highlighted numerous deficiencies within the responsible agencies (DLPP, DAL, PNGFA and CEPA) and the unscrupulous behaviour of some companies and powerful elites (Numapo, 2013). In response, in 2011, the national Government imposed a moratorium on the grant of SABLS and several larger leases have since been cancelled (Filer, 2017; Filer et al., 2020; USAID, 2020). It is estimated the cancellation of the SABLs and challenges to their operation have prevented over five million hectares of allocated land from converting or transitioning to permanent agriculture (Global Green Growth Institute & CCDA, 2021a).

The government also grants other leases or licenses over customary land for resource development using sector-specific agreements with the customary landowners. These agreements vary from 10 to 50 years and cover about 15 percent of the total land area (7 million hectares) (USAID, 2020)

As a result of the changes described above, perhaps less than 70 percent of land in PNG remains under customary ownership without unencumbered leases or agreements.

Most recent developments

A series of National Land Summits have been held, with the inaugural summit in 2005 establishing the National Land Development Taskforce (2006), which recommended developing a system for accessing customary land for development. The National Land Development Program (2007) was established, in part, to improve the administration of customary and alienated land. The 2019 summit incorporated guidance for the formalization of customary land titles and the conversion of these titles into marketable assets. These recommendations were endorsed by the NEC in 2019 and PGK15 million per year was allocated over the next five years to Phase II of the National Land Development Program, which aims to "unlock customary land for economic development" (GovPNG, 2022). Key goals include the creation of a customary land development agency, review of existing customary land legislation, strengthening of the land court system, reform of existing agencies responsible for the management of customary land, and implementation of measures to ensure the bankability of customary land titles (Oxford Business Group, 2022).

Vision 2050 (launched in 2009) acknowledges land as a key enabler of wealth creation and that land reform is needed to enhance the performance of the PNG economy. This Vision and the National Strategy for Responsible Sustainable Development strongly outline a 'green' direction for the country's future. However, the PNG Development Strategic Plan 2010-2030 and the Medium-Term Development Plan III 2018-2022 (MTDPIII) (Department of National Planning and Monitoring 2018:25) set targets for the mobilization of customary land for development purposes. The MTDPIII aims to "increase bankable land for productive utilization" [94] by pursuing a

[92] By means of the Land Groups Incorporation Act 1972, amended in 2009.

[93] SABLs are based on a lease-lease-back arrangement whereby the customary landowners form an ILG, register their land for development and lease it to the government, which then leases the land back to the ILG, which subleases it to a company to develop and manage (Nelson et al., 2013). See also Filer (2017) and Hambloch (2022).

[94] Bankable land refers to: land alienated during the colonial period; remaining SABLs; and titles formally registered as properties of ILGs by 2016 (USAID n.d.).

strategy "to make more land available in the formal market for the land-owners to become effective partners and benefit from its development". Strategy 12, "Unlocking land for economic development", aims to raise the proportion of bankable land in the formal market from less than 5 percent to 20 percent in 2022 (Dept National Planning and Monitoring, 2010). The PNG Government views the 'unlocking' of customary land as necessary to promote future growth, especially in agriculture and industry and to improve the quality of life of its people. The land administration system is to "facilitate the marketing of customary and alienated land" (GovPNG, 2010: p. 44).

The Voluntary Guidelines on the Responsible Governance of Land Tenure (FAO, 2012) promote land formalization as a means to grant international investors access to large areas of land, often owned by customary landowners. However, the links between land formalization and improved social welfare indicators are historically unclear and unproven (B. Allen, 2009; Hambloch, 2022; Martin, 2013). In New Britain the customary land formalization process was captured by powerful 'big shots', and their patronage relations to the state, the elite, and companies, within a weak and changing governance structure (Hambloch, 2022; Martin, 2013). Thus, while voluntary guidelines may be useful, they are likely to have limited effectiveness in PNG, where land formalization and registering individual titles to land present a range of potential difficulties, including the possibility of large numbers of people, especially women, losing their ownership and rights to land, multiple claims over land, ongoing land disputes over ownership and boundaries, limited ability to administer the registration system and the potential for corruption.

9.2 Legislation, policy and agreements

In this section key legislation and policy most relevant to LUP are outlined. Matters related to LUP are evident at many levels in PNG, starting with the Constitution. However, much of the LUP legislation is outdated and some has resulted in severe negative impacts. LUP is in its infancy partly due to limited recognition of the important role that physical planning plays (DLPP, personal communication, 2022).

9.2.1 International conventions and agreements

Globally, land is seen as a key issue for both urban and rural people, and LUP is viewed as a missing tool in NRM.

Table 45: International conventions and agreements

International conventions and agreements	Comments
Convention on Biological Diversity	Key agreement for conservation. For a report on progress under this Convention, see the comprehensive 6th National Report (Conservation and Environment Protection Authority, 2019).
Convention for the Protection of the Natural Resources and Environment of the South Pacific Region and related Protocols (SPREP Protocol)	Under this Convention, PNG must: take all appropriate measures to protect and preserve rare or fragile ecosystems and depleted, threatened or endangered species and their habitats; and establish protected areas and prohibit or regulate any activity likely to have adverse effects on species, ecosystems or biological processes that such areas are designed to protect. This is a strong basis for identifying and including these areas within LUP at all levels.
Declaration of the Rights of Indigenous Peoples (UN 2007)	Article 19 - obtain free, prior and informed consent before adopting and implementing legislative or administrative measures. Article 26 - right to the lands, territories and resources … and the right to own, use, develop and control the lands, territories and resources they possess by reason of their customary ownership. Article 32 - determine and develop priorities and strategies for the development or use of indigenous lands, territories and other resources. These principles should underpin all matters related to land, land tenure and LUP in PNG.
Global Land Tool Network	Established as a coalition of partners (e.g., World Bank, FAO and bilaterals such as Sweden and Norway that are funding the International Land Coalition) to address pro-poor planning standards, land records, maps and improved governance. This network identified there are insufficient pro-poor land tools to implement land policy (Augustinus 2008). The International Federation of Surveyors and International Institute for Geo-information and Earth Sciences are developing a Social Tenure Domain Model to include legal rights, claims, secondary rights, overlapping claims onto the same information system. This will make it possible to place pastoral rights, women's rights, customary land tenure, on the same system. This information system can also be used to create land records (Augustinus 2008).

9.2.2 Key national legislation, policies and strategies related to land use planning

At a national level, the physical planning system in PNG provides the framework for spatial planning. The DLPP is the central agency addressing LUP across PNG. It comprises the divisions of Land Services (management of State Land), Customary Land Services (acquisition of customary land, ILGs, land leases and land projects) and Corporate Affairs. Customary land is not included in the realm of physical planning, which is centred on towns and cities. Statutory Physical Planning Boards are required at the national, provincial and local level, although these are largely absent at the provincial and local levels. There is some sustainable LUP at the local level, often supported by NGOs, that has driven successful economic development and sustainable land management activities, but this is often weakly linked with national and provincial planning systems and the plans have limited legal recognition (Schmidt, 2018).

Table 46: Key national legislation relating to land and sea use planning

Legislation	Comments
Physical Planning Act 1989 and Physical Planning Regulation 2007 (Office of the Chief Physical Planner, DLPP)	The Act requires the development of land use plans for provinces, districts and local levels and provides for land use planning of any resource development and of all land which is executed through the National, Provincial and Local Physical Planning Boards (i.e., the 3% of State-owned land). No land use plans have been developed outside urban areas through government processes. Customary land is not included in the realm of physical planning.
Planning and Monitoring Responsibility Act 2015	Provides a strong framework around which sustainable land use planning and development planning can be integrated.
Land Act 1996	Provides for the establishment of a National Land Board to advise the minister on the grant of leases on state land. Administered by DLPP.
Land Groups Incorporation Act of 1974 and Land Groups Incorporation Amendment Act 2009.	The incorporation process is administered by the Incorporated Land Group (ILG) Division of DLPP under this Act. The purpose is to establish a legal basis for customary land groups to register land tiles and enable them to lease land to government agencies or private investors. Established the Voluntary Land Registration (VCLR) system.
Land Registration Act of 1981 and Land Registration Amendment Act 2009	Responsible for the registration of customary land - enables customary ILGs to register land titles and enables them to lease their land to government agencies or private investors. Administered by the Customary Land Leases Division of the DLPP.
Special Economic Zones Authority Act 2019	To enable the establishment, development, operation and regulation of SEZs to encourage development of new and additional business activity. The Authority can acquire SEZ lands either by agreement with the owner or compulsory acquisition under the Land Act 1996 or lease arrangements (s52(1)). Landowners must be informed of the acquisition and agree to it; and agree to the compensation package (s52(2)). No taxes or imposts including income tax (for 15 years), customs duties, excise duties, stamp duty (s60). Schedule 1 includes a list of 20 proposed SEZs.
Road (Management and Fund) Bill 2020	Establishes the PNG Road Fund Authority, responsible for maintenance, safety and rehabilitation of the National Road Network. To establish an efficient road management and ownership system and create a sustainable funding regime to eliminate the accumulation of the maintenance backlog.
Organic Law on Provincial and Local Level Governments 1995	Addresses decentralization and provides the structure of the LLG (comprising assemblies of elected ward members, ward development committees and village planning committees). Allows citizens to participate directly in the affairs of their communities and influence decisions at the sub-national level and in framing development initiatives in their communities (Kiau, 2020).

Table 47: National strategies and policies relating to land and sea use planning

Strategies and policies	Comments
National Sustainable Land Use Policy 2022	Provides a framework for improved allocation, management and optimal use of land and its resources, including the release of customary land for development purposes through planning the use of land in rural and urban areas. [95] Allows the zoning of land linked to its importance for environment and development and enables provinces to actively prioritise physical planning (within urban settings) and LUP (from a regional perspective). It is anticipated that the NSLUP will result in the development of a National Sustainable Land Use Plan and development plans, along with a centralised National Land Use Information System and promote sub-national planning and the integration of economic planning into spatial planning.
Development Strategic Plan (DSP) 2010-2030 (Department of National Planning and Monitoring, 2010)	Contains sector goals, objectives, targets, and indicators; and acts as the road map for achieving the long-term results of the Vision 2050. Proposes economic corridors across the country i.e., regions where the government will provide "a well-planned zoning system, a comprehensive and effective network of transport and utilities and quality education and health services" (GovPNG 2010:18). 10 economic corridors were identified (e.g., the petroleum resource area economic corridor), although how these were determined is unclear, especially in light of the absence of an overall land use plan or policy. Little progress in implementation apart from increased development of future mines, LNG projects and infrastructure projects.
National Strategy for Responsible Sustainable Development 2014 (StaRS) (Department of National Planning and Monitoring, 2015a)	StaRS recognizes that previous planning documents, such as the DSP, did not give the natural assets of PNG sufficient recognition. The strategy promotes cost-effective and resource efficient ways of responsible sustainable development and calls for a paradigm shift towards a green economy based on the need to protect assets that are the basis of the country's wealth and future development.
Medium-term Development Plan III 2018-2022 (Department of National Planning and Monitoring, 2018)	Sets the goal of "Securing our future through inclusive sustainable economic growth"; focuses on key investments to stimulate economic growth in the medium-term. Sustainability is one of eight key result areas. Makes no mention of biodiversity conservation or protected areas.
Sustainable Development Goal 13 Roadmap: 30 actions by 2030 (Government of Papua New Guinea, 2020b)	Outlines a phased cross-sectoral approach to achieving 30 actions by 2030, all relating to climate change and related SDG goals.
National Oceans Policy 2020-2030	Aims to provide a framework to improve ocean governance and management, the strategic direction for planning and resource allocation and to promote sustainable management and use of ocean resources within and beyond PNG's national jurisdiction. Reaffirms the recognition of Indigenous and local community ownership regimes of any ocean space and natural resources within PNG's national jurisdiction, recognizes the need for ecosystem-based management and sustainable use, promotes marine protected areas, and requires environmental impact statements, using a precautionary approach for any likely impact.
National REDD+ Strategy 2017-2027	Three action areas are identified including 'Strengthened land-use and development planning'.
PNG Policy on Protected Areas 2017	Our protected area network across land and sea safeguards our precious and outstanding natural and cultural heritage.
National Population Policy 2015-2024	Aims to ensure that population growth does not constrain economic growth and responsible sustainable development. It addresses aspects including migration, health and women's rights.
National Urbanisation Policy 2010-2030 (Office of Urbanisation 2010)	Provision of infrastructure and services in urban areas, building capacity to better manage urbanization, and the development of urban management policies and plans. Envisages compulsory acquisition of customary land for water, power and road easements.
National Climate Compatible Development Management Policy 2014 (PNG Office of Climate Change and Development, 2014)	Addresses the significant changes that will result from climate including rising sea levels affecting coastal communities and livelihoods, possibility of more frequent and severe droughts, higher temperatures, and increased heavy rainfall.
Connect PNG Development Infrastructure Program 2020-2040	Aims to connect PNG's four main regions with integrated road corridors.

[95] Minister's Statement, in the draft NSLUP used for consultation purposes (DLPP 2018).

9.3 Current status and progress towards goals

Effective LUP contributes to a number of CBD Aichi targets, and it is a key target in the post-2020 Biodiversity Framework. In PNG, progress towards the targets is slow.

Table 48: Progress in relation to Aichi targets

Source	Target/goal	Comment
Aichi Biodiversity Target 1: Biodiversity awareness	By 2020, at the latest, people are aware of the values of biodiversity and the steps they can take to conserve and use it sustainably.	Status: (a) Awareness to conserve biodiversity – progress towards target but at an insufficient rate; (b) Awareness on sustainable use of biodiversity – no significant change (Conservation and Environment Protection Authority, 2019) Much environmental knowledge is utilitarian and based on extensive traditional knowledge. This knowledge is slowing eroding.
Aichi Biodiversity Target 2: Biodiversity values are integrated (into accounting systems)	By 2020, at the latest, biodiversity values have been integrated into national and local development and poverty reduction strategies and planning processes and are being incorporated into national accounting, as appropriate, and reporting systems.	Status: Moving away from target (Conservation and Environment Protection Authority, 2019). LUP system in its infancy and restricted application Provincial and LLG's – little formal LUP or maps (of priority biodiversity areas). Recently approved NSLUP.
Aichi Biodiversity Target 4: Sustainable production and consumption	By 2020, at the latest, Governments, business and stakeholders at all levels have taken steps to achieve or have implemented plans for sustainable production and consumption and have kept the impacts of use of natural resources well within safe ecological limits.	Status: Moving away from target (Conservation and Environment Protection Authority, 2019). Food poverty increasing; subsistence agriculture production is not sustaining populations who depend on it. Aim to mobilise or unlock customary land for development (MTDPIII).
Aichi Biodiversity Target 5: Habitat loss halved or reduced	By 2020, the rate of loss of all natural habitats, including forests, is at least halved and where feasible brought close to zero, and degradation and fragmentation is significantly reduced.	Status: Moving away from the target (Conservation and Environment Protection Authority, 2019). Recently approved NSLUP but no national sustainable land use plan. Little LUP at provincial level. Some LUP at local level to protect habitat.
Aichi Biodiversity Target 7: Sustainable agriculture, aquaculture and forestry	By 2020 areas under agriculture, aquaculture and forestry are managed sustainably, ensuring conservation of biodiversity.	Status: Moving away from target (Conservation and Environment Protection Authority, 2019). NSLUP aims to encourage investment in agriculture, aquaculture and forestry through an improved LUP framework e.g., formalising and releasing land and integrating economic and spatial planning. Some local LUPs identify constraints and opportunities and zones for development. StaRS aims to integrate environmental concerns and natural resource use into development planning, including specific strategies related to agriculture and forestry.
Aichi Biodiversity Target 10: Ecosystems vulnerable to climate change	Ensure all areas under agriculture, aquaculture and forestry are managed sustainably, in particular through the conservation and sustainable use of biodiversity, increasing the productivity and resilience of these production systems.	Status: progress towards target but at an insufficient rate (Conservation and Environment Protection Authority, 2019). LUP in its infancy at all levels hence little protection of ecosystems vulnerable to climate change (e.g., montane forests, coastal ecosystems)

Source	Target/goal	Comment
Aichi Biodiversity Target 14: Ecosystem Services	Fully integrate biodiversity values into policies, regulations, planning, development processes, poverty reduction strategies, accounts, and assessments of environmental impacts at all levels of government and across all sectors of the economy, ensuring that all activities and financial flows are aligned with biodiversity values.	Status of REDD+ ecosystem services: progress towards target, but at an insufficient rate (Conservation and Environment Protection Authority, 2019). Landowners aware of ecosystem services, but little information formally recorded. LUP at all levels is yet to formally incorporate ecosystem services into plans and actions.
Aichi Biodiversity Target 15: Ecosystems restored and resilience enhanced	By 2020, ecosystem resilience and the contribution of biodiversity to carbon stocks has been enhanced, through conservation and restoration, including restoration of at least 15% of degraded ecosystems, thereby contributing to climate change mitigation and adaptation and to combating desertification.	Status: progress is slow Slow and disjointed progress in LUP – no widespread spatial planning; limited capacity and systems to deliver required outcomes for biodiversity. Lack of integrated sectoral responses to land use,
Proposed post-2020 Biodiversity Target 1.	Ensure that all land and sea areas globally are under integrated biodiversity-inclusive spatial planning addressing land- and sea-use change, retaining existing intact and wilderness areas.	
SDG 15 Life on land	15.9 By 2020, integrate ecosystem and biodiversity values into national and local planning, development processes, poverty reduction strategies and accounts.	Land use planning is relevant to many other SDGs in relation to people's access to land, food and water.
SDG 15 Make cities and human settlements inclusive, safe, resilient and sustainable	11.3 By 2030, enhance inclusive and sustainable urbanization and capacity for participatory, integrated and sustainable human settlement planning and management in all countries.	The very high customary land-owning base within PNG requires innovative solutions to address rising urbanization and informal settlements. Progress remains slow.

9.4 Opportunities

9.4.1 Funding and partnerships

REDD+ strategies, the newly established Biodiversity Trust Fund, and a range of NGOs (e.g., USAID, WWF, UNDP), CBOs and international and national government support can provide opportunities for investment in LUP as a mechanism to conserve biodiversity and ecosystem services and enhance the achievement of SDGs and the Aichi targets. For example, implementation of REDD+ has resulted in mapping of forested areas, and collaborative approaches to LUP in New Britain Island are providing essential information to inform LUP (PNG Forest Authority, 2018). A key action area of the National REDD+ Strategy 2017-27 is strengthened land use and development planning and a draft REDD+ Finance and Investment Plan aims to continue support for the delivery of REDD+ outcomes. DLPP has responsibility for coordinating much of the funding assistance that is being provided.

9.4.2 Strong environmental base on which to develop sustainable land use planning

Extensive intact forest and other important ecosystems (e.g., grasslands, wetlands, marine) remain. Many natural areas of priority have been assessed and mapped and customary landowners have extensive knowledge of these areas. The timing is opportune for PNG to develop an effective, socially responsible, and widely supported LUP system. This opportunity must be 'grabbed' to ensure more sustainable development and greater prosperity for the people of PNG. This will require extensive consultation with sectoral agencies, particularly agriculture, forestry, mining, infrastructure, planning (urban) and environment and the community. A significant opportunity exists to explore and develop community-based LUP initiatives as a first option.

9.4.3 Effective traditional approaches, community projects, and champions to support sustainable land use planning

PNG's communities have worked with their land and seas over centuries and have managed their social relations with other communities. For example, in an urban context, Port Moresby's history of settlement demonstrates that customary kinship and tenure arrangements are sufficiently flexible to manage their dealings with urban settlers and migrants (Walta, 2017). Working with and utilising the knowledge and experience of customary landowners provide diverse opportunities in a range of areas related to LUP. Frequently in PNG formal institutional arrangements (e.g., land titling and registration) can fail to recognize the realities on the ground, where flexible customary arrangements may be preferred and perceived as 'good enough' (Kiddle & Hay, 2017). For example, Fiji was one of the first Pacific islands states to recognize

the rights of informal settlers and extend services to them, creating a 'policy bridge' and links between formal and informal sectors (Phillips & Keen, 2016).

With limited political will to effectively address diverse urban land issues, local champions are needed more than ever. Opportunities exist for successful LUP processes to be championed and expanded in a sequential process across the country. This will require LUP at all levels to effectively engage with customary landowners and ensure that they are fully informed of proposed actions and their consequences so that they can effectively engage in discussions about land use policy, legislation, land tenure and land formalization and development options. Through this process, effective engagement with all stakeholders can underpin an agreed, sustainable and integrated LUP process and system.

9.5 Effects of land use planning on people, especially those 'left behind'

9.5.1 Rural communities

Customary landowners can be left in a difficult position if land formalization and registration processes diminish or eradicate the 'bundle of rights' attached to their land (Table 43). For example, many rural people require cash incomes and hence development interests can look appealing. However, weak regulatory and enforcement systems related to land tenure, LUP and development can result in a loss of land and land rights, including loss of access to land, fisheries and forests, with impacts on food security, cash incomes, the ability to provide housing for this and future generations.

The SABL process resulted in foreign ownership of many agricultural leases and highlighted that many local people were poorly informed of their rights. Many remain unaware that they have lost their traditional lands and have been disenfranchised. The ILG process enabled some people to speak for a group/clan/family without seeking full disclosure and approval from all relevant landowners. Thus, many people were not fully informed of the options available and the consequences of their decisions. This process significantly impacted on some of the poorest communities in PNG and will have intergenerational impacts.

9.5.2 Women

Women have limited ownership of land in PNG and unequal access to resources and decision-making. Women often only have indirect tenure rights allocated by male members of their family. Women rely on land and sea for resources (food and fuel) to support their families. Changing socio-economic conditions often fail to ensure that women have access to the resources they need. Migration to urban centres and informal settlements have seen a rapid rise in the number of rural families with women as heads of household, but without effective decision-making powers and little/no voice in community governance and increasingly without security as individuals under traditional law. Attempts to assert their rights can cause conflicts, with women often left with whatever rights are given my male relatives. This can impact significantly on single, divorced and widowed women.

9.5.3 Coastal communities impacted by climate change

Many coastal communities will be impacted by climate change due to effects on ecosystem services (e.g., loss of marine resources), displacement and unmanaged human mobility, loss of land to erosion or sea inundation, loss of livelihoods and homes, and community instability. Some people from the Carteret Islands have already been relocated, although many problems have been experienced with this process (James, 2018). Effective LUP can identify and map sites prone to sea level rise and other impacts of climate change and begin to work with communities who will have to adapt to the changed conditions. This also raises the issue of finding land for these potential climate refugees.

9.5.4 Urban and informal settlers

About 13 percent of Papua New Guineans live in urban settlements and the rate of urbanization is increasing rapidly. Migrants to cities such as Port Moresby face little or no availability of state land for settlement. Much of the settlement expansion occurs on customary land, with the owners developing 'quasi-legal arrangements with settlers' (Walta, 2017). These arrangements can provide returns to the landowners and security for the residents. However, informal settlements often lack basic services with many residents living in poverty and declining environmental conditions.[96] The Government has embarked on a programme of unlocking customary land for development in part to narrow PNG's affordable housing gap and aims to lower the number of people in informal housing to 15 percent by 2030 (Oxford Business Group, 2022) arguing that formalising land titles would enable the improved provision of ancillary services in these areas, including water and electricity.[97] However, in Port Moresby, shared access to land was a feature of 'the flexibility of customary land arrangements' in the past (Walta,

[96] Over 50% of Port Moresby's population reside in informal settlements, as well as the original Hanuabada village that was established in the colonial era (Jones & Sanderson, 2017).

[97] About 20-25% of the water supplied to Port Moresby is distributed to informal settlements through illegal constructions. Authorities are working to expand PNG's electrification rate from 13% (2010) to 70% by 2030 (Oxford Business Group, n.d.).

2017). Any policy that aims to implement top-down settlement upgrading is likely to impact on informal settlers and result in discontent and greater social division.

9.5.5 Many of PNG's provinces

Poor and non-existent LUP has resulted in very uneven development and planning. Many provinces are plagued by poor services (roads, infrastructure, services), few plans, limited planning capacity and little finance. Effective LUP can help to identify provincial growth centres and put in place strategies to fully support the implementation and delivery of sustainable land use and infrastructure planning.

9.6 Recent and current projects and programmes

9.6.1 New Britain land and sea use planning (2014-2017)

New Britain island and the neighbouring Bismarck Sea are a globally important region for biodiversity, abundant in natural resources including fish, reefs, and mineral deposits. This area has been the focus of several funded projects that have been collaboratively delivered across New Britain.[98] The overall aim was to improve strategic decision making by developing land and seascape plans that consider diverse challenges including population pressures, climate change, and extensive land use change (Lipsett-Moore et al., 2017). The approach took a holistic Ridges to Reefs system view, used adaptive pathways and evidence-based and transparent decision making (Butler et al., 2017). The primary output was the development of land and sea use zoning plans and decision support tools across New Britain. The 'decision support framework' includes values, decision support tools and zones.[99]

9.6.2 Identifying key sites for biodiversity conservation (2015-17)

In 2015-17, as part of the GEF-5 supported programme, the project "Review and Integration of the Terrestrial and Marine Program of Works on Protected Areas" used reserve planning software combined with expert panel recommendations to analyse priorities and propose ways to integrate conservation planning across landscapes and seascapes (Adams et al., 2017). This project built on previous efforts from the 1990s onwards to identify priority protected areas. Despite these and previous attempts to identify priority areas, no reserve plans have been implemented. As part of the project, government officers were trained in advanced GIS skills, including the use of Marxan software, but there is no indication that these skills have been used.

9.6.3 Infrastructure development and Special Economic Zones

Road infrastructure is to be expanded throughout PNG (Figure 15), in part to facilitate the export of agricultural, forestry, mining and other products and to provide better access to health, educational and other services. Special Economic Zones (SEZs) are being declared under the *Special Economic Zones Activity Act 2019*. 20 zones are proposed in the legislation. These areas are designed to attract investment opportunities for international businesses to help the country move beyond its reliance on extractive industries by growing small to medium businesses and encourage better utilization of PNG's other natural resources. The Government will offer a range of incentives, including tax concessions. In the absence of an overall land use plan for the nation it is unclear how these zones were determined and whether they are located to bring the greatest benefits, with limited impacts on the environment and the people.

9.6.4 Establishing systems for sustainable integrated land-use planning across New Britain Island in Papua New Guinea (2021-27)

This GEF-7 funded project aims to develop integrated landscape management systems (Component 1). The project drivers include the desire for economic development and income (and greater equality), population growth, the importance of agriculture in the economy and knowledge gaps (e.g., land use options and impacts). A core objective is to establish a sustainable system of LUP to guide future land development activities across PNG. The project intends to help 'join up' the land use decision-making processes from national policies and objectives to community decision-making and help to increase the voice of communities and other vulnerable groups in decision- making, strengthen the capacity of government officials to support decision-making processes and help guide companies to support sustainable practices. Actions will focus on establishing national and subnational policy, regulatory and operational systems that will help create a framework within government that provides positive incentives and guidance for sustainable LUP, including establishing a NSLUP and implementation framework (output 1), building the tools for its implementation, i.e. a national LUP information

[98] UNDP funded projects in New Britain include: (a) Community-based Forest Conservation and Coastal Resource Management in Papua New Guinea (GEF 4) – mapping workshops to underpin decision making in West New Britain to support sustainable natural resource management and a broad land use plan for West new Britain; (b) Building capacity for responsible and sustainable development in the Bismarck Sea, a collaborative venture with CEPA, the Australian Government, TNC and CSIRO in East and West New Britain Provinces; (c) Establishing systems for sustainable integrated land-use planning across New Britain Island in PNG - to reduce rates of agricultural-driven deforestation and biodiversity loss and establish a sustainable system of LUP to guide future land development activities across PNG.

[99] Key stakeholders included The Nature Conservancy, CEPA, representatives from wards, LLGs, districts and provinces, national media, women's groups, PNG Fisheries, churches, NGOs (e.g. Live and Learn).

and coordination system (output 2), enhancing the capacity of stakeholders to do this (output 2 and 3), and fully integrating sustainable land management into jurisdictional plans across New Britain (output 3).

9.6.5 Landscape Management in Enga Province (2021-26)

The 'Strengthening Integrated Sustainable Landscape Management in Enga Province, PNG' project focuses on integrating sustainable land use and development planning within provincial and district development planning. This will catalyse community action on sustainable projects. The project will partner with UNDP's Small Grants Programme to support community initiatives. The approaches developed in the overall project are to be integrated into provincial and district planning processes with capacity building to strengthen implementation and linkages with private sector entities. Initiatives include mapping high conservation value areas, improving monitoring of target areas and developing improved base maps and digitization of spatial information of importance in LUP (UNDP 2020). This project was initiated in 2022.

9.7 Gaps in land use planning and risks

Gaps in LUP

- Lack of an agreed national land use planning system. Until recently, there has been no holistic, national approach to LUP in PNG, and little sectoral harmonization of relevant legislation and codes, with no framework to balance development with conservation and sustainable rural development (DLPP, 2018). Most development plans are not fully implemented, compliance and enforcement are weak, and the Physical Planning Boards focus more on planning applications than policy formulation and research (DLPP, personal communication, 2022)
- Lack of integrated land use planning including a failure to effectively integrate infrastructure expansion, Special Economic Zones (SEZs), mining, agriculture and forestry/logging sectors into the LUP process. Institutional barriers and conflicting mandates limit effective LUP outcomes
- Lack of policy, guidelines and protocols and limited consultation at the national level related to LUP. It is unclear how well the customary landowners, including women and youth, have been engaged in recent discussions related to land tenure, land formalization, release of land for development, establishment of SEZs and road and other infrastructure
- Outdated legislation, plans, programmes and frameworks. The absence of a National Land Use Plan results in land use being fragmented and incomplete (DLPP, 2018), with the prioritization of economic over social and environmental goals and of short-term development over long-term goals. The approvals' process is also very slow, bureaucratic and inefficient, in part due to the government's intermediary role in acquiring land from customary landowners
- Absence of coordinated institutional and administrative oversight of settlement development; lack of recognition of the permanency of many informal urban settlements, including in Port Moresby; and poor and inaccurate data on urban settlement development and growth (Walta, 2017)
- Limited institutional and human capacity at all levels to support the decentralization of LUP across the country (Schmidt 2018; Barbara & Keen, 2017). Most universities in PNG do not have planning schools to provide the needed human planning capacity in the future. Planners study abroad and on return find that there is no career pathway and undertake employment outside of planning (DLPP, personal communication, 2022)
- No effective and culturally appropriate land registration system. Information about most customary and/or informal land uses are not recorded in any register and the multiplicity of different ownership and occupation interests in land makes it difficult to have a documentary title system
- Poor information systems and tools to support spatial planning and address pro-poor outcomes. Diverse stakeholder groups have little or no access to information and existing systems are not adapted for pro-poor purposes
- Financial and technical restrictions and inequities limit effective LUP and most land administration resources are directed to the three percent of land that has been alienated
- Much government funding is not tied to rigorous reporting and evaluation. Many policies and strategies, including Vision 2050 and the PNG Development Strategic Program 2010-2030, while espousing great ideas and ideals are not institutionalised in statutory provisions. The 'development budget' is allocated to national members of parliament including the District Services Improvement Program funds and the Provincial Services Improvement funds and these representatives do not have to justify their spending by reference to these strategies and policies (Kaiku, 2020). This limits the available funding for effective LUP at all levels
- Limited connections and networks among stakeholders. Governments at all levels have limited engagement with local communities. In urban areas there is a lack of locally grounded social movements to support the many informal residents. There are gaps in the engagement of women, youth and powerful sectoral interests in LUP processes and decision-making.

Risks associated with LUP

- Loss of biodiversity and cultural heritage values. Poor LUP processes and structures can result in poor decisions related to the location of development resulting in the loss of customary

land, declines in biodiversity, and loss of culture, diverse languages and traditions

- Many trends are worsening. Future projections of rapid population increase, food insecurity, migration to urban settlements, shortage of land and resources (e.g., forests, arable land), environmental degradation, severe impacts from climate change and poverty are high level risks at all levels. The failure to implement agreed approaches to LUP place the people and the economy at heightened risk, can lead to conflict (especially around land tenure) and further environmental degradation, and limits the Government's ability to meet agreed international and national targets and goals
- A dysfunctional land tenure/property rights system and governance of land tenure (including corruption in dealings with land) risks land and/or decisions about land being made without the knowledge of the customary landowners who depend on that land. The transitional costs or risks may include dislocation of traditional social structures, urban drift, high levels of urban unemployment, poverty and food insecurity, serious urban land and law and order problems as well as inappropriate developments. Conflicts over land tenure can impact whole communities and also influence business willingness to invest in PNG
- Failure to effectively address urban development and informal settlements risks rising conflict, evictions, increasing poverty and greater social divisions. PNG has a growing urban population. The National Development Strategy 2020-30 aims to "develop urban centres according to international town planning standards in order to cater for urbanization and socioeconomic progress and deliver quality of life for all urban people" (GovPNG, 2010:83 -Goal 4.13). Provision of secure land is a key strategy to accommodate this growth. However, there have been many examples in Port Moresby of forced evictions from informal settlements, including some people who have lived in these communities for over 30 years. About half the city's population live in informal settlements and between 2012-2021 almost 19,000 people were forcefully evicted (Rooney, 2021), mainly from state land registered to private lease holders. Often these evictions are dealt with by the courts, who favour the legally registered owners by title, with limited attention given to customary landowners or ensuring the human rights of communities impacted by evictions are protected (Rooney, 2021). A failure to address urbanization and growing informality risks growing inequalities, instability and social division (Connell, 2017) and makes the people within informal settlements highly vulnerable and puts at risks effective future LUP if they are excluded from planning processes (Barbara & Keen, 2017)
- Little integration of knowledge and evidence-based decision-making processes risks wasting money, resources and people's time. For example, the decision support tools applied in New Britain produced new information, data storage capacity and zoning plans but little of this work has been integrated into planning systems at all levels and has failed to lead to major shifts in development, thus limiting sustainability and long-term outcomes and putting at risk any significant improvements in LUP and limiting sustainable outcomes.

9.8 Recommendations

9.8.1 Underpin the LUP process with a focus on respect for customary landowners' rights

Planning in PNG should begin from the premise of respecting customary landowners' culture and heritage, needs, aspirations, rights, and responsibilities.

- Support customary land ownership and tenure by recognizing the intergenerational nature of the 'bundle of rights' attached to land
- Ensure that legislative and policy changes support traditional customary approaches to land (i.e., individualised land tenure and land alienation may not reflect traditional PNG society). Adopt and support customary concepts of property rights and strengthen existing, successful land tenure arrangements
- Facilitate gradual evolution in land tenure to limit social and personal dislocation. Ensure adequate safeguards to avoid infringing on or extinguishing the tenure rights of customary landowners (e.g., safeguards to protect women and vulnerable groups who may have rights to access, gather and garden) (Food and Agriculture Organization of the United Nations, 2012).

9.8.2 Build on and accommodate informal and semi-formal arrangements in land reform

Land formalization and reform should identify all existing tenure rights and rights holders and include all these people in consultation processes to ensure their free, prior and informed consent. Consultation and decision-making processes should be conducted in a climate of trust (FAO, 2012). One solution is to better understand the many existing local arrangements that currently accommodate 'outsiders' on customary land. These informal systems are widespread and have been operating over many decades across PNG (Koczberski et al. 2017). The NSLUP and related LUP system should complement and build on these informal institutions and land transaction agreements rather than potentially alienate land from customary landowners.

9.8.3 Strengthen women's land rights and consult and fully engage with women

Secure land rights for women are an explicit cross-cutting catalyst for achieving SDGs, especially eradicating poverty, achieving food security and improved nutrition and gender equality and

empowerment (Goals 1,2, 5). However, customary restrictions, including the dominance of men in leadership, resource allocation and decision making (even in matrilineal societies where decisions on land are often delegated to male clan members), make it challenging to include women in many aspects of LUP and decision-making.

- Ensure equitable engagement of women to achieve fair and effective LUP processes, policy making, and development of legislation and regulations (including related legislation such as laws on inheritance, agrarian reform, land titling and registration, and resource management)
    - Reform laws that discriminate against women in relation to property rights
    - Ensure that efforts to title or register land recognize women's land rights (across a bundle of rights) and do not worsen women's tenure security (Doss and& Meinzen-Dick 2020)
- Ensure certainty in the terms and duration of women's tenure rights, so that they are not impinged on by divorce, death or other customary circumstances
- Ensure that women's rights to land are enforceable and that women have effective access to forums to protect these rights
- Implement information programmes, training and capacity building to ensure that women are aware of their rights to land and other resources, understand the meaning of their rights, how to document their rights and use them to their benefit
- Establish equitable benefit sharing arrangements that ensure women have equal access to any benefits resulting from LUP decisions and investments
- Ensure that dispute resolution agencies and forums are physically, socially and linguistically available to women so that women can present a claim, have their case heard and have the decision implemented
- Ensure that policies to promote large-scale land acquisition for agriculture or infrastructure do not negatively impact on women's tenure security and that there is full consultation with women before agreements are made with potential commercial or development partners.
- Incorporate gender analysis into future policies to ensure that the particular constraints faced by women are addressed
- Amend accounting practices related to land, including incorporation of gender analysis, to improve information and future planning.

9.8.4 Develop 'fit for purpose' systems for land registration, administration of land tenure and LUP

- Develop a culturally appropriate, reliable and effective land registration system to record customary and individual tenure rights, including eliminating unnecessary legal and procedural requirements and barriers where needed
- Develop policies to promote sharing of information, including spatial information on tenure rights for use by government agencies, customary landowners, civil society, private sector, academia and public. Develop national standards for the shared use of information (FAO, 2012)
- Promote a culture based on service and ethical behaviour
- Establish accessible and effective dispute resolution processes and mediation mechanisms at all levels
- Develop relevant professional associations for services related to land tenure and LUP
- The planning systems (from local to national) and the people who rely on them (e.g., the customary landowners, development sectors and governments) need agreed principles or foundations for planning and decision making.

9.8.5 Review, develop and update relevant legislation, policy and plans

- Implement the National Sustainable Land Use Policy (NSLUP) and ensure the subsequent NSLUPlan is based on identification of key areas for conservation and other uses, including forestry, agriculture, mining, settlement and infrastructure at the national level
- Review the Physical Planning Act and related legislation; review the role and functions of the Physical Planning Boards; and establish these boards at all levels of government
- Support provinces to review, develop or update legislation relevant to LUP (e.g., province-based environment and planning law), regulations and policies/plans.

9.8.6 Address corruption in dealings with land

Governments at all levels should strive to prevent corruption in relation to LUP and tenure rights:

- Adopt and enforce anti-corruption measures, limit the arbitrary use of power, address conflicts of interest, adopt clear rules and regulations
- Provide for the administrative and/or judicial review of the decisions of implementing agencies.

9.8.7 Address issues related to informal land and settlements

Recognize informal tenure through participatory, gender-sensitive processes, with particular regard to the inhabitants and facilitate access to legalization services to minimise costs (FAO, 2012). Develop guidelines to help upgrade informal settlements. Work with residents and other stakeholders to undertake this upgrade and incorporate needed

infrastructure e.g., piped water and road networks (Ezebilo & Savadogo, 2021). Processes should also be in place to discourage the emergence of new informal settlements. Where it is not possible to provide legal recognition of tenure rights the government should prevent forced evictions (FAO, 2012).

9.8.8 Use bottom-up processes and data to inform LUP and decision making

Identify what is valued by a range of stakeholders at the local level, use simple decision support tools to gather essential information to inform land and sea use planning and delineate zones with specific values and uses. In most contexts in PNG there is sufficient broad-scale data and relevant local knowledge to underpin LUP projects. Focus future projects on plan-making rather than assessments and data gathering.

9.8.9 Address conflicting perspectives through collaborative processes

Consultation processes that address land and LUP need to be sufficiently resourced to ensure comprehensive engagement of all relevant stakeholders, and be underpinned by awareness raising about proposed changes to enable effective engagement.

9.8.10 Pilot cases at the local level should be upscaled to LLG and provincial scales

Improve integration of plans and information across sectors and levels of government to ensure 'buy-in' and help to develop more widely agreed land use zone boundaries, goals and strategies and budget support, leading to more aligned decision making and achievement of sustainable development goals. For example, the pilot land and sea use planning projects in New Britain are a model for developing similar plans across PNG and should be incorporated into higher level planning processes to inform decision-making and funding.

9.8.11 Develop effective data storage and usage systems

An effective national land use information system is needed, with data available in a machine-readable format accessible to diverse stakeholders, with content that is transparent, relevant, replicable and credible to support LUP decision making at all levels. This includes relevant sectoral land use plans (e.g., environment, forestry, mining, oil and gas, agriculture, and provincial, district, LLG and ward level development plans and land use plans).

9.8.12 Training should be directed to enhance capacity where it is needed

Environment and planning positions are needed especially at the local and provincial levels and within relevant national agencies (e.g., CEPA and DLPP). This is especially important as the current GEF 7 project aims to address nation-wide LUP processes. The capacity of staff at all levels of government needs to be improved to develop plans and related legislative and regulatory frameworks and implementation processes, and to provide information on an as needed basis to all levels of government.

Remote sensing and GIS units should be resourced and effectively staffed within provincial governments to monitor land use changes and provide data to assist in LUP (e.g., priority areas and landscapes for biodiversity).

Capacity building also requires the training of professional planners within PNG universities and colleges, and support for professional associations of planners.

It is helpful to support champions at all levels and include government representatives (e.g., provincial governors) as well as people working within and across local communities. Continued support and engagement can assist the champions to promote and showcase well designed and community-led LUP processes.

Chapter 10.

Managing water, waste and pollution


UN
DP

10.1 Context for managing water, waste and pollution in Papua New Guinea

This chapter provides a brief overview of water, waste management and pollution in Papua New Guinea (PNG), encompassing managing water and sanitation, solid and other wastes and marine and other pollution. Pollution from mining activities is addressed in more detail in Chapter 11.

10.1.1 Access to water, sanitation and hygiene

PNG is one of only three countries in the world where less than 50 percent of its population has access to safe water (WaterAid, 2017). Of the 15 developing Pacific Island countries, PNG has the lowest ratings for water and sanitation access (WaSH) indicators. WaSH-related diseases have long-term impacts causing higher morbidity and death rates, reduced educational attainment, and significant economic impacts at both the household and national level (Department of National Planning and Monitoring, 2020). Women, girls and people living with a disability are particularly affected by the lack of private and safe places to toilet and wash, and this affects girls' attendance at school (UNICEF PNG, undated; Water for Women - Papua New Guinea (Plan International), 2020). Detailed information about the importance of WaSH to health can be found in the CCA social analysis and is not included here.

> *Apart from violating a core human right, PNG's low WaSH coverage affects people's health, education and nutrition, causing significant damage to PNG's long-term development perspectives and the livelihoods, especially of the most vulnerable people in rural and peri-urban settings (European Union, 2020, p.6)*

Since 2016, the country has experienced huge urban drift in most major cities such as Port Moresby, Lae, Mount Hagen and Kokopo. As such, most urban centres are now faced with extreme pressures to provide additional services including health care, education and basic shelter due to expansion of urban settlements. Demand for quality drinking water and proper sanitation and waste management practices pose significant challenges for most urban and municipal governments throughout the country (Department of National Planning and Monitoring, 2020).

10.1.2 Water supply

Average rainfall varies widely across PNG. On the mainland, the mean annual rainfall ranges from less than 2,000 mm along the coast to more than 8,000 mm in some mountain areas. Islands to the north and northeast have an average annual rainfall between 3,000 and 7,000 mm. Less than 2,000 mm/year falls in areas southwest of the Fly River, and the Port Moresby coastal area receives less than 1,000 mm/year (FAO, undated). For the period until 2100, climate change modelling projects that average rainfall will increase in most areas (medium confidence), along with more extreme rainfall events (high confidence) (Australian Bureau of Meteorology and CSIRO, 2014).

The high mountain ranges and abundant rainfall lead to high runoff over most of the country. There are nine hydrological drainage basins, the largest of which are the Sepik (78,000 km2), Fly (61,000 km2), Purari (33,670 km2), and Markham (12,000 km2). Other catchments are less than 5,000 km2 in area and are very steep (FAO, undated). The high rainfall means that most agricultural production is rain-fed, rather than irrigated.

The Food and Agriculture Organization estimates PNG's long-term average annual renewable water resources to be comprised of 801 km3/year (or 801 x 109 m3 per year) of internally produced surface water and 211.6 km3/year of internally produced groundwater (FAO, 2019). The groundwater overlaps completely with the surface water, leaving 801 km3/year.[100] However, renewable water resources per capita are declining over time as population increases. FAO estimates that in 2017 renewable water resources per inhabitant was 97,000 m3/inhabitant/year, down from 176,500 in 1992 (FAO, n.d.). In 2010, dam capacity was 0.665 km3 (FAO, n.d.). Even though renewable water resources per capita are declining over time, PNG does not yet have programmes that promote the value of water, and water efficiency (Patricia Kila, pers comm, 2020).

Less than half of PNG households (46 percent) have access to an improved drinking water source; only 29 percent use improved toilet facilities; and 33 percent of households have access to soap and water (United Nations in PNG, 2019).

Patterns of wealth determine whether a household has an improved source of drinking water and improved toilet facilities (United Nations in PNG, 2019). Three distinct cohorts are identifiable: formalized urban areas; peri-urban and informal settlements; and rural areas. Utilities cannot cope with the pace of urban growth in formal settlements and are struggling to provide services to existing customers. Challenges are even greater for extending services to informal settlements, to peri-urban areas beyond utility service districts, and to those in areas which are difficult to service with conventional infrastructure (Asian Development Bank, 2017). The non-government sector provides the majority of WaSH services in rural and peri-urban areas (Department of National Planning and Monitoring, 2015b).

[100] For Australia, a much drier country, this estimate is 492 km3/year average.

In urban areas, a merged state-owned enterprise (SOE), the former Eda Ranu and Water PNG, provides piped water and sewerage services. Prior to the merger in late 2020, Eda Ranu served Port Moresby, while Water PNG was responsible for service provision in most provincial towns on a commercial basis. Water supplies to households in districts and outstations in PNG are provided by provincial and district administrations using diesel engine generators to pipe water to storage tanks or mini dams (Ted Mamu, pers comm, 2020). Informal settlements and communities in non-commercial areas have no access to their services (Asian Development Bank, undated).

In 2017, an estimated 916,000 people were serviced by the two water and wastewater utilities (Pacific Water and Wastewater Association, 2017) – about 11 percent of the population of 8.44 million. In Port Moresby, where (the former) Eda Ranu serviced approximately 522,000 people, daily total water consumption per person was 203 litres. Of this total, daily residential consumption per person was 30 litres. For district towns, Water PNG reported total daily water consumption per person of 123.5 litres, of which daily residential consumption per person was 48.7 litres.

On remote islands, the supply of fresh water for drinking and other household needs is an issue of extreme concern, exacerbated by climate change.

10.1.3 Waste management

Management of waste of all kinds in PNG is limited. The report from the February 2020 meeting of the Pacific Waste programme (PACWASTE) (SPREP, 2020a) recorded that PNG had:

- Outdated legislation governing waste and chemical management;
- Limited sustainable financing mechanisms;
- Limited institutional and human resource capacity at national/municipality levels; and
- A lack of national policies or strategies on waste management.

The Second Biennial Update Report to the UN Convention on Climate Change observes "waste management in PNG remains a poorly managed sector with much improvement needed in the short and long term" (Government of Papua New Guinea, 2022c, p. 28).

The PNG National Strategy for Responsible Sustainable Development (StaRS) (Department of National Planning and Monitoring, 2015a), recognizes that for sustainable development, PNG needs to:

- Increase efficient and productive use of strategic resources such as energy and the environment;
- Improve environmental health and well-being of human beings and biodiversity; and
- Identify green business opportunities and policy responses that lead to increases in output, employment and income in the green sectors.

Improving access to clean water, sanitation and hygiene; increasing resource efficiency; and reducing pollution are fundamental for achieving sustainable development goals.

10.2 Key legislation, policies and agreements relating to water, waste and pollution

10.2.1 Legislation

Legislation for managing water, waste and pollution is outlined in Table 49.

Table 49: Legislation relevant to water, waste and pollution

Legislation	Scope
Environment Act 2000	▸ Requires national policies, and a national solid waste management strategy and regulations ▸ Empowers provincial and local governments to develop environmental legislation, policies and by-laws for waste management ▸ Regulates pollution.
Organic Law on Provincial and Local Level Governments 1995 Local-level Governments Administration Act 1997	▸ Empower local governments to formulate waste management policies, legislation and policies.
National Capital District Commission Act 2001	▸ Provides for public welfare protection in relation to waste and environmental management.
Environment (Prescribed Activities) Regulation 2002	▸ Permits for prescribed activities including waste treatment and import and export of ozone depleting substances.
Environment (Control of Biodegradable Plastic Shopping Bags) Regulation 2010	▸ Controls standards for manufacture and import.
Environment (Water Quality Criteria) Regulation 2002	▸ Sets water quality criteria for protecting marine and freshwater life.
Public Health Act (Amalgamated) (Amendment) 1974 **Public Health (Sanitation and General) Regulation**	▸ Regulates practices of scavenging and waste disposal; and, ▸ Fines for illegal dumping.

Legislation	Scope
Marine Pollution (Preparedness and Response) Act 2013	▸ Relates to oil/other substances; gives effect to relevant international conventions.
Environmental Contaminants Act 1978 **Environmental Contamination (Pesticides) Regulations 1988**	▸ Prevention, abatement, and control of environmental contamination; maintains export permit process for hazardous wastes.
Customs Prohibited Exports Regulations	▸ Restrict export of specific hazardous materials.
Quarantine Act 1953 **Quarantine Regulations 1956**	▸ Biosecurity for international trade.
National Water Supply and Sanitation Act 2016	▸ Coordinates water supply and sanitation services for the country provides head of power for levies, fees and charges; ▸ Establishes Water PNG Ltd.; and, ▸ Repeals National Water Supply and Sanitation Act 1986.

10.2.2 Policies

Policies	Scope
National Strategy for Responsible Sustainable Development in PNG (StaRS) (Department of National Planning and Monitoring, 2015a)	▸ Includes principles aimed at reducing sources of waste and pollution.
PNG National Water, Sanitation and Hygiene Policy 2015-2030 (Department of National Planning and Monitoring, 2015b)	Aims to "substantially improve access to water and sanitation services and to change hygiene behaviours, particularly to the currently underserved rural and peri-urban settlement areas". The policy targets are that by 2030: ▸ In rural areas, 70% of the population has access to safe, convenient and sustainable water supplies and sanitation facilities; ▸ In urban areas, 95% of the population has access to safe, convenient and sustainable water supplies, and 85% have access to safe, convenient and sustainable sanitation facilities; ▸ Every educational institution and medical centre across the country has access to safe, convenient, and sustainable water supplies, sanitation facilities and running water and soap for handwashing; and ▸ All households with improved water supplies practice total sanitation.
Trade Wastewater Policy 2018 (Water PNG)	Establishes guidelines, limits and other requirements for permitting commercial discharges to sewerage systems.
National Marine Spill Contingency Plan (National Maritime Safety Authority, 2017)	Establishes the procedures for responding to spills of oil and other hazardous materials including ballast waters from commercial shipping, into marine waters.
National Capital District Waste Management Plan 2016-2025. For a sustainable Port Moresby	Waste management in Port Moresby.
National Oceans Policy of PNG 2020-2030 (Department of Justice and Attorney General)	Recognizes the importance of integrated approaches to ocean management. Strategic actions including reducing the impact of all sources of pollution on our ocean's environment.
Draft National Waste and Chemical Management Policy (Department of National Planning and Monitoring, 2020)	The first policy for managing and disposal of solid and chemical waste (excluding radioactive waste) is currently being developed. The policy is designed to support actions of government, business, and the community to manage waste by: ▸ Establishing a governance structure for waste management that clearly defines roles and responsibilities at all levels of government; ▸ Requiring professional collection and waste management services that include full coverage in all urban areas and partial coverage in rural areas; ▸ Applying sound environmental management standards at all waste management facilities; ▸ Providing recycling opportunities to all businesses and communities in PNG; ▸ To the extent possible, requiring waste products to be sorted and managed to recover resources, rather than be deposited in landfill or other end-use management system; and ▸ Ensuring that all products, materials and chemicals containing potentially hazardous agents are managed in accordance with PNG's obligations to international conventions governing those agents.

10.2.3 International agreements

PNG has ratified several multilateral environmental agreements and conventions related to waste and pollution (Table 50).

Table 50: Policies and agreements with respect to water, waste and pollution

Stockholm Convention on Persistent Organic Pollutants	
Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and Their Disposal	www.basel.int
Waigani Convention to Ban the Importation into Forum Island Countries of Hazardous and Radioactive Wastes and to Control the Transboundary Movement and Management of Hazardous Wastes within the South Pacific Region 1995	www.sprep.org/convention-secretariat/waigani-convention
Montreal Protocol on Substances that Deplete the Ozone Layer	www.environment.gov.au/protection/ozone/montreal-protocol
International Convention for the Prevention of Pollution from Ships (Annex I,II, III, IV, V) (MARPOL)	www.imo.org/en/About/Conventions/ListOfConventions/Pages/International-Convention-for-the-Prevention-of-Pollution-from-Ships-(MARPOL).aspx
London Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter 1972. PNG has not ratified the 1996 London Protocol.	www.imo.org/en/About/Conventions/ListOfConventions/Pages/Convention-on-the-Prevention-of-Marine-Pollution-by-Dumping-of-Wastes-and-Other-Matter.aspx
International Convention relating to Intervention on the High Seas in Cases of Oil Pollution Casualties 1969	www.imo.org/en/About/Conventions/ListOfConventions/Pages/International-Convention-Relating-to-Intervention-on-the-High-Seas-in-Cases-of-Oil-Pollution-Casualties.aspx
International Convention on Civil Liability for Oil Pollution Damage (CLC) Protocol 1992	www.imo.org/en/About/Conventions/ListOfConventions/Pages/International-Convention-on-the-Establishment-of-an-International-Fund-for-Compensation-for-Oil-Pollution-Damage-(FUND).aspx
International Convention on the Establishment of an International Fund for Compensation for Oil Pollution Damage (FUND) Protocol 92	www.imo.org/en/About/Conventions/ListOfConventions/Pages/International-Convention-on-the-Establishment-of-an-International-Fund-for-Compensation-for-Oil-Pollution-Damage-(FUND).aspx
Convention for the Protection of Natural Resources and Environment of the South Pacific Region (Noumea)	www.sprep.org/convention-secretariat/noumea-convention
Protocol for the Prevention of Pollution of the South Pacific Region by Dumping 1986	www.sprep.org/attachments/Legal/Files_updated_at_2014/Dumping_Protocol.pdf
Protocol Concerning Cooperation in Combating Pollution Emergencies in the South Pacific	www.sprep.org/attachments/Legal/Files_updated_at_2014/Emergencies_Protocol.pdf

The lack of up-to-date and relevant legislation and policies hampers efforts to improve the status of waste disposal and pollution in PNG. A gap analysis of legislation relating to plastic pollution in Pacific islands (Farrelly et al., 2021) shows that PNG's legislation does not meet all the benchmark standards for waste management (Figure 54).

10.3 Current status and progress towards goals and targets

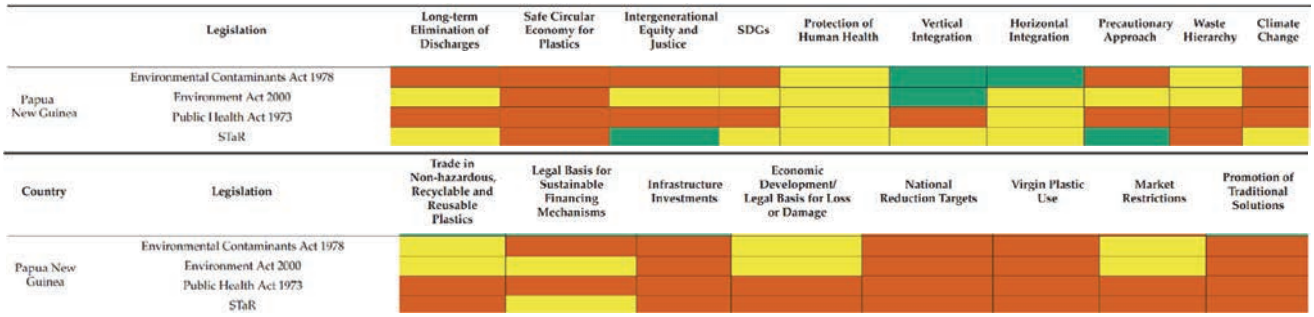

Figure 54: Policies and legislation compared with benchmark standards

Table 51: Status and progress towards achieving Sustainable Development Goals with respect to water, waste water and pollution

Source	Target/goal	Comment
SDG 6. Clean Water and Sanitation	By 2030, substantially reduce the number of deaths and illnesses from hazardous chemicals and air, water and soil pollution and contamination. 2030 Targets 6.1 Achieve universal and equitable access to safe and affordable drinking water for all. 6.2 Achieve access to adequate and equitable sanitation and hygiene for all and end open defecation, paying special attention to the needs of women and girls and those in vulnerable situations. 6.3 Improve water quality by reducing pollution, eliminating dumping and minimizing release of hazardous chemicals and materials, halving the proportion of untreated wastewater and substantially increasing recycling and safe reuse globally. 6.4 Substantially increase water-use efficiency across all sectors and ensure sustainable withdrawals and supply of freshwater to address water scarcity and substantially reduce the number of people suffering from water scarcity. 6.5 Implement integrated water resources management at all levels, including through transboundary cooperation as appropriate. 6.6 By 2020, protect and restore water-related ecosystems, including mountains, forests, wetlands, rivers, aquifers and lakes.	PNG has the lowest water and sanitation access indicators amongst the 15 developing Pacific Island nations. The 2019 update of the United Nations Joint Monitoring Program estimates access to safe drinking water and improved sanitation in PNG (2017) was 41 percent and 13 percent respectively (Department of National Planning and Monitoring 2020). PNG has missed its millennium development goal targets for water and sanitation. It is not on track to meet its own national development targets – i.e., 70 percent access by 2030; 100 percent access by 2050 (World Bank Group, 2017).
SDG 12. Sustainable production and consumption	12.4 By 2020, achieve the environmentally sound management of chemicals and all wastes throughout their life cycle, in accordance with agreed international frameworks, and significantly reduce their release to air, water and soil in order to minimize their adverse impacts on human health and the environment. 12.5 By 2030, substantially reduce waste generation through prevention, reduction, recycling and reuse.	Most urban local-level governments throughout the country do not have the capacity to properly regulate the disposal of both solid and chemical waste produced by urban towns and cities. This results in the pollution of waterways, beaches, and seas through illegal dumping of uncontrolled waste (Department of National Planning and Monitoring, 2020, p. 71). Unsustainable agricultural practices such as forest clearance for agricultural production and mismanagement of hazardous waste of consumable items is becoming a concern for environmental degradation. Energy and water are key elements to enable production and consumption.
SDG 11. Sustainable Cities and Communities	11.6 By 2030, reduce the adverse per capita environmental impact of cities, including by paying special attention to air quality and municipal and other waste management.	Most people in PNG have no rubbish collection services, which are limited to larger urban centres. Generally waste management is inadequate and recycling is very limited.
GOAL 14: Conserve and sustainably use the oceans, seas and marine resources for sustainable development	14.1 By 2025, prevent and significantly reduce marine pollution of all kinds, in particular from land-based activities, including marine debris and nutrient pollution.	No information is available to track the status of marine pollution and debris. Sources of concern include untreated human waste and rubbish due to lack of sanitation and waste systems; discharge of mining tailings into rivers and under the sea; waste and litter from shipping; and sediments from logging and clearing.

Source	Target/goal	Comment
Aichi Target 8	By 2020, pollution, including from excess nutrients, has been brought to levels that are not detrimental to ecosystem function and biodiversity.	Status in 2019 was assessed as 'moving away from the target, with six main potential sources of pollution: 1. Settled centres; (household, industrial, healthcare waste (HCW), vehicular including e-waste) 2. Mining with riverine or deep-sea tailings disposal, 3. Agro industry runoff 4. Forest clearance runoff 5. Fish processing facilities 6. Sea lane pollution (Conservation and Environment Protection Authority, 2019, p. 75)
Proposed 2020 Biodiversity Target 7.	Reduce pollution from all sources to levels that are not harmful to biodiversity and ecosystem functions and human health, including by reducing nutrients lost to the environment by at least half, and pesticides by at least two thirds and eliminating the discharge of plastic waste.	

10.3.1 Access to clean water

Access to safe and reliable water supplies in PNG is very low by international standards. The following tables (Table 50 and Table 51) are reproduced from the PNG national voluntary report on progress towards sustainable development goal 6.1 (WaSH).

Table 52: Progress towards rural water supply target
Department of National Planning and Monitoring, 2020.

	Base line		Actual	
Indicator	**Value**	**Year and source Value**		Year and source
Rural Water Supply				
Proportion of rural population using safely managed drinking water	No Data	2015	0%	2019 (UNICEF KAP survey 2019)
Proportion of rural population using basic drinking water	33.4%	2015 (JMP)	39.3%	2018 (DHS)
Proportion of rural population using limited drinking water	1%	2017 (JMP)	2.3%	2018 (DHS)
Proportion of rural population using unimproved water for drinking	6%	2017 (JMP)	57.5%	2018 (DHS)
Proportion of rural population using surface water for drinking	58%	2017 (JMP)	16.1%	2018 (DHS)
Proportion of rural population with access to an improved drinking water source	34.8%	2015 (JMP)	41.5%	2018 (DHS)

Table 53: Progress towards urban water supply target
Department of National Planning and Monitoring, 2020

	Base line		Actual	
Indicator	**Value**	**Year and source Value**		Year and source
Urban Water Supply				
Proportion of urban population using safely managed drinking water	No Data	2015	No data	2020
Proportion of urban population using basic drinking water	86%	2017 (JMP)	82.2%	2018 (DHS)
Proportion of rural population using limited drinking water	4%	2017 (JMP)	0.8%	2018 (DHS)
Proportion of rural population using unimproved water for drinking	3%	2017 (JMP)	16.0%	2018 (DHS)
Proportion of rural population using surface water for drinking	7%	2017 (JMP)	4.3%	2018 (DHS)
Proportion of rural population with access to an improved drinking water source	89.4%	2017 (JMP)	83.5%	2018 (DHS)

10.3.2 Pollution and waste

In 2017, the waste sector in PNG was responsible for 1006KT of greenhouse gases, compared with 811KT in 2010 (Government of Papua New Guinea, 2022c).

Ensuring an effective waste management system and reducing waste generation through recycling are major challenges for urban authorities in PNG. Urban centres like Port Moresby, Rabaul and Madang are among those that are improving in the above-mentioned areas (Department of National Planning and Monitoring 2020). The PNG Government with the assistance of the Government of Japan is supporting efforts on proper waste management systems in Port Moresby and other pilot centres such as Goroka. For example, in Port Moresby, the upgrading of the waste management processing site is underway in partnership with the Japan International Cooperation Agency to meet international standards and build technical capacity.

Most of the key implementing agencies (such as the Office of Urbanisation, the National Housing Corporation, and the urban town authorities) have limited human resource and technical capacity to develop strategies and undertake key reforms under the SDG agenda. Lack of financing and access to appropriate technologies further compounds the problem. The same is true for waste management. While the national policy is currently undergoing consultations, only a few urban authorities, including NCDC in Port Moresby, have waste management plans.

CEPA recognizes the need for a national waste policy. The PNG Government intends to implement the draft National Waste and Chemical Management Policy, soon to be endorsed by the NEC to "build capacity for urban and municipal authorities and mining township authorities throughout the country [,] with advanced plant and equipment and landfill dumping sites to better regulate the disposal of garbage, sanitation and chemical waste". However, in 2022, the National Newspaper reporting CEPA policy division director said "waste management [is] a challenge for PNG because it [has] no national strategy policy to control the amount of chemical waste going out."

Data about waste streams in PNG are not routinely collected. The first and second PNG biennial reports to the UNFCCC acknowledge limitations in estimating greenhouse gas emissions in the waste sector (Government of Papua New Guinea, 2018a, 2022c). These arise from the lack of information about waste management systems and of data on land-filled waste, composted waste, incinerated/ open burned waste, waste composition, parameters for methane estimation for landfills, industrial waste data, population data by domestic wastewater treatment method, and industrial wastewater data. The World Bank What a Waste country level database for PNG (The World Bank, n.d.) identifies three sources of publicly available information, all of which are snapshots in time (2014, 2016).

Solid waste

In 2021, an audit of waste was conducted through the PacWaste 2 project (Section 10.5). A compilation of the data generated by the study with historical data provided to the study, estimated average waste generation rate of .39 kg per capita per day. The household waste stream comprises approximately:

- 41 percent organic materials of which around five percent is betelnut;
- 17 percent plastics of which approximately four percent are defined as single-use plastics;
- Seven percent metals; and
- less than one percent hazardous.

Of the businesses sampled in this study, the highest recorded material type was plastics at 32 percent of which 23 percent were single-use plastics. This was followed by the paper and cardboard category at 27 percent and organics at 23 percent.

Local-level governments are responsible for collection of household waste, which is only provided in urban areas. Environmental management is shared between the local level and central governments (Pacific Region Infrastructure Facility (PRIF), 2018). Local bylaws in some cases are applied to disposal sites, but not all have an environmental permit from CEPA. The private sector recycles some scrap steel, electronic waste, oil, batteries and plastics (SPREP, 2021b). Local level governments may levy a variety of local taxes and charges, as waste management services are not funded through the national government. Limited revenue is collected, and as a result many communities lack efficient and regular collection services.

Household generation of solid waste varies depending on income, urbanization and other factors.[101] Municipal solid waste generation rates are likely to be higher in Port Moresby, Lae, and other cities, and are considerably lower in rural areas where much waste is organic and most is disposed of through burning or burying.

PNG has over 21 unregulated solid waste disposal sites and one controlled site located in Port Moresby (Pacific Region Infrastructure Facility (PRIF), 2018; Veari Kula CEPA pers comm, 2022). Most solid wastes from households and commercial sites within 22 towns/ cities in PNG are disposed in aggregate quantities at open air dump sites located at the periphery of the town/ city (Government of Papua New Guinea, 2018a). The J-PRISM 1 project supported upgrading solid waste management at the Port Moresby waste facility (JICA, 2014). Most of the 63 settlements in Port Moresby are not serviced for solid waste collection (Pacific Region Infrastructure Facility (PRIF), 2018).

Markets are a significant source of organic compostable waste in urban settings (Veari Kula, CEPA, pers comm, 2020). Diverting organic waste, and processing for compost and/or biofuels could provide livelihood opportunities, particularly for women (UN Gender advisor, pers comm, 2020).

A study of waste in Lae notes that in most towns, rubbish including waste taken to municipal dumps is heaped up and burnt, and this includes medical waste which is disposed of with other waste. There are many concerns for human health with these practices, and improving the situation is a critical need as the city and industry expand (Doaemo et al., 2021).

In addition to the generation of greenhouse gases, potential impacts from burning waste in uncontrolled situations include:

- groundwater contamination due to leaching
- surface water contamination due to run-off on the waste dump
- odours
- rodents
- generation of inflammable gas such as methane
- frequent fires
- spread of epidemics due to stray animals
- soil acidity (Doaemo et al., 2021).

Plastic waste

Daily plastic waste generation is estimated at approximately 282 tonnes (Jenna et al., 2015 cited in (Pacific Region Infrastructure Facility (PRIF), 2018). An estimated 246 tonnes are mismanaged daily, entering the marine environment through release from uncontained disposal sites or by littering. As a result, an estimated 89,835 tonnes of plastic waste became marine debris in the waters around PNG in 2010. The outcome of mismanaged plastic is split into three primary groups: plastic that remains on the surface of the sea as floating debris; plastic that sinks to the ocean floor; and plastic that washes up on beaches.

Recycling

Returning recyclable wastes (like plastics, papers, metals and other items) to overseas markets is expensive and difficult for the recycling companies to sustain in the long term – especially in the absence of supporting government initiatives. For this reason, most recycling operations in Pacificisland countries only collect, process and return high value items overseas for some revenue. Depending on the global market rates, metals such as copper, aluminum, bronze and other non-ferrous metals are the main focus of recycling, while plastics and paper continue to flow to the waste disposal sites (JICA and SPREP, 2018). A feasibility study is investigating options for an Advance Recovery Fee and Deposit scheme to enable collection and export of household recyclable items and problematic waste. A Working Group of several government departments, including CEPA, are involved in the design of the scheme.

In PNG, two recycling services collect and export ferrous and nonferrous waste, used lead-acid batteries and e-waste material to destinations in Asia (Pacific Region Infrastructure Facility (PRIF), 2018). These services collect materials from the mainland and outer islands and transport them to the larger metal recycling operations in Port Moresby, Lae and Tabubil. A smaller firm operates from a temporary building for the baling and storage of aluminium cans and products, as well as copper prior to export. There is limited recycling of glass and plastic (CEPA and SPREP 2020).

Electronic waste

Most e-waste ends up in landfill (SPREP, 2020a). One collection and export business discontinued operations, because it was not viable (Veari Kula CEPA, pers comm, 2020). In 2016, Oceania as a whole generated an estimated 0.7 Mt of e-waste, 80 percent of which was generated in Australia. PNG was estimated to produce under 6 kg of e-waste per person (Baldé et al., 2017).

[101] The average daily household waste generation for Pacific Island nations is 0.5 kg per person (SPREP, 2016). This is approximately one third of the daily per capita generation by Australians (Clean Up Australia, n.d.).

Hazardous waste

Healthcare waste management is the responsibility of the Department of Health. Medical waste guidelines provide for collection and disposal of medical waste either through incinerators and on occasion through burying (SPREP, 2020a). The Pacwaste1 programme supported health waste training in Port Moresby (ENVIRON Australia, 2014); (Suez Consulting, 2017); (Veari Kula CEPA, pers comm, 2020). Healthcare waste was recorded at 572 tons/annum (ENVIRON Australia, 2014). Two MOUs were signed (PNG National Department of Health and SPREP on 2 November 2021 and CEPA and SPREP on 21 October 2021) to progress actions to address asbestos, e-waste and medical waste.

PNG has no national guideline for asbestos management and relies on SPREP/Australian guidelines (SPREP, 2020a).

Mercury, persistent organic pollutants (Stockholm Convention) and hazardous wastes (Basel Convention) require permits under the Environment (Prescribed Activity) Regulation. PNG is not yet a signatory to the Minamata Convention on Mercury but has begun the steps towards ratification (Veari Kula CEPA, pers comm, 2020). A significant number of people engage in small-scale alluvial gold recovery, producing 120,000 ounces of gold in 2019 (Tom, 2020). Many extract gold using mercury amalgam, which may result in mercury being released to aquatic environments, and/or to inhalation of mercury vapour (Reto, 2002). The Minimata Initial Assessment project commenced in 2016, with a view to conducting a comprehensive assessment of mercury management and use (Veari Kula CEPA, pers comm, 2020). In March 2020, the PNG Mineral Resource Authority and the Artisanal Gold Council launched a project aimed at reducing mercury use in the artisanal/small gold mining sector, funded by the US Department of State (Tom, 2020). The project is designed to gain a better understanding of the alluvial gold sector to identify the extent of mercury use, who uses it, and how it is used.

A local company certified by the International Organization for Standardization provides hazardous waste management and recycling services to commercial and industrial clients throughout PNG (Pacific Region Infrastructure Facility (PRIF), 2018). Waste oils are refined and recycled in Port Moresby, and plastic bottles and e-waste are exported to Asian and Australian markets. The company has also partnered with an Australian-based company to receive and recover mercury-containing waste, including fluorescent lighting.

10.3.3 Wastewater and sewage treatment

PNG has the lowest sanitation access indicators amongst the 15 developing Pacific island nations, with access to improved sanitation estimated at 13 percent in 2017 (Department of National Planning and Monitoring, 2020).

Only 12 percent of the PNG urban population is estimated as having access to a 'safely managed' sanitation service (Ellery, n.d.). In Port Moresby, only about seven percent of faecal waste is safely transported and treated. Householders discharge wastewater to stormwater drains to avoid sewer blockages, and sewerage operations' staff can also find it more convenient/necessary to bypass sewage into stormwater drains in the event of blockages or pump station failures. Low soil absorption means that households using septic tanks also connect their outlets to stormwater drains.

Trade wastewater discharges to sewerage systems are managed under the national Trade Wastewater Policy. The wastewater quality entering the sewerage systems have high concentrations of pollutants. The policy indicates that Water PNG undertakes monthly monitoring of treated effluent in major systems, with monitoring in small systems undertaken quarterly.

The merged state-owned enterprises, (the former) Eda Ranu provides water and sewerage services in Port Moresby and Water PNG Ltd maintains sewerage systems in seven provincial business centres. In these areas, all discharge is to either the sea and/or fresh waterways (PNGWater - Sewerage System, n.d.). CEPA is responsible for the regulation of effluent quality and disposal into the environment, consistent with the Environment (Water Quality Criteria) Regulation.

Table 54: Provincial wastewater treatment systems
Source: PNGWater - Sewerage System, n.d.

Location of Water PNG wastewater systems	Collection System	Disinfection on final effluent	Disposal
Alotau	Primary Septic Tank	Chlorination	Sea Outfall
Kimbe	Biological Treatment ponds	Chlorination	Stream Discharge
Kundiawa	Biological Trickling Filter	Chlorination	Stream Discharge
Lae	Pre-treatment – grit chamber + screens + Biological Treatment Pond	Chlorination	Sea Outfall + River Discharge
Madang	Biological Treatment ponds and Lagoons	Chlorination	Stream Discharge
Mt Hagen	Biological Treatment ponds	Chlorination	River Discharge
Popondetta	Biological Treatment ponds	Chlorination	River Discharge

In rural areas, it is estimated that only a quarter of the population is using safely managed sanitation, with 56 percent using unimproved sanitation and 18 percent practicing open defecation (Department of National Planning and Monitoring, 2020).

10.3.4 Greenhouse gas emissions

In 2017, the waste sector was the third largest source of emissions, contributing around nine percent of PNG's total greenhouse gas emissions (including LULUCF). Methane comprised 87 percent of total sector emissions. Table 55 sets out the sources of greenhouse gas emissions from the waste sector and the relative contribution from each sub-sector (Government of Papua New Guinea, 2022c).

10.3.5 Positive achievements in recent years

The National WaSH Policy (2015—2030) has garnered support from a number of donor countries, UN agencies and non-government organizations. For example, an open-source mobile data collection and management platform – i.e., the Water, Sanitation and Hygiene (WaSH) Management Information System (WaSH MIS) – funded by the European Union (EU) is now available for collecting and populating reliable WaSH data across communities, households, schools and health care facilities. The data provide previously lacking information about the status of WaSH, thus contributing to better planning and coordination (UNICEF PNG, 2019) (See also projects currently underway in Section 10.5.1). Women are important partners in WaSH programmes and are major beneficiaries from improvements. Private places to wash and toilets are critical to women's health and security, and to increasing girls' confidence and attendance at school.

Through PacWaste 2014—17 (the SPREP Pacific Hazardous Waste Management Project funded by the EU), PNG addressed healthcare waste at the Port

Table 55: Greenhouse gas emissions from waste subsectors

2015	Amount	Note
Total waste sector emissions	1006Kt Gg CO2 eq	
Wastewater treatment and discharge	67 %	Domestic wastewater treatment and discharge
Solid waste disposal	27%	Unmanaged municipal solid waste disposal sites
Incineration and open burning	6%	Not reported in previous estimates
Biological treatment of solid waste	1%	Composting in rural areas of PNG

Estimates are unavailable for emissions of hydrofluorocarbons (HFCs) arising from refrigeration and air conditioning. Estimated emissions from the waste sector increased by 80 percent between 2000—2017, with the growth influenced by population growth, development, consumption rate, and rural-to-urban drift (Figure 55).

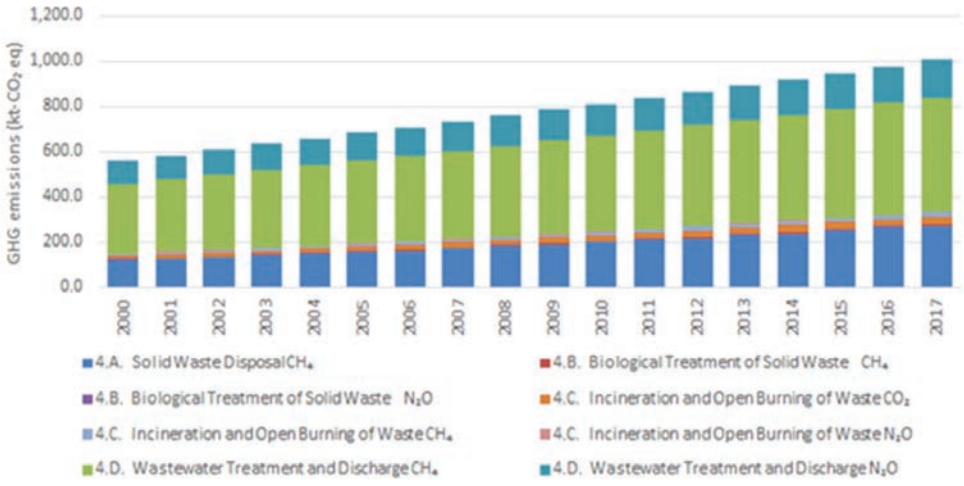

Figure 55: Waste subsector greenhouse gas emissions 2000-2017
Source: Government of Papua New Guinea (2022c, p. 28)

Moresby General Hospital (ENVIRON Australia, 2014). The assessment found that minimum standards for health care waste management were partially met at best, and that improved storage, treatment and disposal solutions were needed, particularly in the area of waste segregation. In response, healthcare waste management training was provided for hospital staff.

In March 2019, the EU committed a further EUR 16.5 million to PacWaste Plus (2019-23) for managing waste in the Pacific Region, to address issues relating to health and wellbeing, marine litter and biodiversity conservation (SPREP, 2019). PacWaste Plus expands the types of waste streams to be addressed from hazardous wastes asbestos, e-waste, and healthcare waste to include solid wastes such as recyclables, organic waste, disaster waste, and bulky waste and the solid wastes found in wastewater pollution effluent from poor waste management (EU/SPREP, nd).

PNG priorities for Pacwaste2 (SPREP, 2020b) include:

- Medical waste [Install 3 incinerators, capacity building];
- Asbestos [Inventory and disposal]; and,
- E-Waste [Inventory and disposal].

There is a proposal to build a covered material recovery facility at Baruni as part of PRISM-2 (Pacific Region Infrastructure Facility (PRIF), 2018).

Methane capture for electricity generation has been fitted at two New Britain Palm Oil Ltd (NBPOL) mills to reduce greenhouse gas emissions from mill effluent (New Britain Palm Oil Ltd, undated; SPREP, 2020a). The projects were approved as Clean Development Mechanisms under the UNFCCC (Ted Mamu, personal communication, 2020). NBPOL intends to roll out methane capture to its other mills (although no timeframe is specified).

10.4 Effect on people especially those 'left behind'

As noted in section 3.1, people living in peri-urban areas, informal settlements and rural areas are underserved in relation to water and sanitation. Over 87 percent of the population live in these areas, with estimates that 33 percent have access to safe water (up from 24 percent in 1990) and only 13 percent have access to improved sanitation (unchanged from 1990) (Department of National Planning and Monitoring, 2015b).

Most people living in rural areas take water directly from rivers, streams and lakes for cooking, drinking and washing (CEPA and SPREP 2020). Most people live outside of serviced urban areas and do not have access to safe water, sanitation or waste disposal. Areas that are frequently inundated are not amenable to normal toilets and need a specialised approach such as 'dry toilets' (SAGO Network, n.d.).

The number of unauthorised dumpsites in PNG is not known. The low recycling rate and unauthorized dumps make it hard to manage and dispose of waste effectively and to reduce the potential adverse air, marine and freshwater impacts from landfills, garbage burning, littering and disposal of hazardous waste (CEPA and SPREP 2020).

10.5 Development partner projects and programmes

There is significant multilateral (World Bank, EU, ADB) and bilateral (Japan, Australia) investment in improving WaSH and waste management in PNG. Dealing with these issues will reduce pollution, particularly arising from urban and peri-urban areas. It is also likely to reduce greenhouse gas emissions from the waste sector.

These investments are guided by multilateral, national and institutional frameworks and strategies. They are accompanied by technical guidance, project monitoring and evaluation, and capacity building. In addition, PNG has embraced the idea of eco-industrial development where the goal is to create a node of industrial sustainability that minimizes waste and reduces carbon emissions, enhances inter-industry cooperation, and more effectively and efficiently utilises local resources. (Government of Papua New Guinea, 2018a).

10.5.1 WASH

World Bank Water Supply and Sanitation Development Project for Papua New Guinea

In 2017 the World Bank approved finance of US$70 million over five years for a water supply and development project in PNG, with PNG to contribute an additional US$7.3 million (World Bank, 2017). The project aims to develop and strengthen the planning and implementation capacity of water sector institutions, and to increase access to water supply services in selected urban towns and rural districts. Components include:

- Supporting institutional structures for implementing the national WaSH Policy;
- Coordinating and developing a framework for delivering rural and peri-urban water supply, including sanitation through new District Development Authorities; and
- Supporting Water PNG to expand water and sanitation services to district and provincial towns.

Lack of progress towards achieving these objectives, especially in relation to delivering rural and peri-urban water led the World Bank to restructure the project in 2020 and to extend the closing date by 20 months (World Bank, 2020). Other projects aimed at improving WaSH across PNG include:

UNICEF PNG WASH programme

UNICEF PNG (EU-UNICEF, E21.3 million over three years) working with the Government to support WaSH in schools by providing water tanks, toilet and

handwashing facilities and promoting menstrual hygiene management so that all children, especially girls, attend classes regularly and stay in school (UNICEF PNG, undated).

WaterAid PNG/Water for Women

As well as advocating for improved WaSH implementation, WaterAid PNG is working with District Development Authorities to build capacity and support them in their responsibilities for planning and regulating service provision, and ensuring communities, schools and health care facilities have affordable, safe and sustainable WaSH services. WaterAid PNG also promotes long-term behaviour change through public messaging projects (WaterAid, 2017). During Covid 2019, soap-making workshops were held for women to produce their own soap from local materials.

The Asian Development Bank is providing technical advice for WaSH activities, particularly in relation to peri-urban settlements (Marshall K, 2020).

European Union WASH project (European Union, 2020)

As part of its Papua New Guinea: Multi-annual Indicative Programme 2021-2027, the EU has set the following objectives for WASH (Table 56).

10.5.2 Waste management

J-PRISM I and II

The first phase of this project produced outcomes including the Practical Guide to Solid Waste Management in Pacific Island Countries and Territories (2018).

In April 2019, the Japanese International Cooperation Agency (JICA) announced that it will work with CEPA, NCDC and the Dept. of Lands and Physical Planning to implement the second phase of solid waste management (J-PRISM II) in PNG until 2025 (The National, 2019). JPRISM II aims to strengthen institutional capacity for solid waste management at the national and provincial levels. It expects to:

- Provide lessons that can be factored into the new national waste policy and action plan, especially with regard to solid and hazardous waste management;
- Introduce solid waste management plans to the pilot urban local-level governments of Alotau, Goroka, Lae and Kokopo; and,
- Support the National Capital District waste management plan, 2016—2025.

Useful outputs to date of the JPRISM II project have included the development of the Regional Disaster Waste Management Guideline.

Table 56: Objectives and expected results for EU WASH project

Objective	Expected results
1 Beneficiary populations are using and maintaining increased and equitable access to safe, adequate and sustainable water supply and sanitation services, including innovative localized solutions for waste and waste water in selected rural and peri-urban areas, schools, health centres and places of human agglomeration, with particular focus on women and girls, children and those traditionally left behind.	(i) Improved safe, adequate and sustainable water supply, sanitation and hand washing facilities area available in selected rural and peri-urban areas schools, health centres and places of human agglomeration (ii) Increased awareness among the target population in the selected areas on the importance of using and maintaining hygiene and sanitation facilities (iii) Improved WaSH in school environment for adolescent girls (iv) Increased employment opportunities for youths in WaSH provision and maintenance.
2 WaSH policy makers and implementers operate effectively in an enabling environment with adequate capacities (including digital) towards the achievement of national WaSH goals.	(i) Increased availability of WaSH data (including digital) for policy and monitoring purposes at national, provincial and local level government (ii) Improved policy coordination among state bodies, in consultation with non-state stakeholders (iii) Improved WaSH and wastewater planning, budgeting, implementation and monitoring systems (iv) Increased investment in WaSH, including through innovative financing.

PacWaste Plus.

PacWastePlus Programme is being implemented through SPREP and funded by the EU Delegation of the Pacific. Priority waste streams for PNG in PacWaste Plus are health care waste, asbestos and e-waste (SPREP, 2020a). This project has produced an audit of solid waste disposal in PNG. Key Result Areas include:

- Improved data collection, information sharing, and education awareness;
- Policy and regulation - policies and regulatory frameworks developed and implemented;
- Best practices - enhanced private sector engagement and infrastructure development implemented; and
- Human capacity - enhanced human capacity.

Strengthening the institutional framework and national capacity of key stakeholders in Papua New Guinea in waste and chemical management project funded by UNEP 2018-2021.

The project is designed to strengthen institutional structures within CEPA including establishing a waste management division within CEPA; establishing mechanisms for coordinating issues with stakeholders; awareness and capacity building workshops for industry and key stakeholders; and developing a waste management plan for the Alotau municipality in Milne Bay Province (UN Environment Programme, 2018).

Through this, PNG has worked on developing its first National Waste and Chemical Management Policy (Department of National Planning and Monitoring, 2020), which aims to provide a cohesive and uniform approach across the country in management and disposal of solid and chemical waste, but does not include radioactive waste. The policy is designed to support actions of government, business and the community to manage waste by:

- Ensuring PNG has a well-established governance structure for waste management that clearly defines roles and responsibilities at all levels of government;
- Requiring professional collection and waste management services that include full coverage in all urban areas and partial coverage in rural areas;
- Requiring the application of sound environmental management standards at all waste management facilities;
- Providing recycling opportunities to all businesses and communities in PNG;
- Requiring, wherever possible, that waste products are sorted and managed to recover resources, rather than be deposited in landfill or other end-use management systems; and
- Ensuring that all products, materials, and chemicals containing potentially hazardous agents are managed in accordance with PNG's obligations to international conventions governing those agents.

10.6 Gaps and risks in managing water, waste and pollution

Rapid population growth is outpacing investment in WaSH and waste infrastructure and services in urban, peri-urban and rural areas. Improvements are required to reduce the exposure of vulnerable populations to health risks from poor quality water, sanitation and hygiene, and impacts on the environment from unmanaged or poorly managed waste disposal.

The World Bank's major investment in WaSH has recently been restructured to accommodate a lack of progress. The issues that were identified as leading to delays in the WaSH project can be used to inform other major international investments. Lessons that can be applied to other projects include:

- A clear national lead agency is needed to drive coordination and implementation of national policies;
- There should be a high-level of investment readiness at project inception;
- Qualified and experienced technical expertise is required, either internally or externally sourced;
- Clear, coordinated authorization pathways need to be established within agencies; and,
- Ability to travel is vital.

Even if the issues above are addressed and funds and resources flow smoothly, individual communities may not be ready to adopt the behavioural changes needed to achieve a project's objectives. It may not matter if the change is introduced through community development or top-down approaches if the change/objective itself is not a priority for community members.

Risks of not achieving improvement in wash include the exposure of vulnerable populations to health risks from poor quality water, sanitation and hygiene, and impacts on the environment from unmanaged or poorly managed waste disposal.

Other issues contributing to a lack of progress in this area include:

- Inability for national government investment, and lack of provincial and local resources and capacity for waste minimization, recovery, recycling and management;
- Growing population and increasing urban household reliance on packaged goods (Department of National Planning and Monitoring, 2020) rather than locally grown/traded; and
- Scattered and isolated rural communities without access to engineered solutions for waste disposal or WaSH.

Challenges and opportunities identified at the PacWaste meeting in February 2020 are: [102]

- Gaps including outdated legislation on waste and chemical management;
- Limited existing sustainable financing mechanisms such as container deposit legislation;
- Limited financial support from the national government;
- Limited institutional and human resource capacity at national municipality levels. The current J-PRISM focus is on three urban local-level governments, where a huge effort is needed;
- Strengthen private-government partnership arrangements; and
- J-PRISM II is supporting the development of a national policy on waste management.

10.6.1 Poor monitoring of water quality

Monitoring and reporting on water quality (and hydrology) for compliance and trend purposes is under-developed. The national system of water gauging stations established in the 1980s is no longer functional and internal expertise has dwindled. CEPA does not have the resources to restore monitoring stations, even on a priority basis. It relies on company contributions to monitor the impacts of developments. It does not have a platform that enables it to analyse and report on the monitoring data that is collected (CEPA Environmental Protection Division, personal communication, 2020).

10.7 Recommendations for managing water, waste and pollution

Recommendations related to WaSH can be found in the CCA Social/Health analysis. In addition to the recommendations and priorities established in existing strategies and frameworks, from an environmental perspective our recommendations are as follows.

10.7.1 Focus on integrated implementation and capacity building

Rather than having two different programmes of work targeting similar levels of government and target audiences, better integration between provincial and local-level planning would increase effectiveness – especially in regard to implementation of WaSH and waste management. Further integration with local programmes such as adapting to climate change and building resilience to disaster) could also lead to improved outcomes at the local level.

10.7.2 Support implementation of actions to achieve targets related to clean water and waste management services

The lack of capacity to pay among large sections of the population (especially rural, peri-urban and informal residents) needs to be recognized, together with the lack of capacity among local-level governments and state-owned enterprises to collect fees and charges for water and waste services, and find new models for providing partially or fully-subsidised services.

10.7.3 Develop teams capable of maintaining clean water and helping with sanitation and some waste systems at the local level

A network of train-the-trainers, and community and protected area rangers could be trained and equipped to maintain clean water and waste systems in remote locations. People participating in ranger programmes will have remote project management skills, communication skills and technology, and a support network. Participants may also be interested in gaining skills in community education and awareness building; and in trades such as plumbing, electrical and small equipment handling.

Innovative solutions should be sought and supported to overcome the barriers to providing clean water and sanitation in remote and challenging environments.

10.7.4 Reinstate and improve a functional network of water monitoring stations with appropriate human resources

It is vital that water quality be monitored especially in catchments supplying drinking water.

10.7.5 Legislate to control the import and use of certain substances, to reduce production of non-recyclable waste

While proper disposal of waste is essential, there are increasing calls to reduce or prevent the production of unnecessary waste substances in the first place. For countries like PNG that import most of their products, banning imports of some substances is a very effective measure (Farrelly et al., 2021). There is the potential for traditional plastic-free materials to offer locally-sourced, economic and convenient alternatives, such as bamboo, to many single-use packaging and takeaway food container products.

[102] SPREP 2020 PacWastePlus Steering Committee Meeting Report 10-12 February 2020, Nadi, Fiji. (https://www.sprep.org/attachments/Publications/WMPC/PWP/steering-committee-meeting-report.pdf)

Chapter 11.

Environmental impacts of mining, oil and gas extraction


UN
DP

11.1 Context for mining, oil and gas extraction in Papua New Guinea

Papua New Guinea (PNG) is located between the northward-moving continental Australian Plate and the oceanic Pacific Plate, making PNG highly prospective for a variety of minerals including gold, copper, silver, nickel and cobalt, as well as hydrocarbon resources in the form of oil and gas (Mudd et al., 2020). The prospect of deep-sea mining (e.g., in the Bismarck and Solomon Seas) opens possibilities for the extraction of nickel, copper, cobalt, manganese, zinc, gold and other rare earths and minerals. Large-scale mining companies employ about 20,000 people directly and 25,000 indirectly (Bainton et al., 2020; Bainton & Jackson, 2019).

Foreign investment in large mines, and more recently in gas extraction, has been encouraged in PNG, and the sector dominates the formal economy. In 2021 the extractives sector (mining, quarrying, oil and gas industries) contributed 88 percent of exports (40.1 percent mining, 48 percent oil and gas) and 28 percent of national gross domestic product (17.2 percent mining, 10.5 percent oil and gas) (Ernst and Young Australia, 2021). Policy documents, including Vision 2050 and the National Goals and Directive Principles in the preamble to the PNG Constitution, reinforce the belief that gains from mining will finance a range of programmes across the country (Kaiku, 2020).

Mining, oil and gas extraction have the potential to provide economic opportunities and a multiplier effect that can support sustainable growth and the achievement of Sustainable Development Goals (SDGs). This includes opportunities to generate revenue to fund community services, infrastructure and other development, provide a range of jobs based on diverse skill levels, and downstream processing and manufacturing to add value to the mining process. Mining companies can provide training to small enterprises that supply them and to the workers directly involved in mining. They can also help to improve health, education and nutrition and reduce levels of poverty (Yamarak and Parton, 2021).

In PNG, most mining and related infrastructure is located on customary land, but the State has ownership of the minerals in the ground (Section 11.2). The State grants rights to exploration and mining over customary land and compensates customary landowners to varying extents. The State may enter into an agreement relating to the development or financing of a mining development (Mining Act 1992, s17).[103] Provincial governments also derive benefits from mineral development.[104] However, there are some unresolved issues. For example, many 'mining' communities have and continue to claim ownership of minerals based on their customary land tenure. At the Panguna mine in Bougainville the landowners' claim to ownership of minerals on their land was resolved with new legislation.[105] In addition, landowners in several areas have objected to proposed mines, the most recent being the proposed Freida Mine in the Sepik River basin[106], and Rocher et al. (2019:978) indicate that extractive processes "continue to deliver uneven development in PNG" and Burton (2017) states that mining "favours the interests of local elites, proponents and officials over the poor and marginalised".

PNG has a long history of mining. Gold was extracted in the 1880s in Milne Bay Province and oil was first discovered in 1911. Large scale mining began in 1972 with the Bougainville Copper Ltd Mine at Panguna, followed by Ok Tedi (gold and copper) (1984) and later the Kutubu oil project in the Southern Highlands (1992) and several gas projects, with liquefied natural gas (LNG) exports beginning in 2014. The history of mining, oil and gas extraction in PNG commonly involves weak environmental regulation and enforcement, environmental degradation, diverse social impacts and limited community gains.[107] Until very recently, approval has been given routinely for mine wastes to be discharged to rivers or oceans on a very large scale, leading to widespread environmental and social impacts (Mudd et al., 2020).

This chapter focuses on the environmental impact of resource extraction. The broader economic policy settings and the financial gains and constraints form part of the CCA economic analysis.

11.1.1 Mining projects

Existing and potential mines are located in all provinces of PNG and range from small to large scale operations (Figure 56, Table 57). These are operated by large international companies, state-owned enterprises and many small companies. The main large scale mining operations include Ok Tedi, Porgera, Lihir, Hidden Valley, Ramu Nickel, Simberi and Kainantu. Proposed large mines include Freida River and Wafi-Golpu (Bainton, 2020; Ernst and Young 2021).

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[103] The State may elect to acquire up to a 30% participating interest in a mining project. Petromin Holdings PNG Ltd is the nominated State entity that shall exercise the State option (Draft PNG Mining Policy, Pt 14, s1).

[104] "The State shall allocate 5% equity to be shared equally between the provincial government of the mine host province and the customary landholders of the project lease areas on a free carry basis" (Draft PNG Mining Policy, Pt 14, s5). In off-shore locations the 5% equity interest is given to the mine host provincial government(s) (s6).

[105] The Bougainville Mining Act 2015 acknowledges customary ownership of mineral resources located on customary land and the need for landowners' participation in major decisions about their exploitation.

[106] UN special rapporteurs and the chair of the UN Working Group on Human Rights and Transnational Corporations expressed concerns over the proposed Frieda mine, stating the project poses "serious risks to the enjoyment of human rights of affected populations…."; over 2,000 people in 60 villages filed a human rights complaint in relation to the mine.

[107] A major review of Ok Tedi and Porgera mines that surveyed 609 households in mining and non-mining communities found that "…the indigenous peoples affected by mining consider that they have experienced only a small positive impact from mining" (Yamarak and Parton, 2021, n.p.).

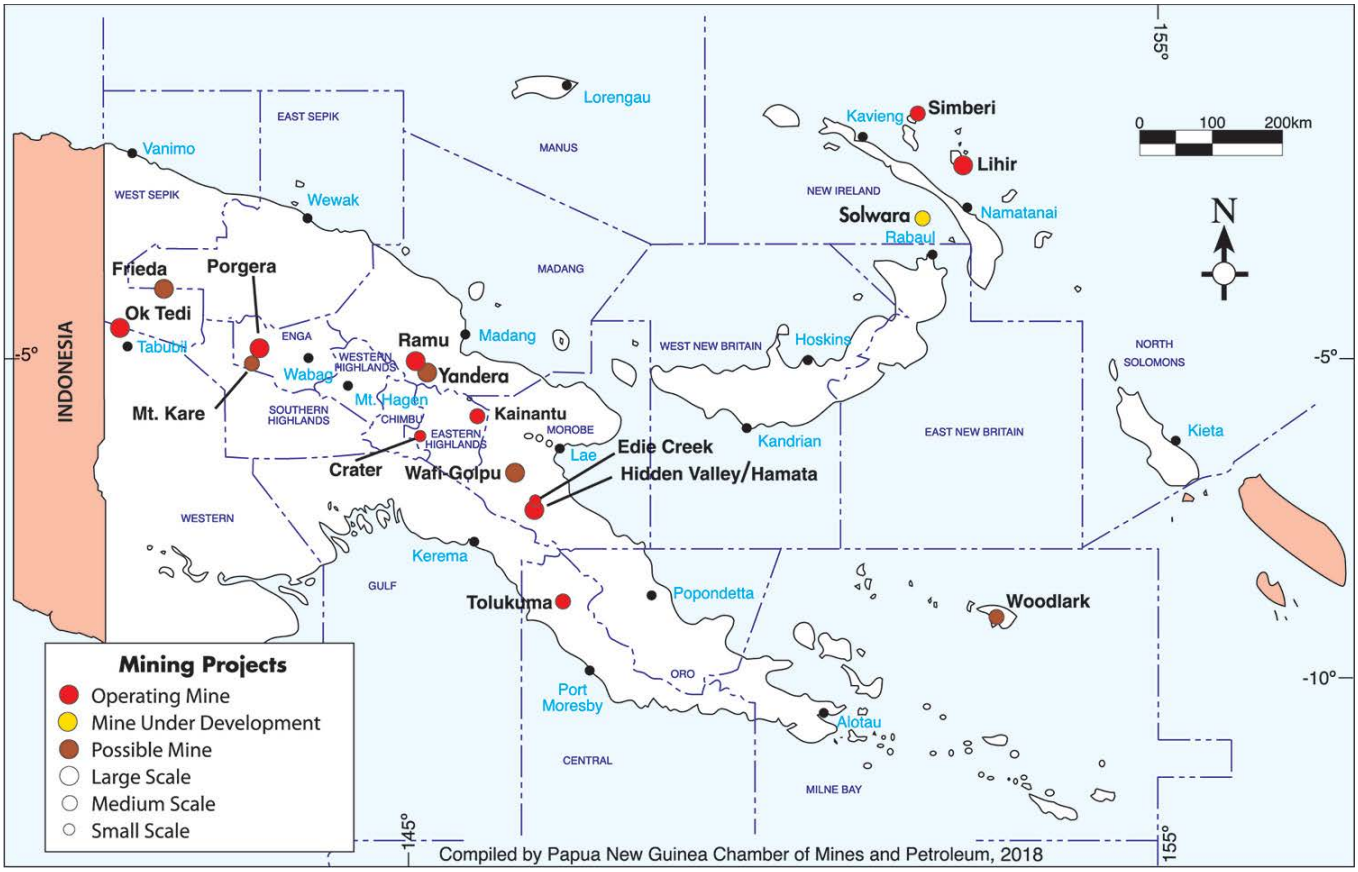


Figure 56: Major mining projects (operational and non-operational)
Source: Ernst and Young (2021), Mudd et al. (2020), Doherty (2019).

Table 57: Major mining projects (operational and non-operational)
Source: Ernst and Young (2021), Mudd et al. (2020), Doherty (2019).

Mine	Production	Waste rock and tailings treatment
Lihir/Luise Caldera mine – SML 6 Lihir Gold Ltd is 100% owned by Newcrest Mining Ltd	Gold and silver 1997—present	Waste rock placed in shallow marine waters of Luise Harbor creating a new landmass; tailings - marine mine waste disposal (Mudd, et al., 2020)
Kurumbukari mine, Ramu – SML 8 Joint venture - Metallurgical Corporation of China (MCC) Ramu (85%) (owned by MCC-JJJ Mining) and NRML (2.5%) and MRML 3,94%) two subsidiaries of Mineral Resources Development Corporation on behalf of GovPNG and landowners; and Nickel 28 Capital Corp. Ramu NiCo Ltd (operator) MCC	Nickel, cobalt and chromite	Slurry piped to refinery at Basamuk Bay. Refinery waste = MMWD (Mudd et al., 2020)
Hidden Valley mine – ML 151 Hidden Valley JV (operator) 100% owned by Harmony through Morobe Consolidated Goldfields	Gold and silver 2009—present	Conventional engineered tailings dam in early construction/operation sediment event from waste rock dump (Mudd et al., 2020)
Edie Creek mine – ML 144 Niuminco Edie Creek Ltd	Gold and silver	n/a
Simberi mine – ML136 Simberi Gold Co. Ltd (operator) is 100% owned by St Barbara	Gold and silver	Marine mine waste discharge to sea @ >100m depth (Mudd et al., 2020)

Mine	Production	Waste rock and tailings treatment
Ok Tedi Mt Fubilan - SML 1 Ok Tedi Mining Ltd (operator)	Gold, silver and copper	River mine waste discharge to Fly River (Mudd et al., 2020)
Kainantu – ML150 K92 Mining Inc.	Gold, silver and copper	Engineered tailings dam (K92 Mining, 2019)
Tolukuma Gold Mines Ltd	In liquidation 2018	River mine waste discharge (Mudd et al., 2020)
Porgera mine – SML 1 Barrick Niugini Ltd (operator) - 50% owned by Barrick Gold Corporation, and 50% by Zijjin Mining Group MRDC (managing funds for Mineral Resources Enga Ltd [MREL] 5%)	Gold and silver 1990—2020. SML not renewed 2020. Production ceased. Matter in court.	River mine waste discharge to Porgera River -> Lagaip River -> Strickland River -> Lower Fly (Mudd et al, 2020)
Solwara - ML 154 Nautilus Minerals. KMH Eda Kopa (Solwara) Ltd 15% (guaranteed by PNG Government)	Deep sea copper and gold. First mining licence, 2011. In administration 2019.	Marine mine waste disposal (Doherty, 2019)
Misima Placer Dome Ltd	Gold and silver, 1989—2004	Marine mine waste disposal to sea @ >100m depth (Mudd et al, 2020)
Panguna Bougainville Copper Ltd	Ceased production in 1989. Agreement to reopen mine reached in 2022.	River mine waste discharge. Waste rock = erodible dumps. Tailings = discharge to Jaba River tributaries (Mudd et al, 2020).
Crater Mountain mine Anomaly Ltd (Crater Gold Mining Ltd)	Gold. Proposed reopening (did not operate 2018 but permitted to resume 2019). The High-Grade Zone is an area of recent artisanal gold mining (2005-13)	n/a
Central Cement and Lime Project Mayur Resources	Limestone, 20-year mining lease – 2020; granted 10-year special economic zone status (2021) with tax relief, import tariff exemptions and other concessions	
Frieda River PanAust and Highlands Pacific JV for 2018. (100% owned by PanAust from May 2019)	Proposed. Copper-gold porphyry. If approved, would be the largest mine in PNG (16,000ha).	Integrated waste rock and tailings dam (Mudd et al, 2020)
Wafi-Golpu Newcrest, 50% and Harmony JV, 50% ownership.	Proposed. Gold-porphyry and copper (underground mine)	Marine mine waste disposal into Huon Gulf (Mudd et al, 2020)
Woodlark - ML508. Woodlark Mining Ltd (owner and developer). Geopacific Resources Ltd (93% interest in WML-direct interest, 51% and through Kula Gold Ltd, 42%; PNG Government, 5% (option for further 25%)	Proposed. Gold. Woodlark Island, Milne Bay. Open cut mine, 4 pits.	Marine mine waste disposal (deep sea discharge) to Wamunon Bay, Milne Bay. (Mineral Policy Institute 2015)
PNG LNG project, operated by ExxonMobil, PNG Ltd, 32.2% equity stake; Oil Search, 29% stake; Kumul Petroleum, 16.2%; Santos, 13.5%; Mineral Resources Development Co (landowners), 2.8%, JXTG Nippon Oil & Energy, 4.7%.	Gas production and processing	n/a
Kutubu Petroleum Development Project Operated by Oil Search (PNG) Ltd, 60.05%; Ampolex (PNG Petroleum) Inc and Merlin Pacific Oil Co., 14.52%; Merlin Petroleum Co., 18.69%; Petroleum Resources (Kutubu) Ltd., 6.75%.	Oil production began in 1992, gas treatment and pipeline	n/a
Gobe Operated by Oil Search (PNG) Ltd; Santos, 9.4%	Oil, gas treatment and pipeline	n/a

Mine	Production	Waste rock and tailings treatment
Agogo Operated by Oil Search (PNG) Ltd	Oil, gas treatment and pipeline	n/a
Moran Operated by Oil Search (PNG) Ltd;	Oil	n/a
Hides LNG – a domestic gas to electricity project Operated by Oil Search (PNG) Ltd, provides power to Porgera mine	Gas production began in 1991. LNG (production began 2014). Eight boreholes; gas conditioning plant at Hides	n/a
Elk/Antelope gas field, Total, 31.1%; ExxonMobil, 28.3%, Oil Search, 17.7%	Gas. Proposed. (5% reserved for the PNG domestic market). Output expected 2024.	
Papua LNG venture, ExxonMobil, 37.1% equity stake (will reduce when PNG Government takes up as 22.5% stake); Oil Search, 28.2% stake	Gas. Proposed.	
P'nyang, ExxonMobil, 49% equity stake (will reduce when PNG Government takes up a 22.5% stake); Santos, 28%; JX Nippon (Merlin Petroleum subsidiary), 12.5%; PNG Government to have 34.5% equity (Agreement signed, Feb 2022).	Gas. Proposed (construction expected 2028).	
Pasca A Gas field. Offshore gas, Gulf of Papua. Twinza Oil (non-binding agreement 2020). PNG government has right to acquire up to 22.5% working interest	Gas. Proposed (construction expected 2028). Licence awarded 2011. Production platform and loading capacities. Applied for petroleum development licence.	
Western Gas Project. Horizon oil; Balang; Kukum Petroleum Holdings	Gas. Proposed. 4 drilled gas fields. Condition plant will separate oil from gas; liquefaction plant in Daru.	
Other proposed projects (Elevala, Ketu and Stanley) are being negotiated; ExxonMobil and Oil Search have significant stakes in gas resources at Muruk field and extensive onshore and offshore exploration permits, including deep-water prospects.	Proposed.	

Other mining activity includes small scale alluvial gold recovery. This is a 'reserved activity' (i.e. reserved for Papua New Guineans only) (Alluvial Mining Policy, s5(1)(a)) and is one of the largest SMEs in PNG with over 100,000 people estimated to be working as individuals, family/community units, or SMEs (Artisanal Gold Council, 2021) (Table 58). However, use of mercury poses major health risks to the miners due the release of mercury to aquatic environments, and/or to inhalation of mercury vapour (Tom, 2020). Sand mining projects are both legal and illegal and some current projects (e.g., Madang) have been highly controversial due to environmental and social impacts. Community members are urging national policy to be developed for sand mining (Magun & Gabi, 2021). Limestone mining projects are scattered across PNG (e.g., Simbu, Morobe Provinces). They pose a potential threat to important cave environments.

The world's first major deep-sea mining project Solwara 1, under Nautilus Minerals Ltd, planned to mine mineral-rich hydrothermal vents formed by plumes of hot, acidic, mineral rich water on the floor of the Bismarck and Solomon Seas (Filer et al., 2020; Hutt, 2018), but the project failed and went into administration (Doherty, 2019). The mining process can involve excavation of materials from polymetallic nodules or hydrothermal vents on the seafloor at depths up to 6,000 m and the drawing of a seawater slurry to ships. Extracted seawater is pumped down and discharged close to the sea floor. The WWF is leading efforts to place a moratorium on further deep-sea mining and some companies and countries including PNG support the moratorium (CEPA and SPREP, 2020). The issue of seabed mining regulation is currently being debated by the United Nations Convention on the Law of the Sea (UNCLOS) and the International Seabed Authority.

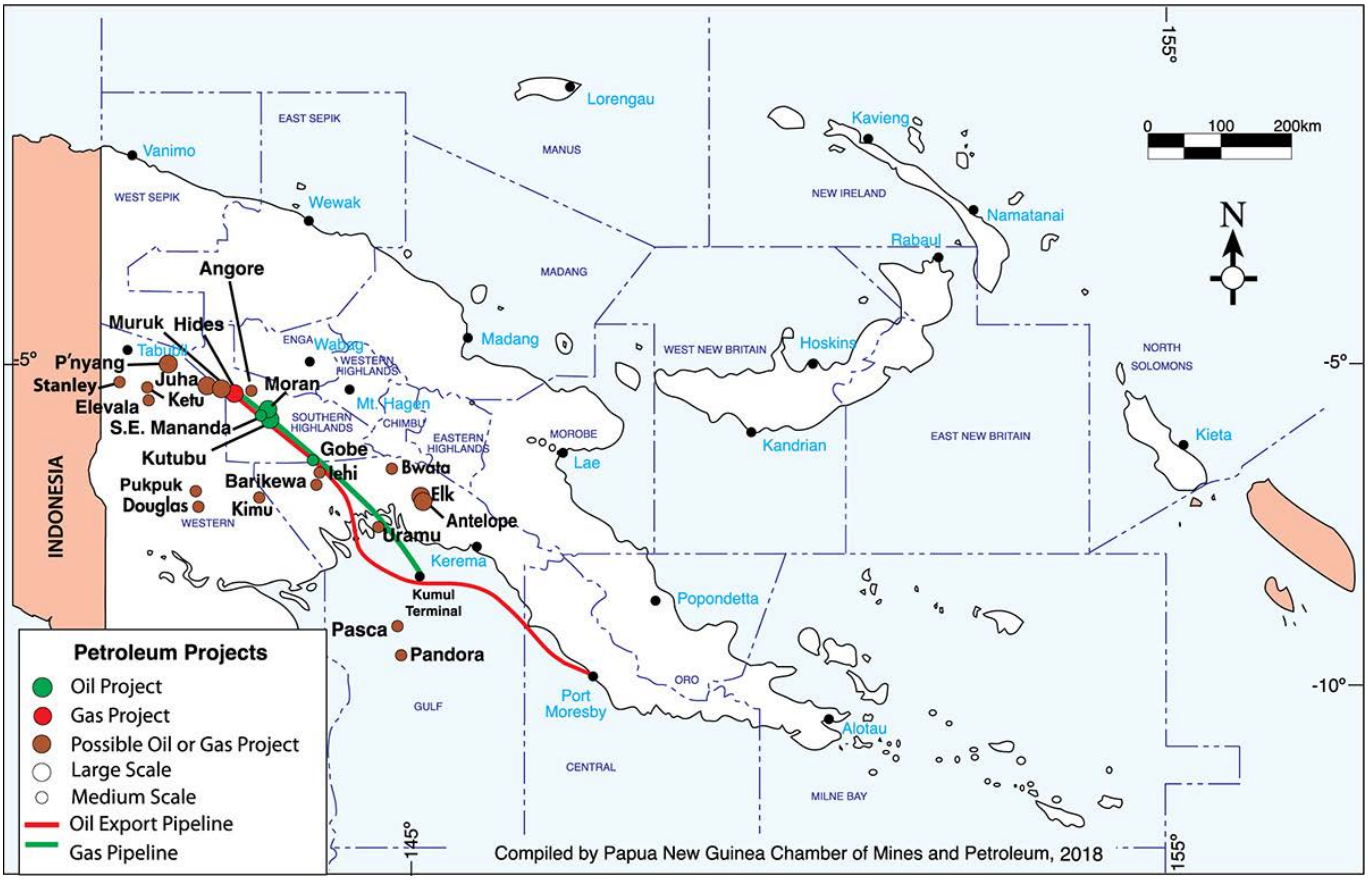


Figure 57: Current and proposed oil and gas projects and pipelines in Papua New Guinea
Source: Ernst and Young Australia (2021)

11.1.2 Oil and gas projects

Commercial oil production began in PNG in 1992 and has been steadily declining since the mid-1990s. Five major oil fields are operating. The PNG LNG project began export production in 2014 (Ernst and Young Australia, 2021). Many companies are actively engaged in exploration and production in PNG, with several proposed projects (Table 55). Oil and gas are produced in inland fields and piped to the coast for treatment and subsequent export. Future projects will extend to offshore locations. Oil and gas interests in PNG are mainly in listed companies and state-owned enterprises (Figure 57).[108]

11.2 Legislation, agreements and policies relating to mining, oil and gas extraction

11.2.1 International agreements and industry initiatives relevant to mining, oil and gas reporting

Many international conventions aimed at protecting the environment and achieving sustainable development have implications for mining and gas production activities (Table 58). However, there are no binding international agreements governing mining and gas production.[109]

[108] A detailed map of petroleum tenements is available from the Department of Petroleum and Energy.

[109] International agreements to which PNG is a signatory include: International Plant Protection Convention (1976), Convention on Biological Diversity (1992), CITES, Convention for the Protection of the Natural Resources and Environment.

Table 58: International agreements and initiatives

Key agreements and industry initiatives	Comments
Extractive Industries Transparency Initiative (EITI)	A global standard to promote open and accountable management of oil, gas and mineral resources. The EITI Standard requires the disclosure of information along the extractive industry value chain, from the point of extraction, to how revenues make their way through the government, and how they benefit the public. Six PNG EITI Annual Reports (2013-2019) were produced by the PNG EITI Multi-Stakeholder group. The 2019 EITI status report has no information on environmental matters (Ernst & Young Australia, 2019).
International Council on Mining and Metals (ICMM)	Dedicated to a safe, fair and sustainable mining and metals industry. Mining Principles define good practice environmental, social and governance requirements for the mining and metals industry through comprehensive performance expectations, including for tailings management (International Council on Mining and Metals, n.d.). Membership is voluntary – PNG operators Barrick (Porgera) and Newcrest (Lihir, Wafi-Golpu) are members of the ICMM. The ICMM does not sanction members if they do not meet ICMM standards.
International Petroleum Industry Environmental Conservation Association (IPIECA)	Industry association for the upstream and downstream oil and gas industries (IPIECA, n.d.). It develops and promotes good practice aimed at improving industry environmental and social performance (IPIECA and IOGP, 2020). Gas companies Exxon Mobil (PNG LNG, Papua LNG), OilSearch (Hides, Papua LNG) and Total (Papua LNG) are members of the IPIECA.
World Bank International Finance Corporation (IFC)	Established eight standards which define clients' obligations for managing environmental and social risks throughout the life of any IFC investment. Performance Standard 6 recognizes that protecting and conserving biodiversity, maintaining ecosystem services, and managing living natural resources adequately are fundamental to sustainable development (International Finance Corporation, World Bank Group, 2012).
Equator Principles	Over 100 financial institutions have signed-up and commit to implementing the Equator Principles in their internal environmental and social policies, procedures and standards for financing projects and will not provide project finance or project-related corporate loans to projects where the client will not, or is unable to, comply with the principles. Institutions should report annually.
United Nations Convention on the Law of the Sea (UNCLOS) 1982	Sets out the legal framework for seabed mining beyond national boundaries. Within this 'Area', the International Seabed Authority (ISA), established in 1994 is the regulatory agency responsible for deep-sea mining. The ISA must ensure effective protection of the marine environment from harmful effects arising from mining-related activities on the seabed (Dunn 2018). ISA is developing regional environmental management plans to address potential impacts from deep-sea mining. PNG can permit commercial mining operations in its Exclusive Economic Zone. In international waters the ISA issues permits, which require State sponsorship. 31 exploration permits issued to entities in over 20 countries in 2022 (Wolman, 2022, ISA, 2022). Countries that permit deep-sea mining operations receive some of the revenues from these operations (e.g., PNG has a 30% share in Solwara 1 project).

11.2.2 National legislation

Much of the legislation relating to mining and gas (Table 59) is outdated.[110] The Mining Act 1992 governs all mining in PNG (excluding Bougainville and Ok Tedi mining projects). All minerals on, in or below the surface of any land in PNG are the property of the State (Mining Act, s5[1]) and all land in the State is available for exploration and mining and the grant of tenements over it (Mining Act, s6), although this may change with the passing of the Protected Areas Bill. However, up to 97% of land in PNG is under customary land ownership and these landowners must be consulted effectively in the process of granting a mining lease. The Mineral Resources Authority (MRA) is responsible for issuing mining tenements, managing the exploration of mineral resources and reports to the MRA Board. The Minister for Mining and the National Executive Council (NEC) (which acts on the recommendation of the Mining Advisory Council [MAC]) grant mining leases. While landowners cannot veto the granting of an exploration licence, they can control the terms of entry onto their land. There are three types of production leases: 1. Mining lease; 2. Special mining lease; and 3. Alluvial mining lease.[111]

The Conservation and Environment Protection Authority (CEPA) is responsible under the Environment Act 2000 for approving the independent environmental impact assessment report and an environmental impact statement (EIS). The issuance of an Environmental Permit under the Environment Act 2000 is a prerequisite to the granting of a mining lease (Figure 56). CEPA is a member of the MAC and is aware of all mining developments from the exploration to development phases. Mining firms must submit an environment management and social management plan explaining how natural and social impacts will be mitigated, and a conceptual mine closure plan at the advanced exploration phase.

Table 59: Legislation relevant to mining, oil and gas extraction

Legislation	Comments
Mineral Resources Authority Act 2018	A statutory authority responsible for oversight, administration and enforcement of mining Acts and associated agreements, as well as any other legislation related to mining.
Mining Act 1992 and Regulation with amendment 2020	Sets out how mining projects should be administered and regulated. The Amendment requires the State to establish and maintain a repository for all mineral and geological data with the Mineral Resources Authority (MRA); establish a central monitoring hub to which every operating mine will transmit live data on mineral production and extraction and sale data; enables the State to have greater control over benefits arising from resource extraction; gives preference to state applicants for mining licences; and amends the arbitration regulation (i.e. disputes with the process of land reservation are subject only to PNG laws).
Mineral Resources Development Corporation Act 1996, amended 2020	State-owned enterprise for mining related activities. Privatised in 2020, previously a statutory corporation.
Mining (Safety) Act 1977 and Regulations 1935	Stipulates safety requirements on mine sites, providing for investigations/ inquiries into mine accidents and establishing a regime for certification of prescribed mining roles.
Kumul Petroleum Holdings Ltd Authorisation Act 2015	Establishes a state-owned enterprise for oil and gas related activities.
Unconventional Hydrocarbons Act 2015	Governs all aspects of hydrocarbons that are not derived from 'petroleum pools', e.g., shale, coal seam gas.
Mining (Ok Tedi Agreement) Acts	Governs the operation and development of mineral deposits in relation to the Ok Tedi mine and mine impacted communities and environment.
Mining (Bougainville Copper Agreement) Act 1967	Governs the Panguna mine, Bougainville. Although separate mining legislation for the Autonomous Region of Bougainville (Bougainville Mining Act 2015) was passed by the Provincial Government in 2015, the relationship between these respective pieces of legislation is unclear as the former has not been repealed, nor have the references to it in the Mining Act been amended.

[110] Note: A range of other PNG Acts and regulations are applicable to the construction and implementation of mining, oil and gas projects, mainly related to environmental issues e.g. Environment (Water Quality Criteria) Regulation 2002, Fauna (Protection and Control) Act 1979, Dumping of Wastes at Sea Act 1979 etc.

[111] (1) Mining leases - granted to small or medium-sized mines for up to 20 years, with a possible 10 year extension and up to 60 km2 in size; (2) Special mining lease granted for up to 40 years with a possible extension of 20 years more where the mining firm must have a mining development contract with the state before the SML is granted and the Minister has the power to convene a public forum to hear the opinions of the local community and governments and negotiate a benefit-sharing agreement; (3) Alluvial ore mining is reserved for customary landowners, providing this is non-mechanised (if mechanised, a mining lease for alluvial mining purposes is required and is granted for five years and renewable for an additional five years). A separate lease for mining purposes or mining easement is required to build mining related infrastructure. Once operational, firms must submit monthly production and royalty returns and a comprehensive annual report to the MRA (production, export, revenue, resource and reserves information) (Oxford Business Group, 2020).

Legislation	Comments
Oil and Gas Act 1998 with amendments 2020 and the Oil and Gas Regulation 2002	Governs the petroleum industry under the administration and management of the Department of Petroleum and Energy (DPE). States that petroleum resources belong to the state and licences are required to explore for, recover or sell these resources. Projects must provide for the protection of the environment and welfare of the people of the area (s57). Amendment (2020) aims to enable the State to have greater control over granting licences and the benefits arising from resource extraction (e.g., Minister may impose a minimum expected level of return for the State in relation to projects of 'national significance').
Environment Act 2000	Governs matters relating to the environment within mining and exploration tenements with amendments stated in the Environment (Amendment) Act 2014. Provides the legal framework for requiring an Environmental Impact Statement (EIS) and Social Impact Assessment (SIA) (s51). Administered by CEPA. A mining tenement or petroleum development licence cannot be granted until CEPA grants environmental approval under this Act. CEPA facilitates three levels of environmental permit approvals.
Lands Act 1996	Provides for three modes to acquire customary land: i) by agreement (s10); ii) by lease-leaseback (s11), and iii) by compulsory processes. All these processes require that owners of the land must be consulted, and their consent obtained. The Minister must be reasonably satisfied that the land to be acquired is not needed by the landowner.
Physical Planning Act 1989	The Minister for Petroleum and Energy should have regard to physical planning considerations before granting relevant approvals and may need zoning approval for projects of national interest.
Organic Law on Papua New Guinea's Ownership and Development of Hydrocarbons and Minerals and the Commercialisation of State Businesses 2020 ("2020 Organic Law")	Notified in the National Gazette in July 2020. To replace Organic Law 2016. Not listed as of 2022. Currently ownership of oil or gas transfers from the State to the developer at the wellhead i.e., when minerals are dislodged and released in their natural state. Under the proposed production-sharing regime, PNG's state-owned entities (Kumul Minerals Holdings and Kumul Petroleum Holdings) would retain ownership throughout exploration, development, and up to when minerals are physically exported. Instead of the developer being in charge of the project, they will either be engaged as contractors or they would become joint venture partners (James, D, 2020).

11.2.3 National policies and strategies

PNG's policies and strategies relating to mining, oil and gas are listed in Table 60.

Table 60: PNG policies and strategies relevant to mining and gas extractions

Key policies and strategies	Comments
PNG Policy on Protected Areas (Independent State of Papua New Guinea, 2014)	Provides a basis for identifying a comprehensive, adequate, representative and resilient protected area network and the development of management plans that protect the environment and livelihoods.
Development Strategic Plan 2010-2030 (DSP)	The DSP contains sector goals, objectives, targets and indicators, and acts as the road map for achieving the long-term results of the Vision 2050.
Strategy for Responsible Sustainable Development 2014 (StaRS)	PNG's mineral and fossil fuel resources are to be used responsibly for the benefit of present and future generations.
National Energy Policy 2017-2027 (Department of Petroleum and Energy)	Aims to ensure affordable, competitive, sustainable, and reliable supply of energy to meet national and provincial development needs at least cost, while protecting and conserving the environment.
Medium term Development Plan 2018-2022	Sets the goal of "Securing our future through inclusive sustainable economic growth" by focusing on key investments to further stimulate the economic growth in the medium-term. Sustainability is one of eight key result areas.
National Oceans Policy of PNG 2020 -2030 (Department of Justice and Attorney General)	Provides a framework to improve ocean governance and management. Identifies the hazards and risks associated with managing the environmental impacts of deep-sea mining and disposal of tailings into marine environments.
National Marine Spill Contingency Plan, 2015	Establishes the procedures for responding to spills of oil and other hazardous environment into marine waters.

Key policies and strategies	Comments
Papua New Guinea's Sustainable Development Goal 13 Roadmap: 30 actions by 2030	Includes a commitment to prepare a climate change plan for the minerals' sector.
Geothermal Resource Policy 2020	Relates to exploration, development, production, use and management of geothermal resources
Alluvial Mining Policy 2021	Provides guidance to regulate small scale/artisanal alluvial mining and semi-mechanised mining activities (about 90% of alluvial mining is by family units on customary land without any environmental permit or lease).
Draft PNG Mining Policy	Ensure mining is conducted in a socially, economically and environmentally sustainable manner. Explain mineral ownership and exploration rights, fiscal provisions, employment, training, compensation, town development etc.
Women in Mining Program, managed by Mineral Resources Authority	Directive of NEC to address development issues faced by women landowners in mining communities. Aims to build capacity of women, empower them to participate in decision making and development programmes during mining development to improve their livelihoods.
Artisanal Gold Project, 2020 MRA, Artisanal Gold Council	Aims to reduce mercury use in the artisanal/small gold mining sector; gain a better understanding of the alluvial gold sector to identify the extent of mercury use, who uses it and how it is used.

11.3 Current status and progress relating to mining, oil and gas extraction

Mining globally is widely acknowledged to have contributed to many of the challenges that SDGs are trying to address: environmental degradation; displacement of populations; worsening economic and social inequality; armed conflicts; gender-based violence; tax evasion and corruption; increased risk for many health problems, and the violation of human rights (CCSI, 2016). However, the industry has many opportunities to contribute to progress against the SDGs.

Table 61: International targets related to mining, oil and gas extraction

Source	Target/ goal	Comment
SDG 1 End poverty in all its forms everywhere	1.4 By 2030 ensure that all men and women, in particular the poor and the vulnerable, have equal rights to economic resources, as well as access to basic services, ownership and control over land and other forms of property, inheritance, natural resources, appropriate new technology and financial services, including microfinance	Some improvement in income and welfare for landowners at the mine site. For communities displaced by the mine, the loss of existing livelihoods and damage to the environment and culture reduce security and wellbeing (Lasslet, 2020; Roche et al., 2019; Bainton et al., 2020; Busilacci et al., 2020).
SDG 3 Good health and wellbeing	3.9 By 2030, substantially reduce the number of deaths and illnesses from hazardous chemicals and air, water and soil pollution and contamination.	At several mine sites the local population has been exposed to serious health risks and environmental hazards (Table 60).
SDG 5 Gender equality	5.2 Eliminate all forms of violence against all women and girls in the public and private spheres, 5.5 Ensure women's full and effective participation and equal opportunities for leadership at all levels of decision-making in political, economic and public life.	Women are often not consulted in discussions about mining, benefit sharing or decision making at all stages of the approvals process (Lasslett, 2020). Women bear a disproportionate share of the burdens from mining including loss of access of land and sea resources, social dislocation, violence and abuse (Table 60). However, women's associations are established at several mines. Ok Tedi Mine allocates 10% of its benefits package directly to women and children. Ramu Nickel supports women's groups and payment of royalties goes directly to four women's associations. Awareness raising is being undertaken at Wafi-Golup projects (MRA, 2022). Women in Mining Program initiatives continue (Table 58).

Source	Target/ goal	Comment
SDG 6 Clean water and sanitation	6.3 By 2030, improve water quality by reducing pollution, eliminating dumping and minimizing release of hazardous chemicals and materials, halving the proportion of untreated wastewater and substantially increasing recycling and safe reuse globally.	Provision of clean water and sanitation is a key request made by communities in the mining approvals process. Communities directly impacted by mining may receive these services, but there is often a lack of provision of clean water and sanitation to adjacent and surrounding communities. Runoff from mine sites and disposal of wastes have impacted severely on some communities downstream of mines.
SDG 13 Climate Action	13a ...meaningful mitigation actions and transparency	StaRS calls for a change in thinking towards a sustainable clean energy future based on a low or zero carbon-generating clean inclusive economic growth path.
SDG 14 Life under Water	14.1 By 2025, prevent and significantly reduce marine pollution of all kinds, in particular from land-based activities, including marine debris and nutrient pollution	Mining has resulted in the disposal of tailings into rivers and coastal waters causing loss of biodiversity and impacts on health.
SDG 15 Life on Land	15.5 Take urgent and significant action to reduce the degradation of natural habitats, halt the loss of biodiversity, and, by 2020, protect and prevent the extinction of threatened species.	Large-scale mining operations have caused long-term impacts on biodiversity and water quality, causing increased sedimentation, which has an impact on river flow and potentially exacerbates floods (Table 45) (Department of National Planning and Monitoring, 2020; GovPNG, 2020).

The State holds the right to acquire a participating interest in any mining or petroleum project in PNG at par value, or 'sunk cost', after the exploration risk has been eliminated. The State receives a share of profits and creates state-owned enterprises (SOEs) to hold its ownership interests in various projects. Existing SOEs include Kumul Petroleum Holdings Ltd (all hydrocarbon assets), Kumul Mineral Holdings Ltd (all mining assets), and Ok Tedi Mining Ltd (Ernst and Young, 2021).[112] In April 2022, the MRA launched its Central Monitoring and Repository Hub. This will allow MRA to check how much mineral is being shipped, though a live video feed. It allows the public to see all current, closed and proposed mining tenements, including the application dates and the registered companies. This helps to meet the requirements of the EITI (Figure 58).

A mining tenement or petroleum development licence cannot be granted until CEPA grants environmental approval under the Environment Act 2000. CEPA facilitates three levels of environmental permit approvals (Section 11.2.2).

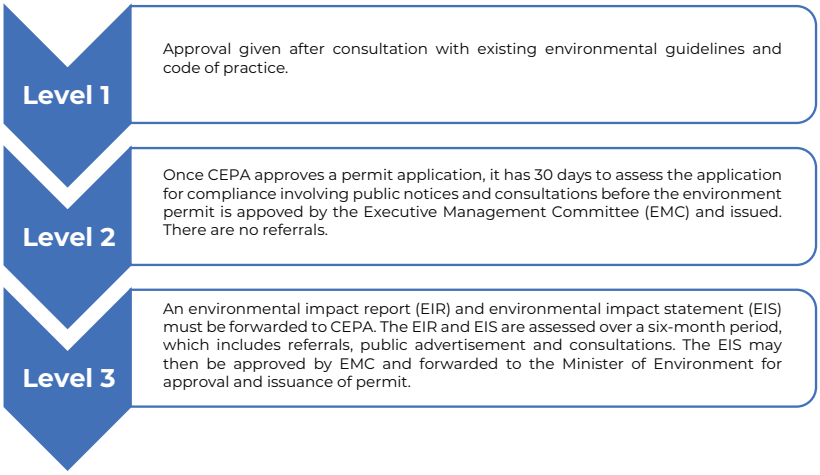


Figure 58: Three levels of approvals required from the Conservation and Environment Protection Authority
Source: adapted from Ernst and Young (2019) with advice from G. Dutson.

11.3.1 Environmental and social impacts of mining, oil and gas extraction

The 'extractive dispossession' framework (Roche et al. 2019) (Table 62) provides a useful starting point to address the impacts from mining, oil and gas extraction, particularly on the people who are subsequently 'left behind' in PNG. Examples of some of these impacts are outlined in this section.

> *. . .The form of environmental impact from the extractive sector is both point-specific and linear. The latter tend to be focused along river systems while the former largely focused on discharge into an island or valley system. The environmental impacts arising from mining are largely irreversible" (CEPA & SPREP, 2020)*

[112] It is important for the State's equity to not compromise its regulatory roles.

Table 62: Environmental and social impacts of mining, oil and gas extraction
Source: Columns one and two adapted from Rocher et al. (2019)

Factor	Explanation	PNG impacts
1. Gendered inequality and inequity	Hyper-masculinised mining reinforces existing and introduces new inequalities for women (e.g., left out of consultation and/or decision-making and benefits; being vulnerable to violence and loss of status).	▸ Silencing, misrepresenting and ignoring women's knowledge and culture. Traditionally, women have little involvement in decisions relating to land and associated mining (Roche et al., 2019; Manning, 2016). ▸ Unfair benefit distributions - a failure to effectively integrate women into discussion about benefit sharing. The 'Women in Mining Action Plan' has helped to address some of these gender-based issues e.g., better gender equity in benefits management, inclusion in project approval processes and separate budget allocations for women's activities in communities (World Bank, n.d.). ▸ Discrimination, economic deprivation and loss of status. Women can lose access to environmental services that provide a cash income, thus inverting traditional roles where women played a key role in food production and other activities; and many women fail to gain employment in mines and become more dependent on men for livelihoods. ▸ Domestic violence and rape. Victims are typically marginalised and migrant women striving to provide for their families and communities (Bainton et al., 2020; Manning, 2016).
2. Fraudulent consent	Including inadequate or uninformed consent; proponents creating representative structures for communities; omitting individuals or segments of the community (including women) from consultation, approvals, benefit-sharing arrangements, and decision-making processes.	This can include: ▸ Poor access to relevant information and lack of transparency. ▸ Failure to obtain free, prior and informed consent of all who should be involved. ▸ Inadequate and inequitable representation e.g., often involving men and local elites. ▸ Corrupt processes that can preference local officials and proponents (Burton, 2017). ▸ Poor social mapping and landowner identification studies (these underpin the grant of mining and petroleum licences, with the developer responsible for this process). This must be done before the Development Forum for the project. There have been many instances of stalled processes to identify beneficiaries and many examples of violence as a result (e.g., Porgera mine) (Bainton et al., 2020).
3. Poor and degraded government services and facilities	Results from the state withdrawing in anticipation of transfer to the mine proponent/operator.	Infrastructure and service provision is poor and often short-term. Mining contracts frequently include the provision of roads, housing, education and health facilities. However, these need upkeep and investment post-mining and this has not always been delivered.[113] Another important factor is the State's withdrawal of infrastructure and service provision in anticipation of transfer of responsibility to mine proponents (Roche et al., 2019). As the lead time from exploration to the granting of a mining leas can be very long, many communities witness significant failures in the upkeep and provision of needed services and infrastructure and are left behind.

[113] For example, the PNG LNG Umbrella Benefits Sharing Agreement and Local Benefits Sharing Agreements led customary landowners associated with the PNG LNG site to expect a series of social services and infrastructure projects, but the majority had not been delivered (Main and Fletcher, 2018). The PNG LNG project significantly increased 'horizontal inequality' to unprecedented levels in the project impact area i.e., certain individuals have access to wealth, largely as a result of securing business opportunities associated with construction, while the majority of the population remains impoverished (Main and Fletcher, 2018). In 2021 the Petroleum and Energy Department ordered ExxonMobil to pay compensation to the Tukuba Walo Incorporated Land Group for damage to their land (Pacific Mining Watch, 2021).

Factor	Explanation	PNG impacts
4. Enclosure of the commons	Causes alienation and commodification of communal, common, subsistence/ancestral lands, and waters.	Loss of land and access to common or shared resources. Most mining occurs in remote areas where communities live mainly subsistence lives relying on the resources of the land and sea for survival, food security and the continuance of culture and language. ► Mining can take away land on which local people depend for hunting, gathering, gardening, access to water and building materials and rarely provides sufficient alternative sources of livelihood (e.g., employment)[114] ► Communities can lose access and connection to land and sacred sites, with impacts on individual and community identity and relationships (Roche et al., 2019). This can create profound inequalities that become cumulative, leaving some people stranded with 'no land, no work, no welfare, and no allies' (Li, 2014, cited in Bainton et al., 2020:9). Often governments or mining companies can fail to recognize that "Landowning communities may not want to forgo their way of life and cherished assets, regardless of the significant revenue flows this sacrifice may create" (Lasslett ,2020).
5. Displacement (resettlement)	Causes in/voluntary resettlement and separation/severing of cultural ties, relationships, land access which in turn threatens ethno-diversity e.g., internal migration following Ok Tedi disaster	Mining frequently requires resettlement and separation/ severing of cultural ties, relationships and access to land, representing a threat to PNG's ethnodiversity (Roche et al., 2019). This includes: ► Overcrowding, lack of basic services, conflict with customary landowners, reduced safety for women. Many sites experience uncontrolled in-migration. ► Difficulties in accessing full tenure rights on new lands and/or compensating others for loss of access. ► Community disruption and changes to social relationships.[115] ► Loss of access to small-scale gold mining, which can provide basic needs for local people. Granting of a mining lease can preclude this activity and leave many individuals and communities worse off. ► Separation from ancestors, sacred sites and special elements in the environment.
6. Destruction of sacred sites and places	Causes disruption of relationships and ceremony.	Sacred sites incorporate places, interconnected spirituality, processes and relationships (Roche et al. 2019). Loss of these 'sites' has impacts on culture and society and include loss of connections to ancestors, who are present across time and are important for traditional ceremonies; loss or destruction of particular sites that provide meaning to the community; and loss of access to resources e.g., traditional medicinal plants, body paints, grass, dyes. Erosion of traditional practices and processes: Some mining systems and processes can ignore or disregard traditional social structures, practices and ways of knowing and being (Roche et al., 2019), causing social disruption, loss of identity and language. This has intergenerational implications with whole cultures left behind.

[114] At the proposed Wafi-Golup mine, resettlement is being negotiated amidst a lack of clarity resulting in stress, powerlessness, fear and anxiety with concern about where people will live, what houses they will live in and how social relations will be impacted (Roche et al., 2019).

[115] In the case of the Ok Tedi environmental disaster, people in affected areas were forced to move into safer areas, mainly Daru. "…. In this case, resettlement is unplanned and … is known to generate 'new poverty', with poor people becoming even poorer, resulting in devastating consequences for long-term sustainable development. The resettlement effects … [are] amplified by the cultural notion that traditional 'land is life' and that land is the basis for sociocultural identity. As such, the footprint of mining operations goes well beyond material concerns" (Busilacci et al. 2020:221).

Factor	Explanation	PNG impacts
7. Imperialism/ epistemicide	Causes erosion of structures, relationships and processes that give society its form and function; imposes western (industrial) values and ways of operating.	Disruptive social impacts in remote rural communities e.g., disease, domestic violence, alcoholism, prostitution, sexually transmitted diseases, crime, cultural dislocation, poverty and food insecurity.
8. Displacement of traditional sustenance and economic activities	Loss of fertile soils and aquatic species that support communities (e.g., Ok Tedi),	Leads to a reliance on money and traded goods.
9. Environmental impacts	Land alienation Pollution: runoff from tailings damages freshwater and coastal ecosystems (e.g., increased sedimentation, heavy metal contamination, acid sulphate soils); small scale alluvial gold miners often use mercury amalgam that may result in mercury being released to aquatic environments Biodiversity changes/loss - loss of vegetation, aquatic species and ecosystems including wetlands, mangroves, fringing reefs, and lagoons; opening of corridors especially from oil and gas industry (risk of invasive species, secondary disturbance and human disturbance) Dewatering draws down local groundwater supplies and may be permanent GHG emissions and impacts on climate change (see below) Deep-sea mining, e.g., loss of biodiversity due to habitat destruction, reduced connectivity, destruction of landforms, compaction of the sea floor, sediment displacement and toxic plumes, noise, vibration, light pollution, reduced ability to store carbon, changes to marine food webs (Dunn 2018) and difficulty in controlling accidents.	Until very recently, mine wastes have routinely been approved for discharge to rivers or oceans on a very large scale, leading to widespread environmental and social impacts that are often spread far beyond the mine site. The broad environmental impacts of riverine tailings and waste rock disposal (Mudd et al. 2020) are: ► Increased sedimentation leading to changes in hydrology and often greater flooding of adjacent floodplains, and to lower levels of dissolved oxygen and subsequent impacts on biodiversity; ► Increased heavy metal loads to the riverine and adjacent ecosystems and the uptake by biodiversity, including bioaccumulation through food chains, the potential exposure of subsistence communities; and, ► Impacts on water quality, particularly if tailings/waste rock contain sulphides. Ore bodies are commonly sulfidic (Gavin Mudd, pers comm, 2020), especially those mined for gold and copper. Waste rock and tailings are acid-forming when exposed to air and water, which in turn results in metals (including heavy metals), salts and acids being mobilised into the environment and having detrimental environmental and human health consequences, including contaminating food and water sources. [116] Deep-sea disposal of tailings is an alternative practiced in 16 mines in six countries across the world. It is now banned in most countries due to its environmental impacts, but experts consider that it may be a viable alternative in a few countries including parts of PNG where deep water is in close proximity to the shore, provided strict conditions are followed (GESAMP, 2016; Kwong et al., 2019). Disposal of waste to the marine environment can result in increased sedimentation and lowering of available light, resulting in changes in species richness and ecosystem composition (Haywood et al., 2016).[117] In March 2020 the NEC approved the Constitutional and Law Reform Commission's review of environmental and mining laws related to managing and disposing of mine tailings (Office of the Prime Minister, 2020) and recommended a total ban on all riverine tailings' disposal for all future mines. The ban is not retrospective, and legislation has not yet been passed.

[116] A well-publicised example is the Ok Tedi mine waste, which has had severe impacts on more than 500 km of the Fly River over time with impacts including acid sulphate soils, extensive and severe heavy metal contamination, sedimentation, loss of fertile floodplains, destruction of nearly 2000 sq km of vegetation, and a massive decline in fish stocks (Busilacchi, Curth-Bibb, et al., 2020). It is estimated that 150,000 people from 158 villages have been affected. The resultant mass migration of the people to Daru has also had social and environmental effects (Busilacchi, Curth-Bibb, et al., 2020; Busilacchi et al., 2018; Hettler et al., 1997). Customary landowners interviewed from the Tonda Wildlife Management Area (WMA) stated: "We are feeling the impacts of the Ok Tedi mine – for example cyanide and heavy metals in the water, soil, fish and other wildlife. People call this the genocide of our people. People are experiencing deformities, abnormalities, birth defects, joint pain and growths over their bodies. Ok Tedi mine has effluent that enters the WMA. This causes health complications ... There is a gas that comes up through the river (it bubbles) – it smells and kills prawns – we don't know what it is" (Leverington et al. 2017).

[117] One of the longest conflicts relates to Ramu NiCo, which has been licensed to dump five million tons of hot tailings per year into the Astolabe Bay near Madang. Lihir mine uses deep-sea tailings placement, with discharge from a subsea pipeline onto the seabed (Newcrest, 2017). The tailings' slurry is contaminated with cyanide and other toxicants (Judd, 2015) and these have accumulated in rivers and are detectable up to 20 km east of the discharge point and to at least 2000 m water depth, resulting in greatly reduced abundances and changes in species composition of the sediment fauna, impact on bottom dwelling fauna and macrofauna (Hughes, 2015) and poisoning of food supplies for local people (Judd, 2015)

Factor	Explanation	PNG impacts
10. Social impacts	Health and domestic violence, cultural dislocation, crime, poverty, food insecurity.	Contaminated drinking water and bioaccumulation in aquatic species used for food affect human health; spread of disease.
11. Militarization, conflict and violence	Prioritise mine security over local communities; imposes presence of state and/or private security personnel (e.g., Panguna Mine, Porgera, PNG LNG).	Militarization, conflict and violence: State or private security forces allegedly have been involved in killings, intimidation, rape and the prioritization of mine security over local communities (Roche et al., 2019).[118]

In relation to GHG emissions (refer Section 7.3.2), the energy sector was responsible for emissions of 8,673 kt CO2 e.g., in 2017, an increase of 28 percent from 2000. Of this, liquid fuel combustion contributed 68 percent. Fugitive gases contributed methane (CH4) equivalent to 16 percent of the total and an additional 1 percent CO2. The increase in GHG emissions from this sector from 2014-2017 is mainly due to increased demand for electricity and increased production of liquified natural gas (Government of Papua New Guinea, 2022a).

Social and environmental impacts have resulted also from poor mine closure, rehabilitation and remediation processes (Mudd et al., 2020). These issues remain important as major mines draw towards the end of their life – as ore bodies are depleted or they become economically or politically unviable. The Mining Project Rehabilitation and Closure Guidelines for PNG indicate that mine closure and reclamation need to be conducted progressively and planned for in the early stages of a mining project to maximise the beneficial outcomes following mine closure. The Guidelines specify that the post-closure landscape must be physically and chemically stable, reasonably safe and healthy for humans, the environment (wildlife and ecosystems), and promote a smooth socioeconomic transition.

11.4 Effect of the mining, oil and gas industry on the people 'left behind'

Considerable socio-economic benefits can be delivered to landowners and communities as a result of mining, oil and gas extraction[119], i.e. schools, hospitals, roads, water, sanitation and livelihood projects. However, many people fail to receive these benefits (Section 11.3.1), and it has been alleged that industry processes "favour the interests of local elites, proponents and officials over the poor and marginalised" (Bainton et al., 2020). There are often large gaps between people's expectations of the benefits from projects and the reality.

11.5 Environmental gaps and risks in management of mining, oil and gas extraction

- Deep-seabed mining lacks appropriate regulation. There is no offshore mining policy and incomplete regulatory frameworks. For example, the now liquidated Solwara 1 project, a largely untested mining venture, has resulted in losses to the government (15 percent equity in the venture)
- Insufficient government officers in the field to help determine land ownership, negotiate compensation, speak with communities and address landowner problems on site. Accurate and comprehensive identification of beneficiaries of mining, oil and gas projects is lacking, and existing processes can take years to complete.
- No relevant policy, law or management guidelines and monitoring standards related to sand mining (Magun & Gabi, 2021)
- Failure to effectively address social impacts of mining on both the directly and indirectly affected communities.

Oil Search/Santos in Lake Kutubu

Sustainable Community Development Programme – help communities establish and expand agricultural projects e.g. Kutubu Foe Women's Co-operative Society

Contributions to community health programmes

Develop and maintain primary and secondary school facilities; develop technical and vocational skills

Supports Kutubu Kundu and Digaso Festival

Funding for Resource Centre at the Lake Kutubu WMA

[118] For example, Panguna Mine (1972-1989) in Bougainville ended in a decade-long civil war (that lead to up to 20,000 deaths), social dislocation and tensions and a fracturing of the community (Lasslett, 2020). Conflicts continue in many mining communities with disputes over government payment of royalties, compensation and service provision, resulting in escalating conflict and human rights abuses (Burton, 2014; Bainton et al. 2020) with many people feeling left behind as a result of mining.

[119] This should be paid for by production royalties (paid to government and communities), Infrastructure Development Grants (e.g. to provide improved access), Special Support Grants (equal to 1 percent of the value of export production of the mine), revenue from taxation, dividends from equity participation, and the Public Investment Program. The benefits accruing from a project are agreed in a Development Forum with stakeholders (State, company, provincial government, LLG, landowners) and are set out in a MOA which is not disclosed publicly (Ernst and Young, 2021).

- Lack of effective planning to manage mine closures and the economic transition that is required (Bainton et al., 2020). Often communities revert to subsistence agriculture and small-scale mining to survive, demonstrating limited progress in converting the country's mineral wealth into forms of economic development that benefit the bulk of the population and few long-term sustainable benefits. For example, the Misima gold mine is the first mine in PNG to complete a full project lifecycle, but the social aspects of mine closure were insufficiently addressed resulting in the near total collapse of the economy and service provision (Bainton et al. 2020). At Panguna mine following the closure, people returned to small-scale mining in response to rural impoverishment
- Compensation for the impacts of mining lacks a standard format, and compensation records and agreements are often ad hoc, patchy in quality and lacking in statutory compliance. Registrars and wardens are unable to form an overview of the compensation practices of the mining and petroleum industry and hence give guidance or support (Filer et al., 2000)
- Limited capacity of local governments to regulate small-scale mining and its social and environmental impacts
- Limited and inequitable compensation for environmental harm. Landowners may receive rent from the lease area and compensation for damage or loss of land resulting from mining activities (determined by the Mining Warden's court or paid in accordance with the agreement with landowners and miners). While the direct impact of mines on land can include the placement of open pits, waste rock dumps, land for infrastructure and settlement, there are many examples in PNG where other land and water are impacted from tailings deposits that have been discharged to rivers that cause large areas of land to be unusable to the people living in these areas (e.g., Panguna, Ramu NiCo and Ok Tedi mines). Thus some are compensated for loss of land but many other communities receive little compensation for the harm inflicted by mining, oil and gas extraction
- There is rapidly increasing global demand for minerals used in a range of new technology industries e.g., electric vehicles, electricity networks, batteries. Clean energy technologies' share of total demand over the next two decades is anticipated to rise to over 40 percent for copper and rare earth elements, 60 percent for nickel and cobalt and almost 90 percent for lithium (IEA, 2021). This is likely to increase the pressure that mining companies will place on the PNG Government to expand deep-sea mining operations despite limited science to determine the full impacts. Mining companies are showing interest in abyssal plains, seamounts and hydrothermal vents that are rich in minerals such as manganese, nickel, copper, cobalt and zinc (Alberts, 2022). PNG is pursuing the possibility of deep-sea mining and three companies, Neptune Minerals, Nautilus Minerals and Kiost are involved. This may put at risk often unknown ecosystems and the people who rely on these systems for their sustenance.

11.6 Recommendations

Recommendations outlined below relate mainly to improving the industry's environmental performance.

11.6.1 Strengthen environmental legislation, regulations and procedures

- **Review the *Environment Act 2000*,** including a comprehensive overhaul of impact assessment and associated processes to ensure best practice in the approval of mining, oil and gas developments
    - **Develop more effective environmental and social assessment procedures**, including requirements for re-assessing project modifications
- **Review the Mining Act 1992 and related legislation**:
    - **Establish a retrospective system for mine closure and site remediation**, including setting standards and calculating costs for setting bonds. Ensure effective implementation of the Mining Project Rehabilitation and Closure Guidelines. Rehabilitation bonds are one option to provide financial surety. Disclose financial transactions associated with environmental monitoring, compliance (including fines, compensation payments) and closure and site remediation as part of the EITI programme
    - **Increase the transparency in relation to revenue flows** from the companies to government, various landowners' trust funds, associations and provincial governments (Ernst & Young 2021)
    - Increase transparency by introducing a requirement that **all mining company annual environmental reports are publicly available** in a format that allows them to be readily assessed. Transparency underpins accountability and is essential for informed decision making and providing the community with confidence that resource revenues are being used appropriately
    - **Review the regulation of alluvial mining** and consider developing a Code of Practice for alluvial mining and raise awareness of best practice alluvial mining by provincial, district or LLGs as a means to enhance its sustainability. The MRA should work with CEPA to develop the Code.
- **Address issues related to deep-sea mining**:
    - **Address the gap in legislative and regulatory provisions** concerning the approval of deep-seabed mining, including effective impact assessment
    - **Consider placing a moratorium on deep-seabed mining** until the regulatory environment is in place and there is a better understanding of potential impacts on the environment and the communities that rely on ocean resources.

- **Strengthen institutional and policy support for small-scale mining**, including expanded access to training to support more environmentally sustainable approaches
- **Strengthen legislation, policy and guidelines related to sand mining** and ensure effective monitoring and enforcement standards for this sector.

11.6.2 Improve disposal of tailings and other mine waste/fugitive emissions

Although it may be difficult to remediate existing downstream and marine environments affected by tailings and other mining waste deposition and pollutant release, it is possible to prevent further degradation:

- **Develop and/or amend legislation to require tailings and other mining waste for all new mines to be contained and managed**, rather than dispersed to the environment.[120] As a condition of extending mine life for existing mines, **future tailings and other mining wastes should be contained and managed** rather than dispersed to the environment. CEPA has the capacity to require this.

11.6.3 Effectively monitor and enforce environmental legislation and conditions

- **Ensure monitoring and compliance activities** are undertaken by **CEPA independent** of funding from extractive companies. A legal advisor to assist with enforcing compliance may be desirable
- **Enhance CEPA's capacity** to effectively undertake its role in impact assessment and regulation of mining, oil and gas projects and ensure an integrated whole of government approach in regulating this sector
- **Consider using a third party 'assessor'** to report on the environmental activities of mining companies and government, analogous to, or as part of the EITI programme
- **Effectively enforce legislation and environmental conditions** included in existing mining licences
- **Ensure implementation of periodic monitoring and reporting** as per the environment permit and address all breaches. If the discharge to the environment is severe, impose a ban on the current discharge method and implement more effective methods
- **Ensure mineral and gas producers offset their greenhouse gas emissions** as part of national efforts required to meet PNG's Nationally Determined Contributions under the Paris Agreement.

11.6.4 Ensure fair outcomes for customary landowners and other community members

- **Ensure free, prior and informed consent for all mining and gas operations**. Ensure that customary landowners and affected communities, including women and children, have a full understanding of the implications of proposed mining-related development, including any expansion, before exploration or extraction begins. Consider using the 'extractive dispossession' framework (Roche et al. 2019) with communities to enhance understanding of proposed mining projects and their impacts
- **Improve processes for identification of landowners** who are beneficiaries of mining, oil and gas projects (i.e. through more detailed social mapping and landowner identification studies). This identification should take place before the application for a relevant petroleum or mining licence
- **Ensure that women as well as men are involved at all stages** of mine exploration, approval and closure. This includes effective engagement in discussions about benefit sharing arrangements, with the option that women are enabled to negotiate a separate benefits package, if required, and to be trustees of development funds to ensure that they receive a fair share of the benefits. Reporting on this engagement should be part of the mining approvals' processes
- **Develop and implement a 'whole of system planning' approach** for mining, oil and gas exploration and extraction. Planning should effectively anticipate, consider and take responsibility for urban development and migration as a result of the mining enterprise, both within, near and downstream of the mine. Settlement requirements should be planned for pre, during and post-mine development
- **Ensure on-time compensation payments**, with fair distribution to those affected. Provide access to independent advice about investment options
- **Where relocation is required, ensure compliance with international standards** including that there are minimal adverse impacts and that the number of people potentially affected are minimised and improve the incomes and living standards of those adversely affected (Filer et al. 2000)
- **Provide a forum for enhancing dialogue** between the government, industry, landowners and citizens (Ernst & Young 2021)
- **Facilitate customary landowners' access to the PNG Ombudsman Commission**, which can investigate complaints about government, the conduct of government officials and broad areas of public interest in relation to the mining, oil and gas industry and assist in dispute resolution.

[120] Announced as Government policy although not yet legislated or reflected in mining proposals, e.g. the environmental impact statement for the Golpu mine proposal.

Chapter 12.

Vulnerability to natural and environmental disasters


UN
DP

12.1 Context to disaster management in Papua New Guinea

Located at the northern edge of the Australian plate and in the active Pacific Ring of Fire, PNG is among the most disaster-prone countries in the world, due to geophysical conditions. Prevalent hazards include earthquakes, cyclones, storms, volcanic eruptions, riverine and coastal flooding, coastal erosion, epidemics, and droughts. Climate-related hazards are expected to become increasingly severe as the result of climate change, and PNG is highly exposed to these hazards (Chapter 7).

For more information about the risk factors and the humanitarian response in PNG, please see the 2021 UN CCA Humanitarian Report (United Nations in Papua New Guinea, 2021). The Disaster Risk Reduction Report prepared in 2019 is an excellent summary of the risks faced and the vulnerability of PNG's people (UNDRR, 2019a). The recently released case study of PNG's disaster response is a useful guide to the governance of disaster management and its practical responsiveness to disasters (Humanitarian Advisory Group, 2022) and the Papua New Guinea Disaster Management Reference Handbook is also a useful reference (written from the US viewpoint) (Center for Excellence in Disaster Management & Humanitarian Assistance, 2019). The Framework for Resilient Development in the Pacific outlines an integrated approach to building resilience for both climate change and other disasters (Pacific Community, 2016).

In February 2018, a magnitude 7.5 earthquake in the Hela Province had a devastating impact on the economy and population of PNG (World Bank Group, 2019). Over 100 people died and half a million people were affected, primarily across the provinces of Hela and Southern Highlands, and there was extensive damage to infrastructure. The temporary disruption to LNG production and other mining activities and the impact of response and recovery resulted in GDP growth reducing from 2.8 percent 0.3 percent between 2017-2018. Post disaster rehabilitation and reconstruction efforts triggered a rapid expansion of public debt (World Bank Group, 2020a).

This section outlines the vulnerability of the country to geophysical hazards and disasters. It does not address other disasters such as pandemics and other biohazards, civil conflict or international incursions or outbreaks of violence. However, disease, hunger, social displacement and conflicts often follow natural disasters. Vulnerabilities associated with climate change are important in this discussion and are also referred to in the chapter on climate change. In addition, the generally poor level of environmental management and governance in PNG increases the country's vulnerability to environmental disasters, such as major pollution incidents from the extractive industry.

Natural and environmental disasters in PNG particularly affect the most vulnerable in the community, including children, women, the elderly, people with a disability, and the rural poor. People are often displaced, leading to increased vulnerability. This is briefly discussed in this chapter, and is also discussed in the chapter on 'Those left behind' and the social and economic analyses of the Common Country Assessment.

12.2 Legislation, Policies and Agreements

Key governing bodies (box adapted from the PNG case study [Humanitarian Advisory Group, 2022, p.8][121])

The National Executive Council and the National Disaster Committee oversee The National Disaster Centre (NDC) to coordinate disaster management and disaster risk reduction in PNG at the national level. All provinces have at least a provincial disaster centre and a provincial disaster coordinator. Many districts have a person who is designated as the district disaster coordinator, but that person often has other titles and duties.

The National Executive Council (NEC) is made up of members of the National Parliament and oversees decisions for disaster policy. The National Disaster Committee, which is comprised of the heads of key national government agencies (as prescribed in the legislation), advises the NEC on matters such as when to declare a national emergency, and the need to accept international assistance.

The National Disaster Centre (NDC) is responsible for coordination of preparedness and response activities, including information sharing, national training and planning and financial management. Responsibility for the NDC was transitioned from the Ministry of Inter- Government Relations to the Ministry of Defence in 2020 and has been approved to become an independent authority in 2022.

In addition, the Disaster Management Team is co-chaired by the UN Resident Coordinator and the Director of the NDC. Its members include the UN cluster lead agencies, international NGOs, faith-based organizations, the Red Cross Movement and key development partners (Richard Higgins, pers comm). The team mobilises international resources at the request of the national government.

[121] Roles have been clarified for the CCA by Richard Higgins, UNDP, 2022

The UN agency the International Organization for Migration works in PNG in close cooperation with the National Disaster Center and other organizations, with the vision: "In close cooperation with the Papua New Guinea (PNG) government and other key stakeholders at the national, provincial and local levels, IOM aims to strengthen the response to complex emergencies, reduce disaster and conflict-induced displacement and build community resilience. Through community-based planning interventions and community stabilization initiatives, IOM is strengthening capacity in disaster risk reduction, early warning and preparedness, and promoting peacebuilding".

The Global Network of Civil Society Organisations for Disaster Reduction has held a meeting to investigate potential for establishment in PNG.[122] The primary activity of this network is "advocating for risk-informed development and localisation, and capacity strengthening for civil society organisations".

In 2005, PNG was among the first countries to adopt the Hyogo Framework for Action (Global Facility for Disaster Reduction and Recovery (GFDRR), 2016), which guided international disaster risk reduction efforts between 2005—2015, which was subsequently superseded by the Sendai Framework for Disaster Risk Reduction, 2015—2030 (UNDRR, 2015).

In 2016, the Pacific Islands Forum Leaders (including PNG) endorsed the Framework for Resilient Development in the Pacific 2017 – 2030 (FRDP). The FRDP is an integrated approach to address climate and disaster risk management for more resilient development in the Pacific. The Framework was a global first where the Pacific sought to reduce their exposure to climate and disaster risk, support low carbon development and improve disaster response and reconstruction.

Table 63 and Table 64 list the legislation and policies relevant to vulnerability to disasters in PNG. Note that other legislation throughout the report aims to prevent environmental disasters such as pollution and oil spills.

Table 63: Legislation relevant to vulnerability to disasters

Legislation	Purpose
National Disaster Management Act 1984 (revised 1987)	Mandated the institutionalization of disaster risk management (DRM) at the national level (National Disaster Centre NDC) and provincial levels. The NDC is currently reviewing the Act (Richard Higgins pers comm).

Table 64: Policies and agreements with respect to vulnerability to disasters

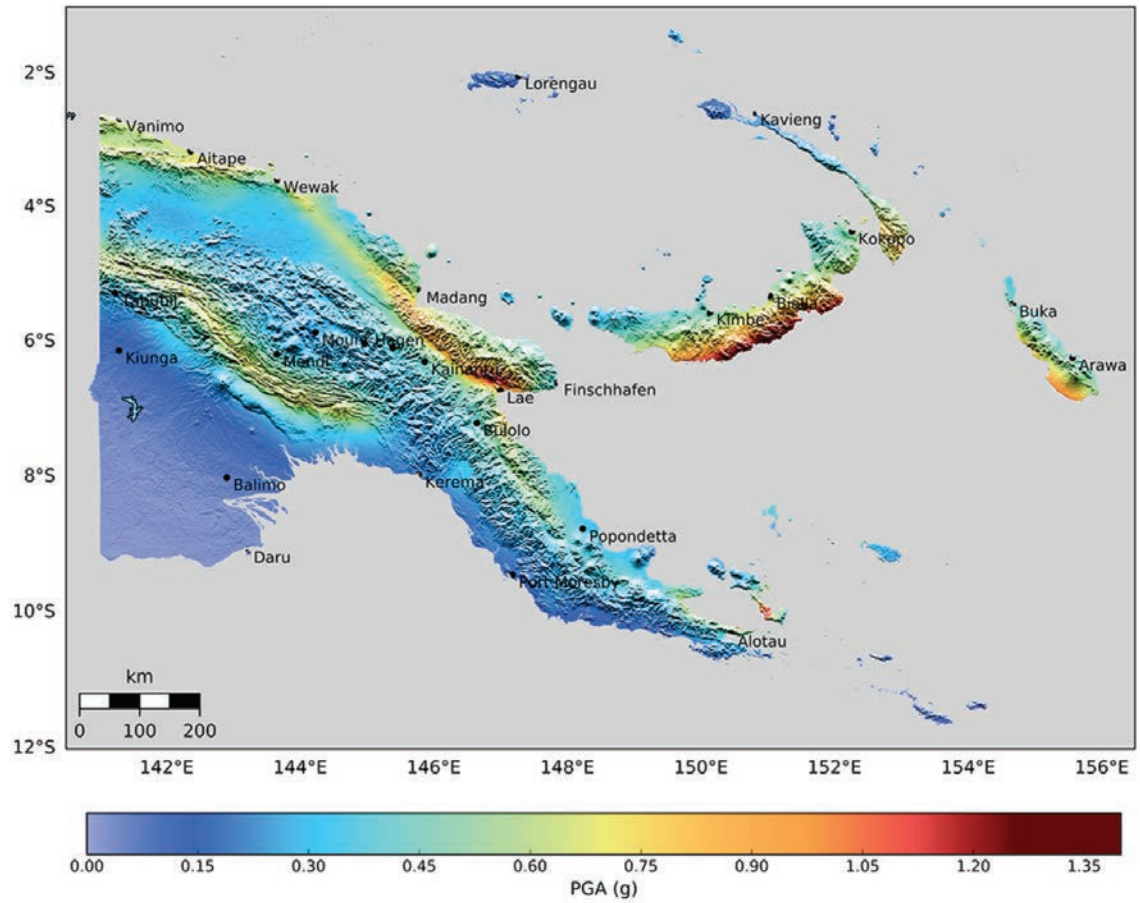
Policy or framework	Purpose
National Disaster Mitigation Policy 2004, 2010	Shifted the emphasis from responsive disaster management towards proactive preparedness and mitigation.
National Disaster Risk Management Plan (2012)	The first comprehensive document to lay out the DRM regulatory and legislative framework for all levels, including sub-national and local operators. (superceded)
National Disaster Risk Reduction and Disaster Risk Management Framework for Action (2005—2015).	Strategic DRM framework aligned with the mandates of Hyogo Framework for Action. (superceded)
National Disaster Risk Management Framework for 2017—2030.	Joint initiative with the NDC and UNDP to ensure that immediate and long-term disaster risk management challenges are addressed, aligned with Sendai Framework for Disaster Reduction and Recovery.

12.3 Risks and vulnerability to disasters in PNG

PNG is extremely vulnerable to tectonic hazards (UNDRR, 2019a):

- It ranks highest in terms of population exposed to severe volcanic risk, with over a million people living within 30 km of 16 active volcanoes. (PNG has 77 volcanos, 20 of which are active and have the potential to erupt)

[122] Richard Higgins pers. Comm. 2022



The new National Seismic Hazard Assessmnet for PNG. 10% probability of exceeedence in 50 years of peak ground acceleration for bedrock.

Figure 59: Seismic hazards in PNG
Source: Ghasemi et al., (2020)

- It is in the top six countries for the highest percentage of the population exposed to earthquakes, with northern parts of the country most affected due to the proximity to fault zones. A seismic hazard map shows the areas most liable to seismic events (Figure 59)
- Landslides and slope failures are common in highlands and mountainous regions associated with heavy rain and earthquakes
- Tsunami hazard is rated as high, with three major tsunamis associated with seismic activity occurring in the last thousand years.

PNG also experiences extreme climatic conditions (UNDRR, 2019a):

- Droughts occur frequently, often correlating with the El Niño Southern Oscillation affecting water availability and food security
- Most of the land area is classified as high risk for coastal and riverine flooding, especially during strong El Niño events, and potentially damaging or life-threatening floods are expected to occur on 10-year intervals
- Coastal regions have a high chance of potentially damaging wind speeds, with the most intense tropical storms occurring in the east.

A map of combined natural hazard risks (Figure 60) shows the eastern and northern part of the country as having the highest risk overall. Note: information on seismic hazards has been reviewed since this map was produced (see Figure 54).

Between 2016 and 2020, the Disaster Management Team has mobilized international resources at the request of the national government for at least one disaster or crisis each year (PNG DMT Secretariat, personal communication).[123] These were El Niño-

[123] The Disaster Management Team is co-chaired by the UN Resident Coordinator and the Director of the NDC. Its members include the UN cluster lead agencies, international NGOs, faith-based organisations, the Red Cross Movement and key development partners (Richard Higgins, pers comm).

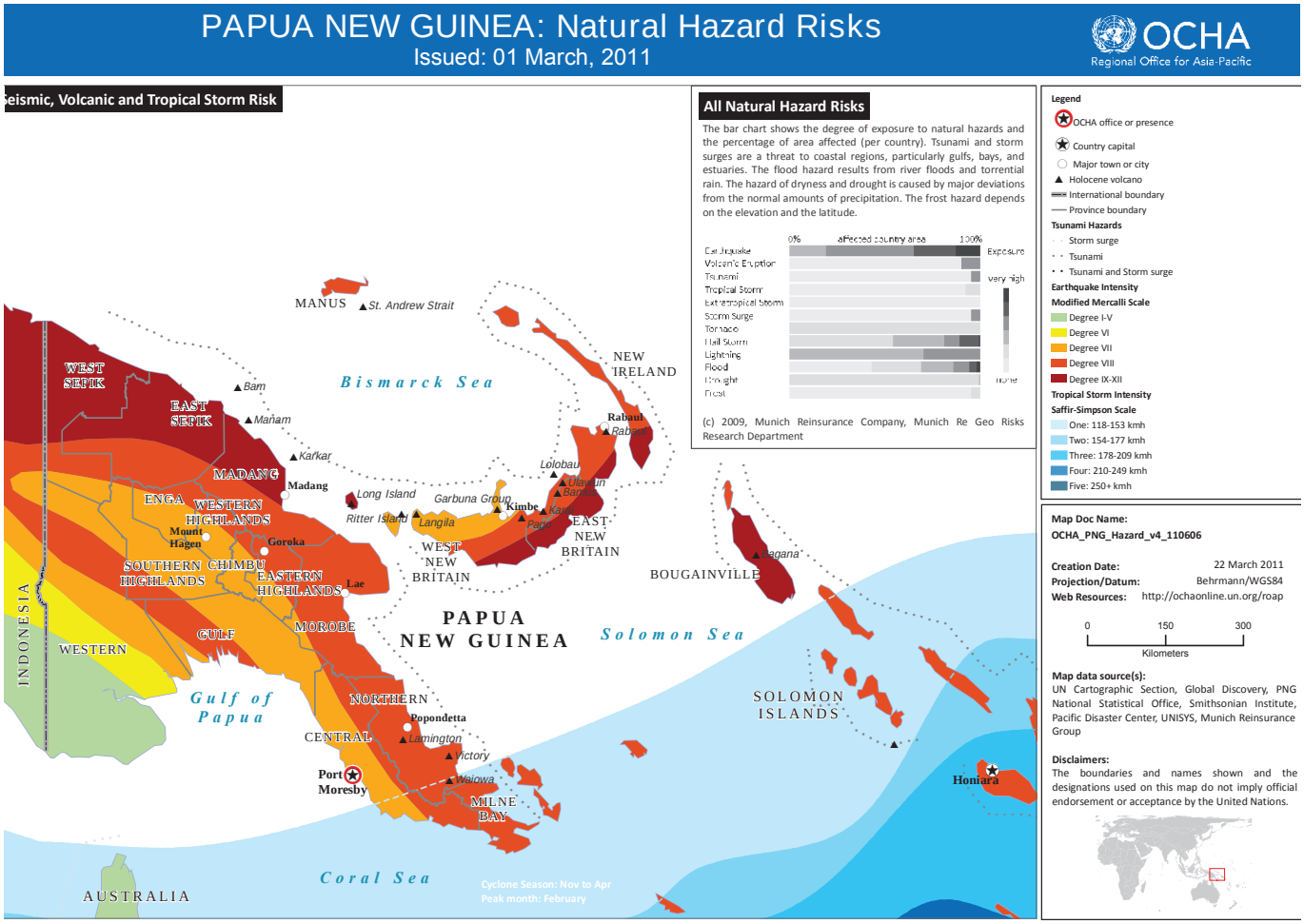


Figure 60 : Combined hazard risk map for PNG
Source: UNDRR website, with information from UN Cartographic Section, Global Discovery, FAO, Smithsonian Institute, Pacific Disaster Center, UNISYS, Munich Reinsurance.

related drought and food insecurity in 2016; Kadovar volcanic eruption displacement in 2017; highlands earthquake displacement in 2018; and polio outbreak in 2018; early action planning for El Niño-related drought, Ulawun volcanic eruption displacement and a small refugee emergency in 2019; and COVID-19 in 2020.

Additionally, the Disaster Management Team monitored at least 12 other emergencies in 2019, including local flooding, cyclone-related food insecurity, landslides, earthquakes, minor volcanic eruptions, and conflict-related displacement. By 2020, it has monitored 21 other emergencies, including biosecurity threats (African Swine Fever and Fall Armyworm), local flooding, earthquakes, landslides, minor volcanic eruptions, and conflict-related displacement. Additionally, in the last quarter of 2020 the DMT is monitoring the potential impacts of La Niña, which will bring higher-than-average rainfall and temperatures to most of the country (Richard Higgins, personal communication, 2021).

The INFORM risk index for PNG in 2022 ranked it as "high": the 22nd most vulnerable of 189 countries, with a score of 5.9 (Table 65, Figure 61). Lack of coping capacity is the leading contributor to the score. Remoteness creates enormous challenges for effectively responding to disasters; and lack of local infrastructure, including communications and transport, or delay in aid delivery can have long lasting impacts on communities in the event of disasters.

Table 65: Components of 2022 INFORM risk index for PNG
Source: INFORM, (2022).

	Value	Rank	Trend (3 years)
INFORM Risk	5.9	22	increased
Hazard and exposure	5.0	45	increased
Vulnerability	5.5	41	stable
Lack of coping capacity	7.4	13	stable

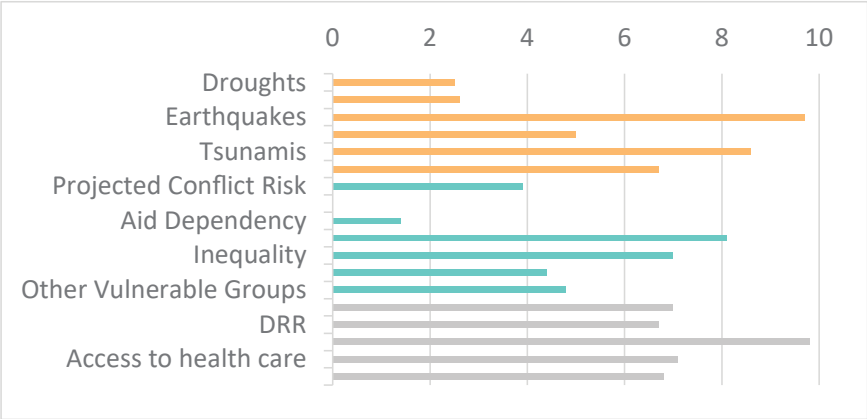


Figure 61: INFORM detailed ratings
Source: INFORM (2022). Note: colours match the index categories in Table 65.

Similarly, in the 2021 World Risk Index Report, PNG was rated as very high for exposure and vulnerability, the ninth worst in the world.

Floods, volcanic eruptions, landslides, earthquakes, and storms are the top five most frequent of the natural hazards in PNG, based on the EMDAT International Database from 1990 to 2020 (Figure 62)[124]. According to nationally reported losses between 1990—2014, the greatest cause for disaster-related mortality was earthquakes (39 percent), followed by tsunamis (36.7 percent), landslides (8.2 percent), and drought (7.4 percent). Flooding (4.4 percent), cyclones (3.4 percent), and other causes (0.8 percent) comprised the remaining categories of mortality (UNISDR, 2015). Since 2016, the Disaster Management Team (DMT) has mobilised international resources at the request of the national government for at least one disaster or crisis each year.[125]

Biophysical hazards with the potential to cause local or national disasters include pandemics and human and crop/livestock disease outbreaks. This chapter does not discuss these hazards. But notably, geophysical disasters may cause or exacerbate such disease outbreaks and hinder responses.

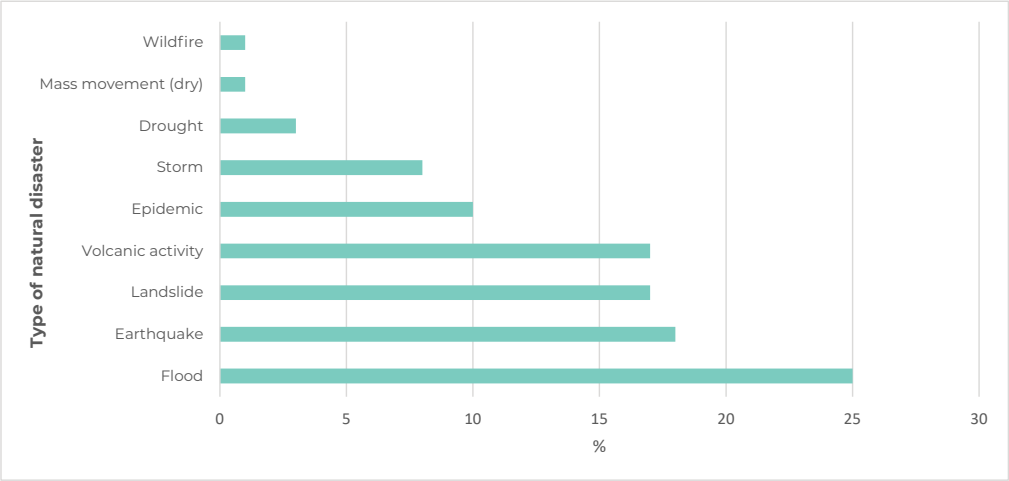


Figure 62: Natural disasters recorded in PNG from 1990 to 2020

12.4 Progress and contributions towards targets

The SDG goal most relevant to this topic is Goal 11: Sustainable cities and communities 11.5 By 2030, significantly reduce the number of deaths and the number of people affected and substantially decrease the direct economic losses relative to global gross domestic product caused by disasters, including water-related disasters, with a focus on protecting the poor and people in vulnerable situations.

[124] Centre for Research on the Epidemiology of Disasters (n.d.)

[125] The Disaster Management Team is co-chaired by the UN Resident Coordinator and the Director of the NDC. Its members include the UN cluster lead agencies, international NGOs, faith-based organisations, the Red Cross Movement and key development partners (Richard Higgins, pers comm 2020).

The Voluntary National Review in 2020 concluded (Department of National Planning and Monitoring 2020):

> *"The Government of PNG (GoPNG)] with the support of many of its development partners have worked over the past few years to build and strengthen the response and management capacity of the National Disaster Centre. It is now directly under the auspices of the Prime Minister and with the recently launched National Disaster Risk Reduction Framework 2017—2030, aligning with the targets of MTDP and SDGs. GoPNG will continue to strengthen its coordination with all the subnational levels and partners in implementing the strategies under the framework.*
>
> *Although considerable capacity building has been ongoing with the National Disaster Centre and linking with the provinces, lots of capacity and mismanagement issues have surfaced with handling of recent crises such as the Highlands earthquake. It is important that those lessons are taken and improved on in future disaster response and recovery efforts" (Department of National Planning and Monitoring 2020).*

The additional relevant SDG is 13.1 Strengthen resilience and adaptive capacity to climate-related hazards and natural disasters in all countries. This is also discussed in Chapter 7. A number of reports point out that though the issues of climate change and disaster management are closely linked, the agencies responsible.

12.4.1 Sendai Framework

The most recent PNG national disaster risk reduction status report (UNDRR, 2019a) provides a snapshot of progress against the four priorities of the Sendai Framework:

- Priority 1: Understanding disaster risk;
- Priority 2: Strengthening disaster risk governance to manage disaster risk;
- Priority 3: Investing in disaster risk reduction for resilience; and
- Priority 4: Enhancing disaster preparedness for effective response and to "Build Back Better" in recovery, rehabilitation and reconstruction.

Understanding Disaster Risk

National databases have integrated data from PNG and seven other Pacific countries into a regional database hosted and maintained by the Pacific Community (South Pacific Commission). This aims to develop risk modelling and tools for assessing earthquake and tropical cyclone risks.

The UNDP Strengthening Disaster Management in Papua New Guinea project (2015—2020) developed a multi-hazard risk assessment methodology (UNDP, 2019b). In 2017, UNDP in collaboration with Regional Integrated Multi-Hazard Early warning Systems (RIMES) supported the NDC in the conduct of a downscaled Multi-Hazard Risk Assessment in PNG. The assessment covered five (5) pilot provinces of Central, Western Highlands, Chimbu, Autonomous Region of Bougainville and Madang (UNDRR, 2019a). As part of the project, the NDC was also supported with the development of a disaster loss database which was handed over to the NDC in 2017.

Strengthening disaster risk governance

The National Disaster Centre leads research, education and response coordination, with provincial disaster committees responsible for preparing emergency relief plans and coordinating relief operations. Multi-stakeholder coordination mechanisms can be established if emergencies cross provincial borders.

The current National Disaster Risk Reduction Framework 2017-2030 (National Disaster Centre, 2017) aligns with the Sendai Framework, articulating targets to be achieved by 2030, including priority actions, stakeholder roles, and indicators. They are as follows:

- Reduce disaster mortality by 2030, by aiming to lower average mortality rate per 100,000 in the decade 2020-2030, compared to 2005-2015;
- Reduce the number of people affected by disasters by aiming to lower the average figure per 100,000 in the decade 2020-2030, compared to 2005-2015;
- Reduce direct disaster economic loss in relation to gross domestic product (GDP) by 2030;
- Reduce disaster damage to critical infrastructure and disruption of basic services among them health and educational facilities, including through developing their resilience by 2030;
- Increase the number of provinces with provincial and local disaster risk reduction strategies by 2020;
- Enhance international cooperation through adequate and sustainable support to complement national actions for implementation of this framework by 2030; and
- Increase the availability of and access to multi-hazard early warning systems and disaster risk information and assessments to people in PNG by 2030.

The national framework was prepared as part of the UNDP Strengthening Disaster Management in Papua New Guinea project, 2015-2020 (UNDP, 2019b). Implementation is occurring in collaboration with technical support from the International Organisation for Migration (IOM) to engage with vulnerable and at-risk communities to build their capacities to develop and implement community-based disaster risk management plans (International Organisation for Migration, 2019).

Investing in resilience

The Pacific Resilience Partnership is the umbrella implementation mechanism for the Framework for Resilience Development in the Pacific, which provides high level strategic guidance to different stakeholder

groups on how to enhance resilience to climate change and disasters in ways that contribute to and are embedded in sustainable development.

Disaster risk reduction programmes rely heavily on support from development partners (UNDRR, 2019a). The United Nations Development Assistance Framework (2018-2022) is a key funding mechanism, supporting PNG to achieve its priorities under the SDGs including developing community resilience and managing climatic risks (United Nations in PNG, 2017).

Programmes addressing resilience to climate change-related disasters are discussed in Chapter 7.

Enhancing disaster preparedness for effective response to 'build back better'

Early warning systems for inland and coastal flooding were assessed in 2014 (Antea Belgium NV, 2014), and continue to be improved. In 2018, flood monitoring and an early warning system were established in the Bamboo River in Morobe Province, in a collaboration among the Government of PNG, UNDP and the New Zealand National Institute of Water and Atmospheric Research. Systems will be established in a further five rivers (UNDRR, 2019a).

In 2017, a sub-regional early warning hub was opened in PNG as part of the Regional Integrated Multi-Hazard Early Warning System (RIMES). The hub aims to generate weather monitoring information, climate and weather forecasts and climate risk analyses for Pacific countries, including PNG, contributing to PNG's early warning systems (The National, 2017).

Two automated weather stations were procured and installed in Chimbu and Port Moresby as part of the regional Disaster Resilience for Pacific Small Island Developing States (RESPAC) project which supports improving early warning systems and developing recovery capacities in the Pacific Region (UNDP, 2019b).

The UNDP Strengthening Disaster Management in Papua New Guinea project, 2015—2020 (UNDP, 2020b) also:

- Established a national disaster loss database within the National Disaster Centre;
- Established a national joint, inter-agency Needs Assessment Standby Team for enhanced emergency preparedness and response;
- Enabled more effective coordination through the Disaster Management Team and cluster system; and
- Created comprehensive disaster response planning for medium to large-scale disasters and hazard events. This has focused attention on the importance of strategic planning for better coordination and financing.

In December 2018, a national-level interagency Needs Assessment Standby Team was established to conduct needs assessment using a standardised multi-sectoral needs assessment tool for conducting immediate assessments and submitting reports. In 2019, training for the team and the disaster managers of the five provinces participating in the disaster resilience project was conducted (Richard Higgins, pers comm).

12.5 Effect on people especially those 'left behind'

The geography of PNG makes it inherently vulnerable to earthquakes, volcanic action, tsunamis, and climatic extremes. Vulnerability is increased by the distribution and socio-economic circumstances of the population, and the lack of capability for governments and communities at all levels to plan and respond for events. Rural people who are dependent on natural resources are often left without shelter or any form of income, and are highly exposed to disease and hunger. The most vulnerable in the community are women and children, for whom these disasters also mean increased risk of exposure to violence, including sexual assault.

The health, livelihoods and food security of PNG's rural population (constituting 80 percent of the population) are particularly vulnerable to the impact of disasters (UNDRR, 2019a). Within this population, women, children, people living with disabilities and the elderly are particularly vulnerable. Women who grow (and sell) produce are critical to food security and need to be specifically targeted in preparing and implementing disaster resilience strategies (pers comm, UNDP gender advisor).

For example, as a result of the 2018 earthquake (World Bank Group, 2020a):

- Around 153,000 became food-insecure after landslides destroyed staple food crops and family vegetable plots;
- Access to schooling was affected for more than 15,000 students with 100 schools partially damaged, and 5 destroyed;
- 80 percent of health facilities in the Hela and Southern Highlands provinces were damaged; and
- Natural water sources were contaminated, and water collection and sanitation infrastructure were destroyed.

The below average rainfall experienced in the 1997-98 El Niño event (CEPA and SPREP 2020) resulted in 260,000 people experiencing critical, life-threatening situations, and a further 1.9 million people suffering from limited food availability (CEPA and SPREP 2020).

In the aftermath of disasters, displaced people resort to migrating to urban areas (such as Port Moresby, Lae and Mount Hagen), where they are further exposed to hardship. Unplanned and informal settlements in Port Moresby lack infrastructure and are vulnerable to flooding, urban fires and diseases (UNDRR, 2019a). As well as stimulating migration to other areas, disasters cause increased mobility within regions and local areas as people are displaced and/or seek food and income. This mobility can lead to violent clashes between groups and in some cases extended conflicts (International Organisation for Migration, personal communication). Internal displacement resulted from 22 disasters in PNG in the two years of 2019 and 2020 (United Nations Office for Disaster Risk Reduction (UNDRR), n.d.).

Communities have some traditional resilience to less severe events, such as storms

There is an understanding that houses are semi-permanent, and not built to fully withstand severe weather. Instead, buildings will often have a sequence of sacrificial elements that reduce the impact of storm damage. Roofs are easily blown away in strong winds, however, the primary structure will remain intact, and roofs can be replaced without the need of reconstructing the entire house. If winds are strong enough, walls (often lightweight weaving) will blow away without damaging the primary structure.

Floods, volcanic eruptions, landslides, earthquakes, and storms are the top five most frequent natural hazards in PNG, based on the EMDAT International Database data from 1990 to 2014 (Centre for Research on the Epidemiology of Disasters, no date, Richard Higgins pers comm).[126] According to nationally reported losses between 1990—2014 (UNISDR, 2015), the greatest cause for disaster-related mortality was earthquakes (39 percent), followed by tsunamis (36.7 percent), landslides (8.2 percent), and drought (7.4 percent). Flooding (4.4 percent), cyclones (3.4 percent), and other causes (0.8 percent) comprised the remaining categories of mortality.

Combined economic losses for the same period were generated by flooding (32.1 percent), volcanic eruption (30.2 percent), drought (13.5 percent), and storm surges (13.1 percent), followed by cyclones (4.9 percent), earthquakes (4.4 percent) and other causes (1.7 percent).

Average annual losses by hazard calculated in 2015 (UNISDR, 2015) are shown in Table 66.

Table 66: Average annual losses due to disasters (UNISDR, 2015)

Hazard	Absolute (US$ million)
Multi-Hazard	169.84
Flood	94.23
Earthquake	73.59
Volcano	13.70
Wind	0.87
Tsunami	0.59
Storm Surge	0.56

Probable maximum losses (US$ million) for mean return period are shown in Table 67.

Table 67: Probable maximum losses due to disasters (UNISDR, 2015)

Hazard	20 yrs	50 yrs
Earthquake	212	380
Wind	6	15
Storm Surge	2	13
Tsunami	1	3

12.6 Recent and current projects and programmes

UNDP Strengthening Disaster Management in Papua New Guinea Project (UNDP, 2020b), January 2015 – December 2020, US $4.3 million (Australian Government).

In partnership with the National Disaster Centre (NDC), other government agencies, provincial governments, and civil society organizations, this project supports the Government of PNG to improve policy settings, preparedness and humanitarian response capacities to reduce the country's exposure to natural and climate-induced hazards in five targeted provinces.

A 2019 review of the Strengthening Disaster Management project found (Chamberlain, 2019):

- **Support for the development of the National Disaster Risk Reduction Framework, 2017—30**: This is a positive example of an effective process resulting in a potentially valuable document. The principal challenge will be to ensure the development of an implementation plan, accompanied by appropriate funding, monitoring and evaluation measures
- **Development of NDC capacity**: UNDP and NDC have cooperated on many areas of the project, but progress in some areas has been slow. Poor levels of staffing, resourcing and general support for role of the NDC by the Government of PNG must be addressed, commensurate with NDC's demonstrated leadership capacity
- **Provincial Disaster Risk Management Capacity Assessments** in five pilot provinces: These show that the institutional arrangements and resources provided for disaster risk management vary between provinces, but human and resource capacity is generally low. The capacity assessments provide a valuable baseline and make a compelling case for a stronger provincial focus for the project
- **Disaster Loss Database**: Information from national, provincial and sub-provincial government records have been captured using a standardised form designed by the project and transferred to a consolidated database. This

[126] For a disaster to be entered into the database at least one of the following criteria must be fulfilled: ten or more people reported killed; 100 or more people reported affected; declaration of a state of emergency; call for international assistance.

activity is potentially useful; but its longer-term sustainability must be addressed

- **Early Warning Systems**: Support has been provided to the National Multi-hazard Early Warning Centre, but the procedures for creating and disseminating warnings requires significant attention
- **Disaster Risk Management Mainstreaming**: Progress has been relatively slow, but the project is now well-placed to address this in the next phase of the project. The project's role in the integration of DRR into the Medium-Term Development Plan III, 2018—2022, and the District Development Plan for Rigo District (2018—2022) in Central Province are significant successes and present opportunities which can be built on in the next phase of the project
- **Multi-Hazard Risk Assessment in five provinces**: The project has worked closely with government agencies to produce detailed assessments of a kind hitherto unavailable in PNG. Whilst this activity is useful the project must be careful to emphasise the limitations of the assessments due to the weakness of current data sources in PNG. However, as data sources improve this should become a very valuable tool
- **Disaster Recovery**: The project has struggled to make progress due to a level of disinterest on the part of the authorities who have preferred to focus on disaster response. A national Disaster Recovery Framework has been created but not signed off. Further engagement by the project is necessary
- **Provision of a Humanitarian Coordination Specialist 2016—present**:[127] This role has provided critical support to the UN Resident Coordinator in the role of co-chair of the Disaster Management Team following the El Niño drought (2015—16) and Highlands earthquake (2018), and assisted with the coordination of other responses. Improvements in coordination mechanisms (such as clusters) have been noted. However, the disruptive effect of these disaster responses on other aspects of the project should not be forgotten. In the future, steps should be taken to manage this more effectively
- **Provincial level activities**: The capacity assessment, the disaster database, and the multi hazard risk assessment establish a baseline, but have not yet enhanced capacity. Action plans have been developed, but there is currently no clear path to implementation.

In July 2020, the Australian Government announced that it would extend the Technical Disaster Risk Reduction programme through to June 2023. Geoscience Australia is developing a dedicated PNG geohazards website and supporting the expansion of the community-based seismic monitoring network (Geoscience Australia, 2020).

The UNDP Regional Tsunami Project 2018—2020, US$70,000 (Japan) (UNDP, 2019b) supported the National Disaster Centre, Department of Education, Department of Mineral Policy, and Geohazards Management to organise and run tsunami evacuation drills for 2,000 children and school administrations in three schools. School-based tsunami awareness raising materials were prepared and are now available for other schools. After participating in the first two phases of this project, PNG participating in phase three, which commenced in 2021 (Richard Higgins, pers comm).

The international Organization for Migration is working in six provinces, with provincial disaster centres, and is rolling out and training people in the use of the Displacement Tracking Matrix. They have also been provided Training of Trainer on Community-Based Disaster Risk Management (CBDRM) and Build Back Safer (BBS) in Shelter Construction. A Provincial Disaster Risk Management Strategy and Standard Operating System has been completed for Milne Bay with technical inputs and funding assistance from the United States Agency for International Development (USAID) Bureau for Humanitarian Assistance. The plan defines the roles and responsibilities of the provincial government and its stakeholders in preparing for, and responding to disasters, including implementing recovery actions following a disaster and will increase their coordination.

The IOM and Provincial Disaster Centres have partnered to Build Community Resilience to Disasters in Morobe, Western and Hela Provinces. This project focuses on communities as the first responders to an emergency. Improved community-based preparedness and mitigation can help save lives and minimize disaster losses. Community-Based Disaster Risk Management (CBDRM) is being developed with the inputs of women, men, youth, and vulnerable groups such as persons with disabilities from the target communities.

PNG is participating in the Flash Flood Guidance System (FFGS) within the Global Coverage programme coordinated by the World Meteorological Organization. The FFGS provides operational forecasters and disaster management agencies with real-time informational guidance products pertaining to the threat of small-scale flash flooding using remote-sensed precipitation (i.e., radar and satellite-based rainfall estimates) and hydrological models (World Meteorological Organization, 2020).

Climate Risk and Early Warning Systems (CREWS) (2017-2022)

The CREWA project is a cooperative effort between PNG National Weather Services, the Australian Bureau of Meteorology and the World Meteorological Organization. It is working to enhance drought monitoring and early warning systems through climate model-based forecast systems. These are communicated through web-based tools and help

[127] The role of Humanitarian Coordination Specialist has been extended until 2021. In addition, the humanitarian coordination team has been separated from the next DRM project for 2021 to remove the potential for disaster response to disrupt other DRM activities (Richard Higgins, pers comm, 2022) .

IOM, at the request of the National Disaster Centre and Madang Provincial Disaster Centre (PDC), deployed a Displacement Tracking Matrix (DTM) assessment on 26 October 2021 in response to volcanic activity on Manam Island. The assessment deployed by IOM, and Madang PDC staff equipped with DTM skills identified 2,460 men and 2,188 women affected by the volcanic activity and needed assistance, and Madang PDC supplied food rations as part of the initial response. A DTM report was published and circulated widely to state and non-state entities to help inform evidence-based planning and decision making. (IOM Newsletter Oct-Dec 20201)

governments and communities to make better decisions, armed with information about likely climate patterns (Kuleshov et al., 2019).

The Disaster Ready programme is funded by the Australian Government and implemented by Australian NGOs and their local partners:

- Plan International Australia (ChildFund) is partnering with the National Agriculture Research Institute; Department of Agriculture and Livelihood; Plan International Bougainville; Pacific Disaster Centre,
- World Vision Australia is partnering with the Department of Education; UNICEF; PNG Red Cross – Madang Chapter; Madang Provincial Disaster Office; private sector (e.g., Coca Cola PNG, DIGICEL),
- CARE Australia is partnering with the Eastern Highlands Provincial Administration (and Provincial Disaster Centre); Eastern Highlands Provincial Division of Agriculture, Livestock and Fisheries; Mt Sion Centre for the Blind and Disabled; ABG Directorate for Disasters and Emergencies, and
- Caritas Australia/CAN DO is partnering with Anglicare, Adventist Development and Relief Agency (ADRA), Baptist Union, Caritas Australia, Evangelical Lutheran Church, Salvation Army and United Church.

The Australian Government also funds the South Fly resilience programme on the southern coast. In this programme, an approach is being trialled to build resilience through an integrated approach that includes training community rangers (male and female), supporting small business establishment, and improving water and sanitation (A. Jacobsen, pers.comm.) The South Fly Resilience Plan builds district-level emergency response capability, with triggers for appropriate relief as needed. Under the SFRP, the Ranger Program was expanded to 40 wards in South Fly, and food relief provided to its 14 Treaty Villages (DFAT, Australian Government, n.d.).

USAID Also works in disaster preparedness and relief in the Pacific (USAID, 2022). Their listed programmes for PNG were: a) Strengthening Early Warning and Preparedness: USAID/OFDA supports IOM to increase disaster preparedness and response in Papua New Guinea's hazard-prone coastal, highland, and outer atoll communities. b) Volcano Disaster Assistance Program (VDAP): This project is implemented by the U.S. Geological Survey, and assists national volcano monitoring organizations through training in hazard assessment, early warning system development, and volcano monitoring equipment installation. The project has assisted the Port Moresby Geophysical Observatory and the Rabaul Volcano Observatory, helping improve volcanic gas monitoring and warning systems.

12.7 Gaps and risks in disaster management

The 2019 UN Office for Disaster Risk Reduction status report for PNG(UNDRR, 2019a) identifies challenges in relation to:

- Coordinating action across government agencies and levels of government and with stakeholders from other sectors – for assessment, planning, response and recovery;
- A mechanism for collecting baseline data for understanding disaster risk is lacking, although it identifies a number of quantitative and qualitative situation analyses and sector reports that could contribute to risk assessments;
- The need to build technical and human capacity especially at the local level and in remote islands for assessing risk collecting data, monitoring and analysis, and building resilience and responsiveness;
- Securing funding allocations from government budgets rather than relying on international aid programmes in order to mainstream disaster risk reduction interventions across sectors;
- Extending early warning systems (capacity, technology, warning dissemination) for floods, especially in highly affected areas of the north coast and islands; and
- Landslide prediction and mapping in high-risk areas to reduce risks to infrastructure, production and settlements.

Due to their proximity to the affected areas, mining and gas companies were major contributors to the response to the 2018 earthquake; they were able to respond with greater speed and reach than traditional humanitarian aid agencies. Their sizable operational and logistical footprints meant they were well-placed to transport people and goods to remote areas. Improved collaboration and understanding of humanitarian principles and approaches would leverage the core competencies of both sectors (Humanitarian Advisory Group, 2018).

Funding uncertainty is also an issue. Investment in disaster planning, response and recovery is funded from donors, rather than from PNG own-source funding. Interventions must be aimed at predicting

and mitigating impacts, and at building capacity for response and recovery. The key issue is about the capacity for sustained implementation at the national, provincial and local levels and greater status and authority across government.

The United Nations agencies and donors continue to support activities aimed at strengthening disaster prevention, response and recovery including expanding early warning systems; and local area preparedness, response and recovery. The investment is coordinated through the National Disaster Centre, which itself still requires additional capacity and capability building.

The National Disaster Risk Reduction Framework 2017—2030 (National Disaster Centre, 2017) sets out a comprehensive set of priorities, and the UNDRR 2019 PNG Disaster Risk Reduction Status Report identifies a number of areas for priority action (UNDRR, 2019a). These are:

- Expand early warning systems;
- Enhance systematic data collection, analysis, and management, required for risk analyses, situational assessments, projection of future scenarios, involving planning for effective disaster risk reduction, and response measures;
- Aid further local efforts to increase capacity of local actors and operators in disaster preparedness, and to effectively respond and recover in the aftermath of disasters;
- Improve the ability of local communities to effectively manage response and recovery through resilience and capacity building, including community-led resilience building;
- Reinforce disaster finance, including investment in increasing community resilience, poverty reduction and environmental protection, in response mechanisms for alleviating loss of livelihoods, and addressing shelter and access to safe water/sanitation in the aftermath of disaster events.

The review of UNDP Strengthening Disaster Management in Papua New Guinea Project (Chamberlain, 2019) indicates that additional effort is required to achieve change, particularly in implementation at provincial and local levels.

The need for greater cooperation and integration between climate change resilience programmes and disaster preparedness has been stressed by both the Pacific as a whole (Pacific Community, 2016) and for PNG (Humanitarian Advisory Group, 2022).

12.8 Recommendations

The existing frameworks focus on preventing and mitigating the socio-economic impacts of disasters, touching only tangentially on environmental impacts. In addition to the important activities being currently conducted by the Government of PNG and its development partners, and the recommendations made in the disaster management reports cited in this chapter, from an environmental perspective we recommend:

12.8.1 Further integrate disaster resilience planning with climate change resilience and other wellbeing programmes

- Disaster resilience planning could be better integrated with planning and implementing strategies for adapting to climate change, rather than having two different programmes targeting similar levels of government and target audiences. This integration is already being fostered in a number of programmes.[28]
- This recommendation could be extended to better integrating local disaster resilience planning with all programmes that are aimed at improving social and economic wellbeing. For example, new buildings for health or education could be designed to also function when needed as evacuation centres during cyclones or tsunamis. Decreasing socio-economic vulnerabilities will build disaster resilience.

12.8.2 Mainstream disaster resilience though adaptation strategies including 'building back better', and stricter building codes for 'formal' and public buildings

- There should be no clearing of mangroves and other shoreline/ coastal vegetation that dampen the impact of cyclones, storm surges and cyclones
- In all land use planning policies and legislation, further development (including industrial and urban development) should not be permitted in areas projected to be affected by sea level rise, minimising development of infrastructure in areas most vulnerable to disasters
- Implementing strategies for waste management in disaster incidents is also important for minimising long-term environmental impacts (SPREP, 2021a)
- All reconstruction efforts should use the best possible environmental and social standards, including green energy, accessible and safe sanitation facilities, and sustainable water use. Due consideration should be made to balancing the use of modern material and design versus vernacular buildings, which have been found to be better adapted to the local environment context and may be disaster resilient (G. Ng pers. comm. 2022)
- Where appropriate, building codes need to be updated with most recent knowledge and strictly enforced. It is recognized that most people in PNG live in less formal buildings, where regulation is neither possible nor desirable. The uninformed use of modern materials for small dwellings has the potential to cause more loss of life than traditional houses which are made with lighter material. These collapse easily but do not crush and can be rebuilt easily at minimal cost (G. Ng pers. comm 2022). However, more formal structures using modern materials, multi-storey

buildings and public buildings such as schools, hospitals and places of worship do need strong building codes, and can be designed to strict codes to withstand strong winds and cyclones. Well-designed public buildings out of reach of floods and tidal inundation can be critical as evaluation centres in emergencies.

PNG's Climate Adaptation Plan (Section 7.4.4) and associated activities aim to improve the ability of various sectors to develop infrastructure and services that take climate change into account, and continuing this adaptation planning is important. However, adaptation activities also need to take into account risks from other hazards including cyclones, tsunamis, earthquakes and volcanic eruptions.

For example, large buildings in cities need to consider the best standards possible to avoid loss of life during earthquakes. According to the Geosciences Australia Assessment: "The building standards and incorporated seismic hazard assessment for Papua New Guinea has not been updated since the 1980s. The integration of modern national seismic hazard models into national building codes and practices provides the most effective way that we can reduce human casualties and economic losses from future earthquakes...In particular, the high seismic hazard of the Huon Peninsula in the revised assessment is not captured in the current seismic zoning map, leading to a significant under-estimation of hazard in PNG's second largest city, Lae." (Ghasemi et al., 2020, p. IV).

12.8.3 Continue and increase coordination and communication in disaster risk management and in resilience strengthening

Management of disaster responses from international bodies is coordinated through the Disaster Management Team, and continuing support for this programme in essential.

A number of programmes are being implemented in PNG to build better preparedness and resilience in relation to natural disasters at levels, involving a range of actors from meteorological organizations and the IMO to bilateral aid agencies and NGOs. It is also important that these bodies coordinate and communicate through their activities, to ensure that duplication is minimised and that some parts of the country do not miss out on activities completely.

12.8.4 Enforce environmental protection measures that will prevent or mitigate the impact of disasters

- Extractive industries such as mining, gas production, agriculture and forestry, as well as all infrastructure developers (pipelines, electricity, roads) should be required to embed good environmental engineering practices to avoid catalysing environmental impacts, such as large-scale sediment and rainfall runoff, landslides, and dam failures. In particular, strict standards around clearing of forest on slopes and destabilization of shorelines and riverbanks need to be implemented, with bonds and fines for contractors or industry that breach the standards. (Work in the climate change adaptation programmes is moving towards setting some of these standards). Recent experience around the world has shown that planning dams etc for "once in 100-year" events is not adequate where the consequences are serious.
- Response plans need to be legislated for all activities with the potential to cause environmental disasters, either through malfunction or as a result of natural disasters. These plan and response preparedness should include mines and gas pipelines, dams, factories, and transport and shipping activities, especially where oil or toxic material are being transported. Companies responsible for any environmental disaster should be legally obliged to pay the clean-up and appropriate compensation.

12.8.5 Develop teams of capable responders at local level

Some activities are already occurring in this regard, such as the formation of community resilience strategies and training being undertaken by the IOM and the South Fly Resilience Program. However, this is currently patchy and only in small areas, and needs to be greatly boosted and undertaken across the country, given the high level of threat.

The proposed network of community and protected area rangers could be trained and equipped to be among the first responders to disasters. People participating in ranger programmes have remote first-aid training, project management skills, communication skills and technology, and a support network. These programmes should include representation of women so they can assist families most affected by disasters.

[128] This recommendation has been echoed in a numberin number of recent reports: "Benefits of a more systematic and integrated approach to reducing the consequences of climate change and natural hazards include rationalising, where appropriate, multiple funding sources and multiple projects that are addressing similar needs. An integrated approach can reduce duplication and optimise use of limited resources and sharing of technical expertise." (Pacific Community, 2016, p. 7)

Chapter 13.

Those left behind – environmental aspects


UN
DP

13.1 Papua New Guinea context of those left behind

People 'left behind' or at risk of being left behind are those who either lack choices and opportunities to benefit from development progress, or are experiencing extreme poverty, or enduring severe disadvantage and deprivation (UNDP, 2018). Factors contributing to those left behind or at risk of being left behind are classified under geography, discrimination, socio-economic status, governance, and those who are subject to shocks and fragility (European Commission, 2016; UNDP, 2018). Of these five factors, this environmental analysis deals primarily with the issues of:

(a) Geography: isolation, risk or exclusion due to location; includes environmental degradation, transport, technology, considering SDG outcomes and opportunities broken down by sub-national locality: inequities in mobility related to transport and internet access.

(b) Vulnerability to shocks: considers places or populations that endure more frequent and/or severe setbacks due to natural or environmental disasters or other shocks.

However, because of the strong influence of intersectionality, this chapter also touches on issues of discrimination, socioeconomic struggles and governance where they are closely linked with environmental issues and opportunities. The environmental analysis applies the LNOB lens by: (a) identifying those who are left behind, including those furthest behind, and those at risk of being left behind; (b) identifying barriers to overcome and the consequences of inaction to overcome those barriers; and (c) offering analysis of risks and opportunities associated with inequalities, exclusion and discrimination, including gender-based discrimination, and violent conflict.

The 2020 Social Exclusion Analysis (PNG National Research Institute, 2021, p. 8) list the following groups in PNG as being particularly vulnerable, and discusses their issues:

- Persons with disabilities (PWDs). In the past, PWDs depended on an extended family system for support. However, the system has continued to weaken, which put PWDs at risk[129]
- Children. Including children orphaned, adopted, and/or fostered, one of the most disadvantaged and vulnerable groups in PNG
- Youths. Many youths are either never been employed or have been out of a job and education for an extended period, making them disadvantaged and vulnerable
- Women and girls. Gender inequality drives disadvantage and discrimination that put women and girls at risk of being left behind. Some discriminations include those resulting in gender-based violence
- Older adults. They often rely on extended family system support for their upkeep and are often left behind, especially in economic downturns and as a result of a breakdown in culture and social relationships
- Settlers and landless people. Lack of services and employment opportunities contribute to the migration of people from rural areas. They become landless after living where they have settled for several years
- People living with HIV/AIDS. This group often faces stigmatisation stigmatization from the community where they live, making it difficult for them to access services such as health care
- People living with tuberculosis (T.B.). Like people living with HIV/AIDS in PNG, people living with T.B. are also stigmatised
- Sex workers. As prostitution is not formalised in PNG, people who engage in it are often discriminated against and at risk of not accessing essential services such as health care
- Sexual orientation. Most communities in PNG are intolerant toward homosexuality (i.e., gay and lesbian). The LGBT+ community finds accessing services (such as health care) difficult.

In PNG there is a wide gap between people who are well off and those left behind. This is seen in the difference between the human development index (HDI) (0.55) (PNG ranks 151 from 184 countries and the HDI adjusted for inequality (0.29). Access to opportunities is very different between different groups in the country (Figure 63).

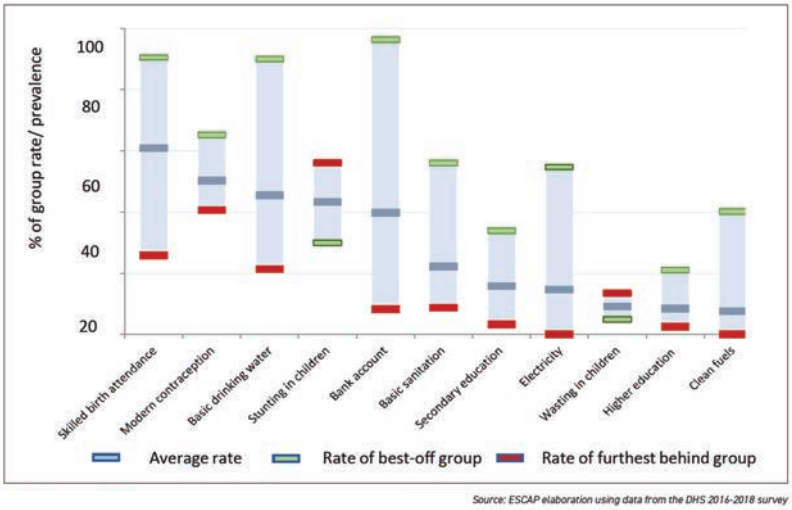


Figure 63: Gaps in access to opportunities in Papua New Guinea
Source: Department of National Planning and Monitoring (2020, p. 19)

[129] In 2013 PNG ratified the United Nations Convention on the Rights of Persons with Disabilities, which includes a commitment to promote and protect the rights of people living with disabilities, provide them with access to services, and support them to improve the quality of their lives.

13.2 How are people left behind in PNG

PNG's people reflect its physical geography, with many communities living in isolated villages scattered throughout the main island and its many smaller islands and atolls (Beehler, 2020). One of PNG's main challenges is the difficulty of governing many hundreds of diverse, once-isolated local societies as a viable single nation (Standish, 2019).

About 80 percent of PNG's population live in peri-urban, rural and remote settlements and rely on artisanal fishing, hunting, gathering and gardening (Bourke, 2020). There is little cash flow and limited access to health care, education, sanitation and clean water. Forty percent of these residents live below the international poverty line . The major causes of poverty for people in rural and remote PNG are lack of food security and access to basic infrastructure and human services, all hampered by physical geography, vulnerability to natural disasters, explosive population growth and land alienation. For those in urban settlements, poverty relates to landlessness and limitations in accessing resources and services. (World Bank Group, 2020b).

In all communities the most vulnerable tend to be women, children and those living with a disability. In addition, women are subject to discrimination and a high level of gender-based violence.

The remoteness of many of PNG's rural communities can create immense challenges for responding to disasters effectively, and lack of local infrastructure and health services can have long- lasting impacts on communities following catastrophic events (UNDRR, 2019a). When specifically considering place of residence (geography) and vulnerability to shocks, a number of factors can determine a population's risk of exposure to disasters. The INFORM risk index measures relative risk of humanitarian crises and disasters, compared with the risk level of 191 participating countries, and uses 50 different indicators clustered into three dimensions:

- Hazards and exposure;
- Vulnerability of people to potential hazards; and
- Lack of coping capacity or resources to help people cope with hazardous events (European Commission, 2016).

As discussed in Section 12.3, on the 2022 INFORM rating of disaster vulnerability PNG is ranked as the 22nd most vulnerable of 189 countries, with a score of 5.9/10. (INFORM, 2022).

13.2.1 Food and water security

Food security is a major issue as most of the population is at least semi-dependent on rain-fed subsistence farming. These small-scale farms (known as gardens in PNG) are subject to the impacts of climate change, including extreme weather events (droughts, floods and fires), declining land productivity, poor soils and increasing biohazards including garden pests and disease. Access to protein is limited and is exacerbated by increasing human populations (Busilacchi, Murphy, et al., 2020; Jackson et al., 2020; Kiros and Sammut, 2019; Reef and Rainforest Research Centre, 2019a; Rosenbach and Schmidt, 2019). However, people who have gardens or access to fish and bush meats are comparatively well off for food, which is very expensive to buy. The people most vulnerable to food and water shortages in rural and remote communities are women – especially widows, divorced women, those with mental or physical disabilities, the elderly, and orphans. This vulnerability is exacerbated by a decline in informal social protection (e.g., sharing of food, labour, and resources), which was once commonplace in rural PNG (Jackson et al., 2020).

Women generally do most harvesting of subsistence food crops and water collecting (Kanua et al., 2016). In recent years their workload has increased due to lower yields, reduced soil fertility, erosion, and more extreme weather events (Mcleod et al., 2018). In major droughts many water sources dry up forcing villagers (mostly women and girls) to walk much further to find water and carry it back to the village. In some instances, when clean water is scarce villagers have to use other sources including larger polluted rivers and muddy water. Sometimes schools are closed due to a lack of clean water (Kanua et al., 2016).

Access to clean water and sanitation in rural areas in PNG is extremely low (Chapter 10).

13.2.2 Infrastructure

Remote inland villages are located in challenging terrain, often only accessible by foot. Road construction costs are high, and existing roads are poorly maintained and vulnerable to landslides due to rugged terrain, high rainfall and natural disasters such as earthquakes. Across the country less than 39 percent of roads are in good condition. Some islands and coastal settlements are only accessible by boat. Many are vulnerable to natural hazards, extreme weather, sea-level rise and other consequences of climate change and have no form of contact for disaster warnings (see Chapter 12). Shipping services are limited and there are frequent deaths due to the sinking of overloaded boats and ferries (Lawrence, 2017).

Access to communications is rapidly increasing. According to the 2021 data report (Kemp, 2021), in January 2021:

- There were 3.11 million mobile connections
- The number of mobile connections increased by 239 thousand (+8.3 percent) between January 2020 and January 2021
- The number of mobile connections was equivalent to 34.4 percent of the total population
- There were 1.37 million internet users
- The number of internet users increased by 270 thousand (+25 percent) between 2020 and 2021
- Internet penetration in Papua New Guinea stood at 15.2 percent.

There is very little fixed telecom infrastructure outside urban centres. In remote areas coverage is either non-existent or limited to 2G. In urban areas, 3G and

4G coverage are more common (Wansink, 2020). Most people who connect to the internet use mobile phones to do so, but costs have been high, and there are other limitations, including lack of electricity and literacy. Due to pricing structures, social media can be effective in communicating to many people. Current initiatives hope to lower prices and improve connectivity (A. Watson, 2020). This would be of advantage both in disaster response and in improving the security of vulnerable people.

PNG has one of the lowest per capita rates of electricity consumption in the world. However, a new Electrification Partnership (Australia, USA, New Zealand, and Japan) has pledged to help PNG meet its target of connecting 70 percent of the country to electricity by 2030 (S. McLeod, 2019; World Bank Group, 2018).

13.2.3 Education

The provision and quality of education services are inadequate in remote areas due to geographical barriers, lack of infrastructure (buildings, power, water, sanitation), a shortage of trained teachers willing to work in difficult conditions and limited resources (World Vision Australia, 2020). Data on education completion and participation is included in the Social Exclusion Analysis.

13.2.4 Access to water sanitation and hygiene (WaSH)

Of the 15 developing Pacific Island countries, PNG has the lowest indicators for access to water, sanitation and hygiene (WaSH) (Department of National Planning and Monitoring, 2020). Only 13 percent of rural residents have access to sanitation and only 33 percent have access to safe water (UNICEF, 2018a). WaSH-related diseases have long-term impacts, causing higher morbidity and death rates, reducing educational attainment, causing significant economic impacts at both the household and national level. Exposure to water-borne disease results in around 6,000 diarrheal deaths every year, and are a major cause of death in children under five years. Women and girls are more disadvantaged when there are no adequate and private sanitation facilities, and lack of facilities means many girls miss school (UNICEF, 2018a).

13.2.5 Health

Provision of health services to remote areas is very poor. Many people in rural and remote areas have no access to health care. Children living in rural areas are twice as likely to die in their first five years of life compared to children living in urban areas (Human Rights Watch, 2022). Even basic midwifery services are not available. There are only 7.74 physicians per 10,000 people, while expenditure on health services is low. More than 2,000 women and girls die in childbirth in Papua New Guinea each year, with deaths largely preventable and due to conditions, such as haemorrhages, infections, and pre-eclampsia or eclampsia. In rural areas, many women have no access to even basic midwifery care. However, overall life expectancy has increased from less than 40 years in 1960 to between 64 and 68 years of age in 2020 (Cairns et al., 2018; European Commission, 2019a; Middleton et al., 2020; Pham et al., 2020; UNICEF, 2018a; WHO, 2020).

13.2.6 Gender-based violence and sorcery

At least 56 percent of PNG women aged 15-49 have experienced physical violence, and 28 percent have experienced sexual violence (Special Parliamentary Committee on Gender-Based Violence, 2021). The Governor for the National Capital District, the Hon. Powes Parkop, recently stated: "[L]evels of violence being perpetrated against women in our country are amongst the highest in the world. We cannot let this continue. It is destroying Papua New Guinea and is our greatest impediment to achieving our full potential as a member of the international community." (UNICEF Papua New Guinea, n.d.). The Government has established a bipartisan 'Coalition of Parliamentarians Against GBV', which presented a report in 2021, with 77 recommendations (Special Parliamentary Committee on Gender-Based Violence, 2021).

Sorcery and witchcraft accusations are an entrenched, widespread and recurrent problem resulting in destruction of property, physical violence and even death of the accused (Department of Foreign Affairs and Trade, 2018; Forsyth et al., 2019).

These issues need to be kept in mind when any programmes related to the environment are planned. For example, encouraging women into positions of leadership in environmental programmes is highly desirable from many viewpoints. However, it can also result in increased levels of risk for participants, especially if their partner or other men in the community resent their opportunities (Robyn James, personal communication 2020). Therefore, strategies to increase opportunities for women approached with careful consideration and with the local cultural context in mind: sometimes a slow development, or approaching through female contacts of the male hierarchy, may be the most effective (Maxine Angina pers.com. 2021). Communicating examples of women working successfully in the field can also be helpful: Rangers from Torricelli Mountains visited Australia and saw females working in the field beside men: this changed their attitudes and now a few females also work in the field there (Jim Thomas pers. comm. 2022).

13.3 Environment-related shocks affecting those left behind

13.3.1 Climate change and extreme weather events

Climate change (refer Chapter 7 and impacts s7.1.3) is already affecting the most disadvantaged and will result in many more people being 'left behind' unless actions are taken. For example, in 2015-2016, an El Niño-related drought left almost half a million people impacted by food shortages (UNDRR, 2019a).

The people living in already very challenging conditions on isolated islands have been badly

affected already by climate change, through increased scarcity of freshwater and food (John Poulsen, pers. comm 2022). PNG is the site of the world's first climate refugees: the Carteret Islanders. Their home comprises seven atolls which are subject to intense coastal erosion and food and water insecurity due to the combined effects of climate change and tectonic activity (Munoz, 2019). Since 1994, these low-lying islands have lost about 50 percent of their area.

In surveys of customary landowners living in or near 59 protected areas, 93 percent said they were experiencing climate change. All nominated climate change as a serious threat, with communities already experiencing effects such as sea-level rise, droughts and floods, and increased unpredictability of seasons and winds (Leverington et al., 2017). People were very concerned about their crops and about travel across rougher and less predictable seas.

McKenna et al (2019) also found community members were reporting changes in rainfall and rising temperatures, and that there was concern about fires and loss of ecosystem services. Women and children were most disadvantaged by these effects, and it was reported that "female workshop participants were often most vocal about dimensions of vulnerability (e.g., population growth) and their links to social issues (e.g., alcoholism, domestic violence and petty crime) [,] which they viewed as likely to be heightened through ecosystem decline".

People who are already living in the most marginal conditions — for example without a reliable water supply, with the least area and poorest land for gardens, or with diseases such as malaria, dengue fever and TB — are the most likely to be worst affected by increased temperatures, droughts and floods that limit food security and wellbeing.

Climate change will result in migrations of people from the worst affected areas and also in increased mobility within regions. This in turn leads to both socioeconomic and environmental impacts.

13.3.2 Earthquakes, tsunamis and volcanoes

Due to its location on the Pacific Ring of Fire, PNG residents are among the world's most vulnerable to natural disasters such as earthquakes, tsunamis and volcanoes (UNDRR, 2019a) (refer s12.3 about risks from tectonic activity). For example, the eruption of Zaria on Manam Island in 2004-05 displaced over 9,000 people to the nearby mainland. Resettlement has resulted in on-going land disputes, often ending in violence (John Connell and Lutkehaus, 2017).

In February 2018, a 7.5 magnitude earthquake affected four PNG provinces. Hela and the Southern Highlands Provinces were the worst affected with Western and Enga Provinces also badly impacted. 544 000 people were affected, and 270 000 needed help to access water, food, shelter and health services. More than 18,000 people were displaced to evacuation camps and facilities, most without adequate water or sanitation. Damaged airfields, bridges and roads made the recovery response difficult, and inter-communal violence further complicated the response (UNICEF, 2018a). In Western Province, major rivers and creeks were affected by landslides and sediment, impacting fish, crocodile and crustacean populations, resulting in a decline of available protein for local residents. Several villages lost garden foods (Jackson et al., 2020). Many displaced women who were forced to seek shelter in neighbouring villages, were prone to rape, abuse and forced labour. Tribal fighting did not ease due to the earthquakes and the conflicts disrupted the distribution of aid supplies (Tlozek, 2018).

The 2018 earthquakes left a lasting legacy. Around 270,000 people needed urgent assistance, including 125,000 children, who suffered shock, significant trauma and stress, which could have negative consequences for their long-term well-being. Many were subjected to loss, confusion, family separation, deteriorated living conditions, lack of food, and disruption of social and school activities (UNICEF, 2018b).

Ulawun volcano, located on the northern side of New Britain Island, erupted twice in 2019, and Zaria on nearby Manam Island also erupted. Although there were no reported casualties, the eruptions destroyed homes, plantations and wells – leaving villagers without food and water and disrupting domestic flights. After the events, around 3,700 people in the Manam area and 11,000 people near Mount Ulawun took shelter in refuge centres (Bevege, 2019).

As with climate change impacts, those affected by these natural disasters may migrate to other areas, or be forced to travel further within the region to seek food and shelter, with implications for both environment and society.

13.3.3 Extractive industries

Large-scale forestry, land-clearing and mining operations (refer Chapter 6, Chapter 11 have caused severe impacts on some communities in PNG, with some negative impacts also experienced from large-scale fisheries and processing industries (refer Chapter 8).

PNG's rural and remote communities are vulnerable to shocks resulting from activities associated with extractive industries (including mining, oil, gas, commercial fishing, logging and oil palm plantations), especially where people are largely dependent on the local environment for their livelihoods. The extractive dispossession framework, as discussed in Section 11.3.1, is useful for analysing the impacts on those left also behind, through factors such as:

- Loss of farmlands and forests through clearing and degradation, leading to shortages of food, building materials and cultural heritage ;
- Pollution of rivers, streams and marine areas, and of land and soils;
- Entry of toxins including heavy metals into the environment and food chain, causing health impacts;
- Declines in fish catch and loss of other marine food sources;
- Siltation with resultant loss of healthy aquatic

systems, blocking of waterways and changes in water flows; and

- Flow-on effects relating from increased mobility and migration, where people who are displaced have to venture further to seek livelihoods.

Environmental shocks also cause social impacts such as increased gender violence, loss of culture and social fragmentation. In general, the social and environmental impacts of PNG's large-scale extractive industries are largely overlooked. There is no systematic monitoring of the extent or impacts of these activities on adjacent ecosystems and the people who depend on them. Nor is there any rigorous assessment or monitoring of social changes due to environmental degradation associated with these activities (CEPA and SPREP, in press; Fletcher and Mousseau, 2019; Mudd et al., 2020).

For example, there are major concerns about the impact of marine mine waste disposal on shallow and deep marine biodiversity and ecosystem processes, but there is no systematic monitoring in food chains for heavy metal content or other health-related concerns (CEPA & SPREP, 2020; Mudd et al., 2020). Negative impacts from the nickel refinery and the tuna cannery on protected areas in the Madang Lagoon include reports of fish kills, algal blooms and declines in water quality, and many view further industrial expansion as a serious threat to the lagoon and its protected areas (Leverington et al., 2017).

Since its initial operation, the Ok Tedi mine has polluted the extensive Fly River system, forcing villagers, who were previously wealthy in terms of natural resources and subsistence living, to migrate to Daru. Impoverishment due to limited terrestrial natural resources, lack of jobs and overexploitation of marine resources is rife among the displaced people, who are now the poorest in Daru. The new settlers live in areas with no water, sanitation or cooking facilities, and are more likely to be involved in illegal take of marine products, as they have no alternative sources of livelihood (Busilacchi, Curth-Bibb, et al., 2020).

Forestry operations can also have negative effects on those left behind. Logging has evolved from selective harvesting of trees that was practiced under customary tenure to broad-scale clear felling, paving the way to the establishment of oil palm plantations, which have increased in recent years. These SABL areas are reported to give few benefits for local residents. Reportedly, residents are no more likely to have access to running water, health care facilities or schools than other locations. People appear to be worse off for not having access to food from traditional gardens, and deforestation has destroyed traditional hunting grounds (Fletcher and Mousseau, 2019).

Women are most likely to suffer when land is opened to extractive industries, and this can lead to increase in conflict and violence (Cannon, 2020). In a 2015 report to the Human Rights Commission, Human Rights Watch included extractive industries as an area of concern, and outlined instances of violence, especially gender-based violence. It recommended that there should be "financial support for the long-term development of local PNG groups with capacity for independent monitoring of the human rights, health and environmental impacts of extractives projects" (Human Rights Watch, 2015).

13.4 Progress towards development goals and targets

In the past, progress towards the Millennium Development Goals (MDG)s was hindered by a lack of the following: data; health issues (including the HIV/AIDs epidemic); poor access to education; increasing population; environmental degradation associated with development activities; lack of legislation and effective governance; deficiency in service delivery; lack of economic opportunities; gender disparity; climate change; geographic isolation, and extreme cultural diversity (CEPA and SPREP 2020).

In 2015, PNG adopted the 2030 Agenda for Sustainable Development and the Small Island Developing States Accelerated Modalities of Action (SAMOA Pathway) to achieve the country's Vision 2050 (European Commission, 2019). The 17 SDGs were integrated into PNG's Medium-Term Development Plan III (2018—2022), with other national delivery mechanisms, including policies, legislative, and budgets (United Nations, 2020).

More recently, results of PNG's first voluntary assessment of how the country is progressing towards achieving the 17 SDGs (Department of National Planning and Monitoring, 2020) indicate that key enablers are in place for most SDGs, but barriers hinder progress in Decent Work and Economic Growth (SDG 8), Peace, Justice and Strong Institutions (SDG 16), and Life Below Water (SDG 14) (United Nations, 2020).

The progress of PNG's people most left behind towards SDGs in relation to environmental issues is summarised in Table 66. This focussed only on (a) place of residence – i.e. geography; and (b) vulnerability to shocks. In reality, this covers most of the SDGs, and some are more relevant than others. The table also aligns the SDGs with relevant Aichi targets. For each SDG and associated targets, the table indicates:

- Who might be left behind: why and how they might be left behind (or potentially left behind);
- What opportunities or enablers exist to enhance progress towards SDGs and targets;
- What barriers prevent progress towards the SDGs and targets;
- Major knowledge gaps; and,
- Consequences if not addressed.

SDG Goal, Target Aichi Target	Who might be left behind? [130] Why? How? How?	Opportunities, Enablers (current, future)	Knowledge gaps	Consequences if not addressed
SDG 1. End poverty in all its forms everywhere	**Who?** Rural and remote communities. **Why?** Place of residence, socio-economic status, governance. **How?** Most people are living in poverty due to limited access to cash, inc. poor education	Informal economy provides viable income earning opportunities and mitigates effects of increasing costs of living by enabling people to afford goods and services and sustain their livelihoods (Kopel, 2017). When cash-generating activities such as trade in handicrafts are possible, people are less likely to be involved in illegal trade (Busilacchi et al., 2018).	Lack of info on the needs of farmers, fishers, herders, vendors and traders in high-risk areas.	Early death/malnutrition and disease due to lack of income to pay for health services, balanced diet, clean water and sanitation. Some forced to trade illegally for cash for health, education, clothing- could lead to fines, prison and overexploitation
SDG 2.4 By 2030, improved sustainable food production systems and practices to increase productivity and production maintain ecosystems; strengthen adaptive capacity to cc and disasters and improve land and soil quality. **Aichi Target 4: Sustainable production and consumption** **Aichi Target 7: Sustainable agriculture /aquaculture, and forestry**	**Who?** Rural and remote communities. **Why?** Place of residence, socio-economic status, governance. **How?** Climate change contributes to ecosystem decline, extreme weather, undermining agriculture, fisheries, livelihoods, and food security. (Disaster/climate change impacts affect people's health and well-being; damages food production assets.)	*mVAM* (Vulnerability Analysis and Mapping) tracks progress towards SDG 2. MASP (Mapping Agriculture Systems Project) has information on livelihood/income from food-cropping and export crops (Moran, 2020). [131] Shift to, risk-sensitive climate-smart agricultural technology practices and farm plans. Support nature-based solutions including ecosystem protection and reforestation/afforestation. Retrofit/construct robust, climate-proof agricultural infrastructure. Strengthen access of small-scale farmers, herders, fishers, foresters to resources, credit, insurance, climate services, risk information and social protection to protect livelihoods. Establish inclusive multi-hazard early warning systems.	Lack of understanding of structural/ underlying causes of food insecurity and malnutrition. Lack of info on subsistence agricultural production levels and trends; hard to get aquaculture production data: this is predominated by inland ponded fish farming often in isolated areas. Need more research on: sustainable agroforestry, multi-tiered agriculture and permaculture. Impacts of previous disasters and extreme weather on food security, health, nutrition and agricultural productivity. Areas of overlap: food insecurity and malnutrition, hazard and climate change impact. Laws, policies and programmes supporting agriculture, forestry and fisheries sensitive to disaster and climate risks.	Early death associated with malnutrition and preventable disease due to lack of health services, balanced diet, clean water and sanitation. If laws, policies and programmes for agriculture, husbandry, fishery and forestry do not consider disaster risk or projected climate change impacts, they could promote maladaptive practices, introduce new hazards and exacerbate existing risks.

[130] Five factors are key to understanding who is being left behind and why: discrimination; place of residence; socio-economic status; governance; and vulnerability to shocks (UNDP, 2018).

[131] Joint initiative initially of the United Nations World Food Program (UNWFP), with the PNG National Disaster Office (PNG-NDO), which later engaged with the Department of Agriculture and Livestock (PNG-DAL) and the National Statistical Office (PNGNSO).

SDG Goal, Target Aichi Target	Who might be left behind? [130] Why? How? How?	Opportunities, Enablers (current, future)	Knowledge gaps	Consequences if not addressed
SDG 3: Good health and well-being **Aichi Target 8: Pollution reduced**	**Who?** Displaced rural/remote residents and their new communities. **Why?** Place of residence, governance. **How?** PNG ranks 155/188 countries by SDG health indicator scores (UNDP, 2019a). Most people in remote settlements have very limited access to health services. Only 13% have access to sanitation; 33% have access to safe water (UNICEF, 2018a). Extractive industry activities can lead to heavy metals and other toxins in food chains.	Effective health services can be provided to isolated areas, with strong management and resourcing (Cairns et al., 2018). 'Building Resilience in Treaty Villages' provides carpentry, plumbing and other skills; first aid and child delivery support training. (Butler et al., 2019).	No systematic monitoring of extent or impacts of mine tailings/effluent on adjacent ecosystems and locals; no monitoring in food chains for heavy metal content or other pollution-related health concerns (Conservation and Environment Protection Authority, 2019).	Health-related issues due to isolation, pollution; lack of food and clean water. Displaced people add to pressures on natural resources; cause conflict between new residents and original inhabitants.
SDG 5: Gender equality and empower all women and girls	**Who?** Women and girls in rural and remote communities. **Why?** Discrimination, place of residence, governance. **How?** Fewer females than males have access to education. Many school children walk long distances or catch several buses each day to and from school. Pregnant women often walk for days to access health care. Gender-based and sexual violence creates fear, isolation and huge health impacts; isolation makes it worse.	More and better resourced health services and schools. Safer roads/transport systems. Kiwai-Wabada island communities in the Fly R corridor are collaborating with Ok Tedi Development Foundation (OTDF) to involve more women to harvest and sell mud crabs (Busilacchi, 2019). Protected area programs can help to address this issue (Leverington et al., 2017). In 2015, the Government of Papua New Guinea developed a comprehensive Sorcery and Witchcraft Accusation Related Violence (SARV) National Action Plan to address the problem of sorcery accusation-related violence. The National Action Plan has the following core areas: services (through counselling, health sector and child protection); prevention through advocacy and communications; legal protection and prosecution; and research (Department of Foreign Affairs and Trade, 2018).	How might women be better supported in small business? How can women and children have access to safe transport to schools and health providers? How might violence against women be eliminated?	Females have fewer jobs/ income opportunities. Increased risk of illness/ death for pregnant women; increased risk of women dying in childbirth and or miscarrying. Higher rates of stillbirths; infant mortality; childhood illness. Increased safety risk for travelling school children. Weak enforcement of laws criminalizing violence against women and children will continue to foster a culture of impunity and lawlessness (Human Rights Watch, 2020).

SDG Goal, Target Aichi Target	Who might be left behind? [130] Why? How? How?	Opportunities, Enablers (current, future)	Knowledge gaps	Consequences if not addressed
SDG 6.4 By 2030, increase water-use efficiency and ensure sustainable supply of freshwater to reduce no. of people suffering from water scarcity. **SDG 6.5 By 2030, implement IWM at all levels.** **SDG 6.6 By 2020, protect and restore water-related ecosystems, mountains, forests, wetlands, rivers, aquifers and lakes.**	**Who?** Rural and remote residents and those subjected to natural disasters and extreme weather events. **Why?** Place of residence; governance; vulnerability to shocks. **How?** Exposure to water-borne disease results in around 6,000 diarrheal deaths p.a. and is a major cause of death in children under five years (UNICEF, 2018a). Disasters and climate change can affect infrastructure, affecting water quality and limiting access to clean water. Climate-related changes to temperatures and rainfall can contribute to drought conditions, water salinization, water scarcity or flooding.	Establish national and transboundary mechanisms for knowledge and info sharing on drought, flood and hazards. Invest in IWM and ecosystem-based DRR and governance, and integrate water issues in DRR strategies and National Adaptation Plan. Mainstream risk assessment, mapping and management in rural development and management of rivers, flood plains, drylands, and wetlands. Regulate, retrofit; construct and build better water infrastructure. Develop and operationalize drought and flood risk management, monitoring and early warning systems and social safety net programmes.	Need research into how climate change will affect availability, quality and quantity of water for basic human needs. Need information on location of sources of drinking water and if there are natural, biological or technological hazards nearby. Need info. on how potable water is extracted, filtered and transported to households. Need info. on resilience of water and sanitation infrastructure to most-likely hazards. Need social and environmental impact assessments and climate change projections applied to water resource management and construction of water and sanitation infrastructure.	Increased risk of illness/death for all rural and remote people without access to clean water and sanitation. Upstream changes in water management, such as damming or irrigation schemes, can influence water access downstream and increase likelihood of drought, scarcity and conflict in-country or in neighbouring countries.
SDG 7.1: By 2030, ensure universal access to affordable, reliable and modern energy services.	**Who?** Rural and remote residents, people in informal settlements **Why?** Place of residence; socio-economic status; governance. **How?** 82.1% have no access to Electricity (World Bank, 2019). As grids expand to reach more communities, more infrastructure is exposed to natural hazards and extreme weather, making supply unreliable.	PNG has several rivers with hydro-electricity potential; tropical sun, also wind, bio-gas and geothermal resources for clean energy. Integrate energy system resilience into local and national DRR plans. Construct, retrofit and build back better energy infrastructure after risk and environmental impact assessment. Develop and maintain multi-sectoral rapid early warning, alert and response systems including comms plan to inform the public prior to and during major incidents.	Need research into how climate change effects (such as extreme weather) will affect energy systems – e.g. risks to energy storage, transportation, transmission and consumption. Need info on main energy sources and methods of extraction – e.g. does extraction increase risk from natural hazards, or risk ecosystems or biodiversity?	Impacts of natural disasters on pipelines, offshore platforms and other infrastructure that process, store or transport energy substances can cause fires, explosions and releases of toxic chemicals. Oil spills threaten marine and coastal ecosystems. Reliance on fossil fuel contributes to climate change.

SDG Goal, Target Aichi Target	Who might be left behind? [130] Why? How? How?	Opportunities, Enablers (current, future)	Knowledge gaps	Consequences if not addressed
SDG 11.1 By 2030, ensure access for all to adequate, safe and affordable housing. **SDG 11. 3 By 2030, enhance inclusive and sustainable urbanization and capacity for inclusive participatory planning and management.** **SDG 11.4 Strengthen efforts to protect and safeguard cultural and natural heritage.** **SDG 11.5 By 2030, significantly reduce no. of deaths and no. of people affected and decrease economic losses caused by disasters, esp. poor and vulnerable people.** **SDG 11.C Support communities to build sustainable and resilient buildings with local materials.**	**Who?** Rural and remote residents. **Why?** Place of residence; socio-economic status; governance. **How?** Lack of transport and other infrastructure (especially in rugged terrain) severely limits access to education, health care, clean water and food. Disasters and extreme weather decrease safety, resilience, and sustainability of people and settlements, especially the poorest and those living in slums and camps. Disasters/ and extreme weather drive economic loss through damage and destruction of housing and infrastructure, disruption of basic services, commerce and transport and accelerated/ unplanned urbanization due to displacement of affected people.	PNG plans to nearly double its national road network (from 8,700 to 15,000 km) over the next three years (Alamgir et al., 2019). With government support, the private sector could establish transportation and storage services and/or local commercial infrastructure in remote areas, negating the need for people to travel into towns. Human services need to be available where people live, rather than making them travel long distances. Allocating resources to amplify the role of churches in rural communities to address COVID-19, as churches operate in places where state agencies are not active (Kopel, 2020). Invest in public awareness for responsible citizenship, civil society engagement, and public-private collaboration on resilience action. Empower local authorities to manage risk and build resilience with regulations for risk management, building codes, and land use; then, support local authorities to enforce legislation and regs. Ensure integration of urban issues in the National Adaptation Plan and develop local DRR strategies. Ensure preparedness for emergency response/recovery from known hazards. Enhance local health provision to deal with specific hazards; enhance local access to basic health care services and safety-nets for post-disaster assistance for populations at risk, with particular attention to maternal and child health services.	What is the urbanization rate and projections on urban growth? How many people live in substandard housing or slum conditions? Is urban planning disaster and climate-risk sensitive? What are the recorded urban impacts of disasters and extreme weather? Which areas of the country are affected by disasters, at risk of seismic activity, or projected to be affected by climate change? What kind of settlements and cities are located in these areas? What kind of disaster and severe weather impacts have been reported in cities and urban areas of the country? What impacts have been recorded in slums, informal settlements and IDP/refugee camps? Is zoning, land use and building code regulations risk-sensitive and enforced? Are there protections on wetlands and waterways? Are urban health systems, water and electricity infrastructure, and road infrastructure built to seismic and climate-proof standards?	Risk-blind urbanization and industrialization can lead to habitat destruction, increase sediment and pollutant loads in waterways; and alter natural water flows, affecting ecosystem health and biodiversity. Urban encroachment on natural habitats increase risk of zoonotic diseases with potential for epidemic and pandemic impact. Unplanned and underserviced urban slums can affect vector and water borne diseases' prevalence and incidence.

SDG Goal, Target Aichi Target	Who might be left behind? [130] Why? How? How?	Opportunities, Enablers (current, future)	Knowledge gaps	Consequences if not addressed
SDG 12: Responsible consumption and production. **Aichi Target 4: Sustainable production and consumption.**	**Who?** Customary Landowners. **Why?** Place of residence; socio-economic status; governance. **How?** > 5 m ha customary land (~12% PNG's total land area) alienated through now suspended land-lease schemes 2003—2011 (World Resources Institute, 2013).	PNG's Sustainable development strategy (2014): To transform PNG's economic prospects for decades, the government will focus on the delivery of four new major mining projects (Wafi-Golpu, P'nyang, Papua LNG and Porgera) by September, 2020 (Tarawa, 2020); Round Table Sustainable Palm Oil (Filer et al., 2020; World Resources Institute, 2013). PNG Forestry Act 1991: This recognises customary ownership of PNG's forest resources. Allocates rights and responsibilities through Forest Management Agreements between customary landowners and government. Landholders sell cutting rights to PNGFA for timber royalties. PNGFA may then grant cutting rights to third parties. Most of PNG's forests are held by communities and clans (Filer et al., 2020; World Resources Institute, 2013). PNG's Constitution (Art 4): Stipulates that PNG's natural resources and environment will be conserved for benefit of all and repaired for the future. (Also involves: Illegal Logging Prohibition Act 2012; Illegal Logging Prohibition Regulation 2012.)	Lack of data to determine sustainability of different economic activities including non-renewable and subsistence agriculture/fishery sectors (Tarawa, 2020). Determining change in rainforest from all causes and separating the impartial interpretation of objective data from subjective reaction has affected this sector. Compliance within logging operations is poorly monitored and enforced.	Current lack of enforcement of legislation leads to illegal and unsustainable logging (World Resources Institute, 2013).

SDG Goal, Target Aichi Target	Who might be left behind? [130] Why? How? How?	Opportunities, Enablers (current, future)	Knowledge gaps	Consequences if not addressed
SDG 13.1 Strengthen resilience/ adaptive capacity to hazards and natural disasters. **SDG 13.2 Integrate climate change measures into national policies, strategies and planning.** **SDG 13.3 Improve education, awareness-raising, human and institutional capacity on climate change mitigation, adaptation, impact reduction and early warning.** **SDG 13.A Implement commitments to the UNFCCC to meaningful mitigation actions.** **SDG 13.B Promote mechanisms for raising capacity for effective climate change-related planning and management, including a focus on women, youth, local, and marginalized communities.**	**Who?** People living in areas prone to extreme weather events, other impacts of climate change. **Why?** Place of residence; governance; vulnerability to shocks. **How?** Disasters with massive societal impact, such as pandemics can potentially detract national or global attention and funding from climate adaptation. Torres Strait and South Fly District has been subjected to significant sea level rise (52 cm since the 1920s), and more frequent droughts and flooding (Reef and Rainforest Research Centre, 2019). PNG's largest macro-economic fishery (the northern EEZ tuna fishery) is under threat from rising global sea temperatures (Pilling et al., 2015).	Strengthen disaster risk modelling, risk assessment, mapping, and monitoring, including indigenous knowledge and climate services. Strengthen risk governance, early warning, financing strategies and adaptation activities addressing both natural hazards and slow-onset climate change impacts, including transboundary mechanisms. Strengthen national capacity for integrating/ensuring coherence between national DRR strategies and National Adaptation Plans, as well as coherence with water, forestry, agriculture and local planning.	Many PNG risk-exposed communities cannot adapt to climate change due to a lack of resources, capacity, knowledge, and institutional and policy support. Forecasting of weather patterns, disasters and extreme weather events is severely limited (UNDP, 2017). What are the disaster risks which – if realized – could potentially affect national capacity and political willingness to implement its climate change adaptation goals? Are climate change adaptation plans, policies and strategies informed by multi-hazard risk assessment including all types of hazards?	If climate change adaptation is not informed by risk assessment/ and analysis of the full range of natural, biological and technological hazards, critical interlinkages may remain unaddressed and risks unchecked. Fishing-dependent coastal dwellers have varying levels of adaptive capacity to future climate change (Maina et al., 2016), which is likely to be reduced if conservation effort is not strengthened.

SDG Goal, Target Aichi Target	Who might be left behind? [130] Why? How? How?	Opportunities, Enablers (current, future)	Knowledge gaps	Consequences if not addressed
SDG 14.2 By 2020, sustainably manage and protect marine and coastal ecosystems to avoid significant adverse impacts and take action to achieve healthy and productive oceans. **SDG 14.7 By 2030, increase economic benefits through sustainable management of fisheries, aquaculture and tourism.** **Aichi Target 6: Sustainable management of aquatic living resources.**	**Who?** 850,000 people in 4,000 rural and remote coastal communities. **Why?** Place of residence; governance; vulnerability to shocks. **How?** Climate change impacts pose huge challenges to marine and coastal ecosystem health, and biodiversity. In addition, disasters such as cyclones, chemical and pollution spills, can critically damage marine and coastal ecosystems. All adversely affect people who depend on marine and coastal resources for ecosystem services. Climate change impacts on coastal lands and islands include threats to ecosystem services; increased displacement and unmanaged human mobility, and loss of land to erosion or sea inundation, which can lead to loss of livelihoods and homes, community instability and forced displacement. Some coastal communities are facing more regular crop failure due to climate change; thus, their reliance on marine resources for food is increasing (Busilacchi et al., 2018; Butler et al., 2020). Bêche-de-mer fishery is boom bust – fishers often exceed TAC despite sound stock monitoring in many provinces. Illegal Fishing within PNGEEZ by SE Asia (Conservation and Environment Protection Authority, 2019). > 500,000 tonnes of fish extracted pa every year.	Opportunity across all fisheries to build on local customary management reinforced by formalised management plans and locally enforced penalties (Conservation and Environment Protection Authority, 2019). Blue car Include risk assessment, mapping and management into coastal plans. Establish mechanisms and incentives to ensure compliance with existing laws, regs and policies – e.g. NOP. Integrate nature-based solutions in National Adaptation Plans and DRR strategies, and protect natural hazard buffers such as coral reefs, sea grasses, sand dunes, mangroves and saltmarshes. Develop and maintain multi-sectoral rapid early warning, alert and response systems including communication.	What climate change impacts are projected in different coastal and marine areas? What natural hazards are different parts of the coastline and islands exposed to? Are there nearby shipping lanes or extractive installations which impact biodiversity and ecosystem health? What are sustainable levels of harvest for different targeted species? Not enough research to understand limits fish stocks (Department of National Planning and Monitoring, 2015a). Do coastal and island settlements have adequate contingency plans and early warning systems in place? Need to find innovative governance solutions to manage illegal take of marine products (Busilacchi et al., 2018).	The adaptive capacity of people to cope with impacts of climate change and natural disasters is reduced. New coastal tourism infrastructure can increase exposure of people, livelihood and assets to tsunami and cyclone risk. Expansion of aquaculture such as shrimp farming may compound climate change-related salinization, changing ecosystems. Offshore and coastal sand and gravel extraction result in coastal erosion, salt intrusion and lowered protection against extreme events. Depletion of fish stocks and other marine products due to overharvesting, illegal activities.

SDG Goal, Target Aichi Target	Who might be left behind? [130] Why? How? How?	Opportunities, Enablers (current, future)	Knowledge gaps	Consequences if not addressed
SDG 15.1 By 2020, ensure conservation, restoration and sustainable use of terrestrial ecosystems. **SDG 15.2 By 2020, implement sustainable forest management, halt deforestation, restore degraded forests increase afforestation and reforestation.** **SDG 15.3 By 2030, restore degraded land and soil.** **SDG 15.4 By 2030, ensure conservation of mountain ecosystems and biodiversity.** **Aichi Target 5: Habitat loss halved or reduced**	**Who?** Rural and remote communities. **Why?** Place of residence; governance. **How?** Climate change impacts on land include threats to ecosystem services; increased displacement and unmanaged human mobility; and loss of land to erosion or sea inundation, which can lead to loss of livelihoods and homes, community instability and forced displacement.	Opportunity to develop a logging plan to review and monitor forestry practices, including illegal logging and to evaluate impacts of logging on surrounding ecosystems and rural populations (Conservation and Environment Protection Authority, 2019). Regulate risk assessment, mapping, and management in rural development and land management. Research and implement nature-based solutions, including ecosystem protection, reforestation/ afforestation, and protective practices. Ensure integration of water and terrestrial management in local and national DRR strategies and National Adaptation Plans. Establish national and transboundary technological, drought and flood risk management, sand and dust storms monitoring and early warning systems.	What kind of climate change impacts are projected for terrestrial ecosystem and ecosystem services?	The adaptive capacity of people to cope with impacts of climate change and natural disasters is reduced. Poor land management and excessive logging (both legal and illegal) can adversely affect terrestrial ecosystem services and the benefits they provide to local residents.

13.5 Recent and current projects and programmes for those left behind

13.5.1 United Nations Projects of relevance

Building resilience to climate change in Papua New Guinea.

Objective: To increase resilience to the impacts of climate vulnerability and climate change and improve capacities of communities in vulnerable atolls and islands, government agencies, and civil society to plan and respond to climate change impacts.

Advancing Papua New Guinea's National Adaptation Plan.

Objective: To mainstream climate change into regulatory and policy frameworks to address climate change adaptation; to increase climate change adaptation awareness amongst key stakeholders at national and sub-national levels.

Strengthening Disaster Management in Papua New Guinea Project.

Objective: To better position Papua New Guinea to prepare for, and respond to natural hazards and disasters.

Community-based Forest and Coastal Conservation and Resource Management Project.

Objective: To develop an effective natural resource management and financing system for community conservation areas in the country.

Sustainable Financing of Papua New Guinea's Protected Area Network.

Objective: To reduce the funding gap for Papua New Guinea's protected areas in order to improve their management effectiveness, and livelihoods of their communal landowners.

Support to Rural Entrepreneurship, Investment and Trade in Papua New Guinea.

Objective: To increase sustainable and inclusive economic development of rural areas. This project will support investments in climate resilience and improved value chains by facilitating access to renewable energy technologies.

13.5.2 Current projects addressing vulnerability to shocks

Projects listed in other sections address vulnerability to shocks.

13.5.3 Current projects related to place of residence (geography)

Projects in protected areas, marine areas and other locations support those left behind.

Mangoro Market Meri (MMM) Program.

This is summarised from Busilacchi, S. (2019), 'Developing future-proof livelihoods through women-led participatory value chain analysis of mud crabs. Phase 1 Report.' [Unpublished draft report]. If taken collectively, the activities in this programme address several SDGs and Aichi targets – in particular those relating to poverty, health, gender equality, life on land, and life below water. Key points are as follows:

- Establish alternative markets.

  Long-term: Market the crabs from Milne Bay and Manus as 'MMM' certified products (to investigate) with Australia as target market

  Medium-term: Open a new market for the women in the communities in Milne Bay and Manus through the exporter Ocean Keris

  Short-term: Consolidate women's activities to connect with external markets, allowing a constant supply of crabs

- Community-based monitoring of environmental and social sustainability of MMM.

  Conduct mud crab stock assessments in the targeted areas. Facilitate training on participatory value chain mapping with a selected group of MMM women who can commit to the long-term to establish a long-term community-based monitoring programme. Household surveys can be used to monitor the sustainability of harvesting and trading practices through time. Carapace size is also a good indicator of the harvesting pressure at the scale of individual mangrove sites and can be used for a rapid assessment of the health of exploited crab populations.

  Identify and monitor social-economic issues arising from the operations and reassess the activities

- Develop and implement awareness, education and training programmes.

  Offer information on the ecology and biology of mud crabs – on mangroves' ecology using

appropriate means of communications. It will be important that MMM women realize the rationale behind the management of the crab fisheries/ trade and the conservation of mangroves. Awareness on the social and economic importance of the programme should also be raised within the communities so to involve not only women, but families as a whole, reducing thus the likelihood of unintended consequences Provide additional training of MMM women on community-based participatory value chain mapping and monitoring to ensure effective on-going monitoring and reporting of the programme.

Pawarim Komuniti – PNG Off-Grid Electrification Programme.

This Off-Grid Electrification Program is funded by the PNG-Australia Partnership to support access to clean energy in rural and remote PNG communities. The programme is part of Australia's commitment under the PNG Electrification Partnership to help PNG meet the target of connecting 70 percent of the country to electricity by 2030 (PNGAus Partnership, 2020). According to the World Bank (World Bank, 2019) PNG's widespread lack of electricity is a major cause of the nation's poverty. An off-grid electrification programme can enable those living in remote communities to improve food storage for their own consumption and for sale at the market.

13.6 Environment-related recommendations to ensure no one is left behind

13.6.1 Strengthen, resource and expand programmes to ensure no one is left behind

Projects such as the Mangoro Mangrove Meri, the Torres Strait Treaty Village programmes, and livelihood, health and education programmes in protected areas, all focus on community-driven planning and actions to improve the opportunities and living conditions of those in the poorest of situations. At the same time, these programmes deliver environmental benefits. Opportunities for women are often profiled. Such programmes should be a priority for support – especially where there have already been successes. In many cases, the best use of resources is to move from numerous trials to much wider implementation, so a real difference can be seen. After more than 30 years of experience in implementing such programmes, many lessons can be drawn on to increase the chance of success. The most critical is that long-term inputs, based on establishing permanent programmes, are critical, rather than short-term projects based on temporary grants or international agency priorities or budget cycles.

Starting or staying very small is not always the best approach. In the Torres Strait Treaty Village Ranger programme, it was found that building a critical mass of rangers and activities elevated the programme's profile, enhanced the community's appreciation of the programme, and encouraged local governments to also take a role (David Rutherford, personal communication).

13.6.2 Ensure those left behind are not subject to further environmental harm

Unfortunately, those most harmed through environmental disasters from pollution and land clearing are often those with little voice or power. For people without reserves of money or qualifications, their land and water are their only source of subsistence. As discussed in other sections, industry needs to ensure there is a fair and comprehensive process for assessing and compensating loss and damage. It is critical that women are given a say in deciding their own futures, as loss of land can affect them most severely and directly. Many further recommendations in other chapters are also designed to benefit those most left behind.

Chapter 14.

Synthesis and conclusions

In this chapter, we review the findings from each of the topics explored during this study, summarise the environmental threats and the suggested mechanisms for improvement, and draw conclusions.


UN
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14.1 Threats and risks to Papua New Guinea's environment

Direct threats to biodiversity and natural resource management in Papua New Guinea have been reviewed in Chapter 3 and discussed throughout the report. This section summarises the extent of the risks using a standard threat classification. A standard classification of threats was developed by the Conservation Measures Partnership in association with IUCN and major conservation NGOs. This classification provides a platform for common reporting on threats, by using a common terminology to describe broad and then more specific types of threat (Conservation Measures Partnership, 2016; Salafsky et al., 2008). This classification has been widely used across the world, for example in the IUCN Red List (IUCN, 2020) and in the protected area Management Effectiveness Tracking Tool (Stolton and Dudley, 2016).

A risk analysis was conducted using this classification scheme, based on an assessment of known threats, consequences, likelihood and vulnerability (L. Allen et al., 2020). The results are summarised in Appendix One. A rigorous quantitative analysis of the likelihood and consequences of the identified threats to environmental quality and sustainability was beyond the scope of this consultancy.

This analysis concurs with other studies that the most serious threats of highest risk to PNG's environment include:

- Habitat loss, degradation and deforestation, from logging, land-use changes, infrastructure development and expanding gardens and settlements. New dams may also result in forest clearing;
- Climate change, which causes direct harm and also exacerbates many other threats;
- Unsustainable hunting, fishing and forestry practices;
- Pollution and sedimentation, including from extractive industries; and
- Invasive species.

All of these threats pose risks to the health and well-being of PNG's people as well as to the environment. In addition, people live with the risk to life and livelihood of volcanic eruptions, earthquakes, tsunamis, landslides, flood and drought (See Chapter 12 and Chapter 13).

14.2 Understanding context and causes

Throughout this analysis, chains of environmental and social context (including root causes, threats and impacts) have been considered for each topic. Of critical importance to all topics is an understanding of PNG's system of customary land tenure ownership; the ways in which this is being challenged by development pressures, the administrative systems, and growing populations, and the implications of changes in land use for the environment and people – especially those left behind (Fletcher and Mousseau, 2019; Karigawa, 2018).

Issues associated with the environmental impacts of forestry, mining and gas extraction, and other sources of pollution, relate largely to under-developed regulatory systems, and stem from the economic importance of extractive industries to PNG's gross domestic product. Clearing and unsustainable forestry activities have had serious impacts on environmental services and biodiversity. Pollution from mining operations has major, long-term environmental and social impacts, which are well documented. The environmental impacts of gas extraction primarily relate to greenhouse gas emissions and any indirect impact from expanding infrastructure networks.

PNG's regulatory agencies are under-resourced and depend on companies providing monitoring reports. Independent compliance checking and enforcement activities do not occur in a systematic and comprehensive way. There is no requirement for reporting to be made publicly available, except for companies with financial backers who have signed up to international standards such as the Equator Principles (Equator Principles, n.d.). There is no financing assurance framework in place to guarantee rehabilitation of impacted sites.

Population growth remains another key driver to environmental threats. The vast majority of PNG's people lead a largely subsistence lifestyle. With much lower population levels earlier last century, this was a sustainable way of life. Hunting and gathering, fishing and shifting agriculture, with little waste, enabled people to harvest and use the environment's abundance of resources without depleting them. However in many parts of the country, an increase in population coupled with the need for cash income has pushed these systems beyond their capacity.

Threats and underlying causes are summarised overall in Figure 64. To interpret this figure:

- The PNG context and root causes are shown in white boxes. These are grouped into governance issues, geography, social context and changing climate;
- Blue arrows connect these with the intermediate causes (yellow boxes), many of which are interconnected and influence each other (these interconnecting influences are also indicated with blue arrows;
- Orange arrows connect these with direct threats (pink boxes) and impacts (orange boxes);
- Green boxes are positive features resulting from the social and geographical context; and
- Green stars are proposed key intervention points in environmental management.

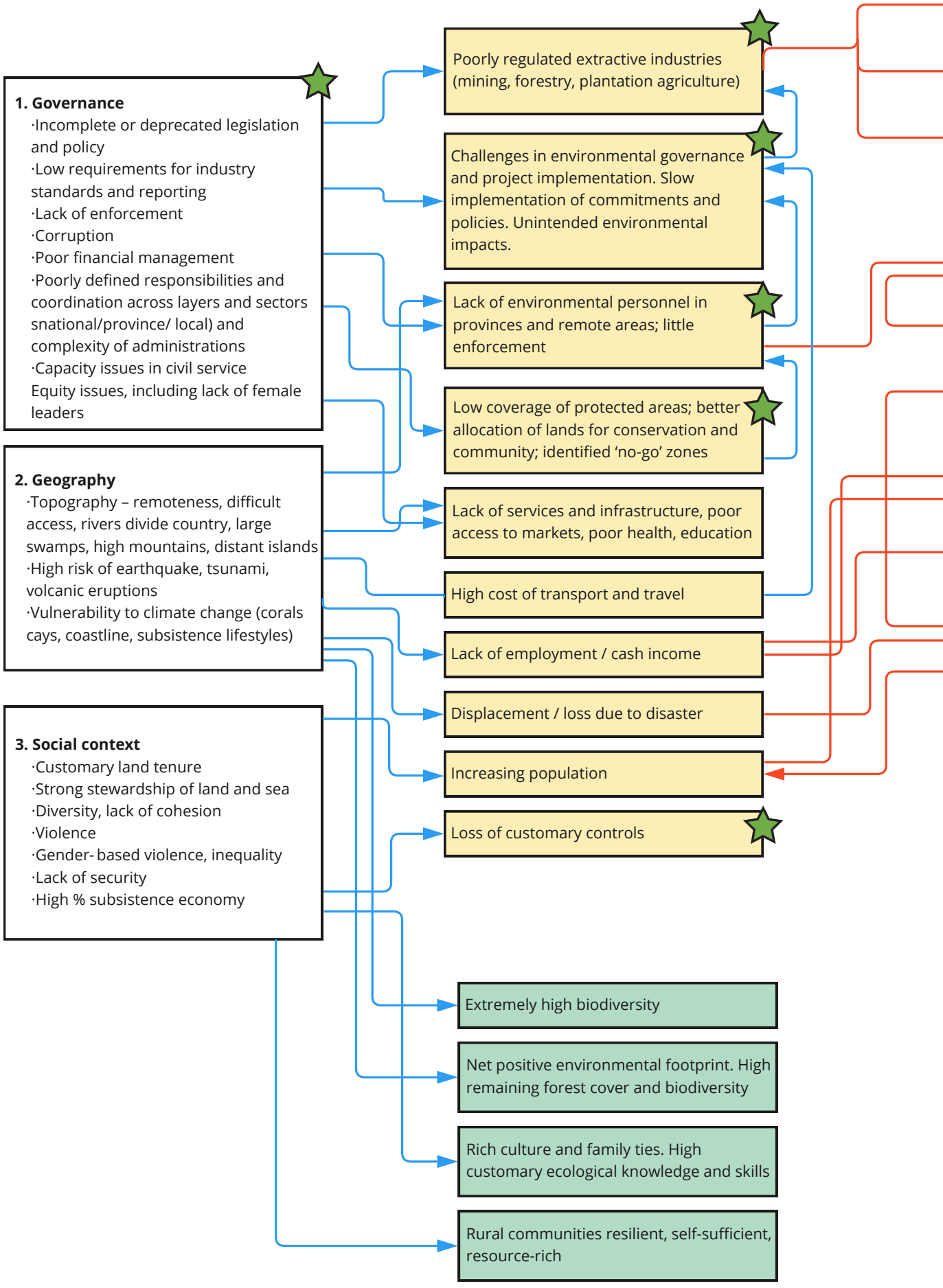
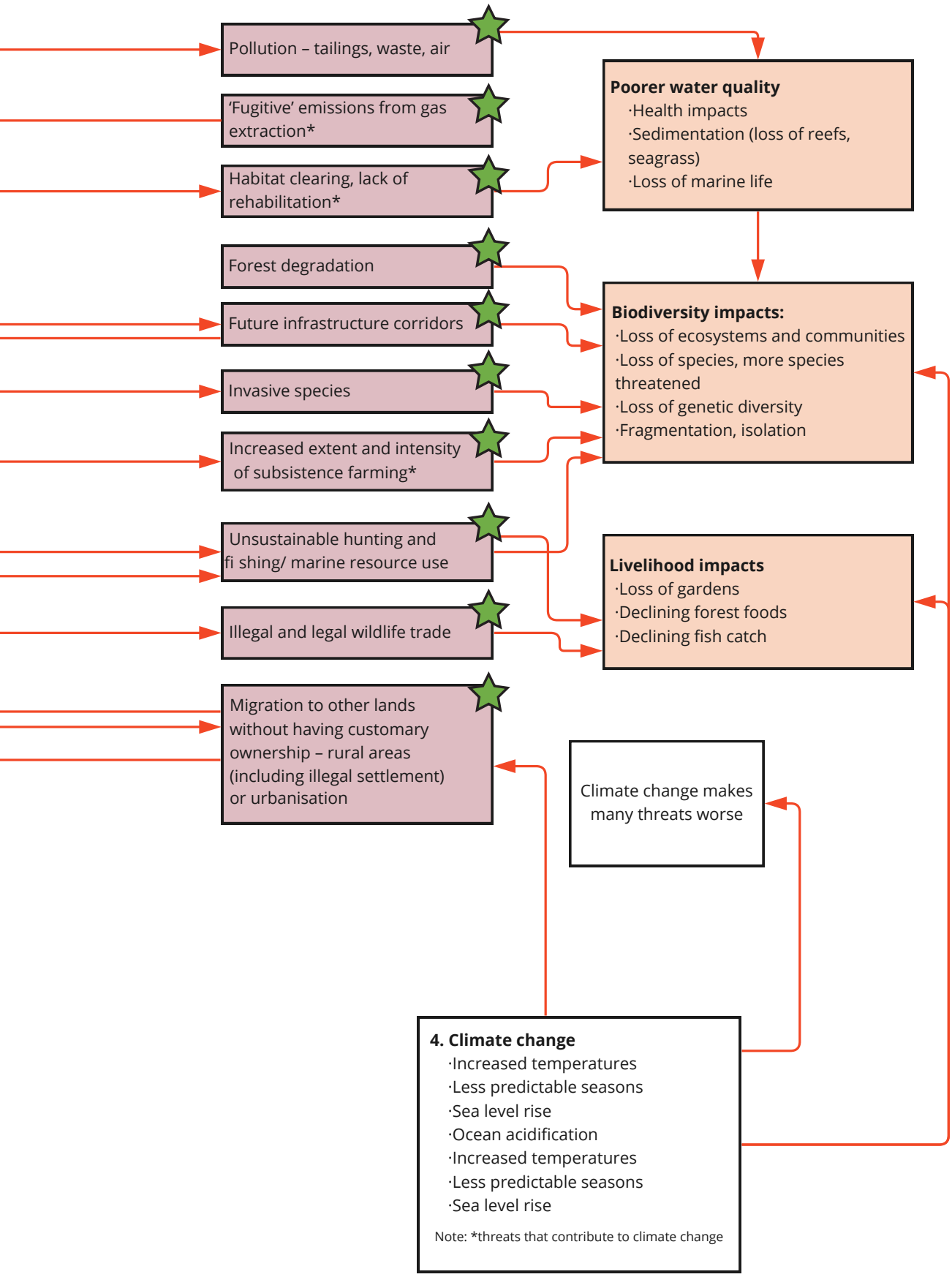


Figure 64: Chain of context, causes, threats and impacts


Pollution – tailings, waste, air
'Fugitive' emissions from gas extraction*
Habitat clearing, lack of rehabilitation*
Forest degradation
Future infrastructure corridors
Invasive species
Increased extent and intensity of subsistence farming*
Unsustainable hunting and fi shing/ marine resource use
Illegal and legal wildlife trade
Migration to other lands without having customary ownership – rural areas (including illegal settlement) or urbanisation
Poorer water quality
·Health impacts
·Sedimentation (loss of reefs, seagrass)
·Loss of marine life
Biodiversity impacts:
·Loss of ecosystems and communities
·Loss of species, more species threatened
·Loss of genetic diversity
·Fragmentation, isolation
Livelihood impacts
·Loss of gardens
·Declining forest foods
·Declining fish catch
Climate change makes many threats worse
4. Climate change
·Increased temperatures
·Less predictable seasons
·Sea level rise
·Ocean acidification
·Increased temperatures
·Less predictable seasons
·Sea level rise
Note: *threats that contribute to climate change

14.3 Progress and current projects

After reviewing progress and current projects for each topic, key gaps and challenges that emerge as common themes include:

- The disconnect between policies and stated intentions, and what is happening on the ground and water;
- Lack of implementation of most policies into ground-level action;
- The need for long-term commitments and continuing programmes, rather than short-term projects;
- The high level of resourcing needed to undertake field work in more remote areas; and
- Challenges in working with governance, especially where there is corruption, lack of capacity, and poor corporate behaviour.

One of the challenges is summarised in a recent report: "Conservationists in PNG must learn to appreciate that they are fighting a long history of extraction and they are battling entire economic sectors. The sectors are made up of multi-million-dollar industries that include tens of thousands of jobs and many stakeholders with a lot to gain. The industries are entrenched in the global economy and institutionalised in national government policies and regulations" (Crane, 2015, p. 56).

14.4 Mechanisms for improvement and ways forward

The following mechanisms are extracted from the whole report, representing a compilation of priority actions for better environmental management in PNG. Many of the proposed actions require government agencies to take the lead, but development partners can support and assist, and can further promote policies and actions that contribute to achieving the SDGs. Not all of the proposed mechanisms will be appropriate for development partners to undertake or support. The key SDGs affected by each of the actions are also indicated.

- Mechanisms have been grouped into the following headings:
- Good environmental legislation and governance;
- Stronger environmental regulation of industry, and enforcement of conditions;
- Wise allocation of land and water;
- Real capacity where it is needed;
- Compensation, incentives and innovation for conservation;
- Responsive and thoughtful actions; and
- Partnerships, awareness and cooperation.

14.4.1 Support improved environmental legislation and governance

While there is a solid legislative and policy background for many aspects of environmental management, some important gaps remain.

Mechanisms for improvement	Theme/s and link	SDGs affected
Review the Environment Act 2000 and strengthen where necessary.	Mining (impact assessment) 11.6.1 Water waste and pollution	8, 12, 13, 15, 16, 17
Require more comprehensive and accurate environmental impact assessments and conditions for all developments (under the Environment Act 2000). Apply avoid/ mitigate/ offset hierarchy.	Biodiversity 4.8.1 Marine conservation Forestry Mining and gas 11.6.1	14, 15, 16, 17
Review and replace the Fauna (Protection and Control) Act 1966.	Biodiversity 4.8.1 Marine	14, 15, 16
Finalise and implement the National Biodiversity Strategy and Action Plan.	Biodiversity 4.8.1 Marine	2, 14, 15, 16, 17
Finalise participation in the Nagoya protocol and legislation and/or policies addressing genetic property rights and access benefit sharing agreements.	Biodiversity 4.8.1	2, 14, 15 16, 17
Include biodiversity values in national and subnational accounting, to reduce the perverse incentives currently applying to development.	Biodiversity 4.8.1	8, 14, 15, 16, 17

Mechanisms for improvement	Theme/s and link	SDGs affected
Finalise and implement the draft offsets policy, with emphasis on avoidance and mitigation of damage wherever possible, followed by appropriate offsets. Pass necessary legislation to give effect to the policy as quickly as possible.	Biodiversity 4.8.1 Mining and gas Pollution and waste Marine conservation Forestry Protected areas	12, 14, 15, 16, 17
Finalise and implement the Protected Areas Bill.	Protected areas Marine Conservation	14, 15, 16, 17
Finalise the review of the Forestry Act 1992 to harmonise with the National REDD+ Strategy 2017—2027. Ensure contemporary allocation and planning of resources are undertaken.	Forestry 6.7.3	12, 13, 15,17
Improve governance of the forestryof forestry industry to strengthen forest legality and effective participation of stakeholders.	Forestry 6.7.3	8, 12, 13, 15, 16, 17
Integrate provincial and local level planning and implementation for WaSH and waste management wherever appropriate, rather than having two different programs of work targeting similar levels of government and target audiences. Wherever possible, strengthen links with other programs including disaster management and climate change adaptation.	Pollution and waste 10.7.1	3, 6, 12, 11, 9, 10, 14, 15, ,16, 17
Legislate to control the import and use of certain substances, to reduce production of non-recyclable waste.	Water, waste and pollution 10.7.5	
Review the Mining Act 1992 and related legislation	Mining 11.6.1	
Address the gap in legislative and regulatory provisions concerning the approval of deep-seabed mining, including effective impact assessment.	Mining 11.6.1	
Consider placing a moratorium on deep-seabed mining until the regulatory environment is in place and there is a better understanding of potential impacts on the environment and the communities that rely on ocean resources.	Mining 11.6.1	
Review the regulation of alluvial mining; consider increased regulation by provincial, district or LLGs as a means to enhance its sustainability; improve access to training to support more environmentally sustainable approaches.	Mining 11.6.1	
Strengthen legislation, policy and guidelines related to sand mining and ensure effective monitoring and enforcement standards for this sector.	Mining 11.6.1	
Increase transparency by introducing a requirement that all mining company annual environmental reports are made publicly available, in a format that allows them to be readily assessed	Mining and gas 11.6.1	8, 9, 16, 17
Increase the transparency in relation to revenue flows from companies to government, various landowners' trust funds, associations and provincial governments.	Mining, oil and gas 11.6.1	1,
Develop and/or amend legislation to require tailings and other mining waste for all new mines to be contained and managed, rather than dispersed to the environment.	Mining 11.6.2	
Further integrate local disaster resilience planning with climate change resilience and other well-being programs.	Disaster management 12.8.1 Climate change	All goals
Complete and implement the National Adaptation Plan for climate change adaptation, with sectoral and provincial adaptationsadaptions	Climate change 7.6.3	13, all others

Mechanisms for improvement	Theme/s and link	SDGs affected
Underpin the LUP process with a focus on respect for customary landowners' rights	Land use planning 9.8.1	1, 2, 3, 5, 10, 11, 15, 16
Strengthen women's land rights and consult and fully engage with women	Land use planning 9.8.3	1, 3, 5, 8, 10, 11, 13, 15, 16
Develop 'fit for purpose' systems for land registration, administration of land tenure and LUP	Land use planning 9.8.4	1, 2, 3, 4, 5, 6, 7, 8, 11, 14, 15, 16, 17
Use bottom-up processes and data to inform LUP and decision making	Land use planning 9.8.8	5, 10, 11, 16, 17
Address conflicting perspectives in land use planning through collaborative processes	Land use planning 9.8.9	5, 10, 11, 12, 16, 17
Upscale effective pilot land use planning cases at the local level to LLG and provincial scales	Land use planning 9.8.10	11, 16, 17
Develop effective data storage and usage systems related to land and use rights	Land use planning 9.8.11	5, 10, 11, 16, 17
Legislate a requirement for response plans for all activities with the potential to cause environmental disasters, either through malfunction or as a result of natural disasters. These plan and response preparedness should include mines and gas pipelines, dams, factories, and transport and shipping activities, especially where oil or toxic material are being transported. Companies responsible for any environmental disaster should be legally obliged to pay the clean-up and appropriate compensation.	Disaster management 12.8.4	
Update and enforce building codes with most recent knowledge.	Disaster management 12.8.2	

14.4.2 Urge and support stronger environmental regulation of industry, and enforcement of conditions

A major issue with all extractive industries is that environmental regulations and standards are not met or enforced.

Mechanisms for improvement	Theme/s and link	SDGs affected
Strengthen timber legality through improved monitoring and surveillance of logging practices	Forestry 6.7.1	8,9,16
Require industry to take responsibility for future settlements (including new developments) for people attracted to and displaced by their activities, as part of 'cradle to grave' impact assessment.	Mining and gas 11.6.4 Forestry	1,3,6, 14, 15, 16,17
Finalise details and implement the ban on 'round log' exports and review all timber concessions.	Forestry 6.7.4	1, 8, 9, 15
Update policy and information on small-scale (>500m3) level forestry.	Forestry 6.7.7	
Implement mitigation actions for the transport sector identified in the Revised Nationally Determined Contribution (NDC).	Climate change 7.6.2 Pollution	
Reduce emissions from the Agriculture Sector through improved agricultural practices as identified in the Revised Nationally Determined Contribution and AFOLU roadmap.	Climate change 7.6.2 Pollution	1, 2, 3, 8,15,16,17
Reduce emissions in the Industrial Process and Product Use and Waste sectors by implementing actions identified in the Revised NDC, including creating a node of industrial sustainability that minimizes waste, enhances inter-industry cooperation, and more effectively and efficiently utilizes local resources.	Climate change 7.6.2 Pollution	3, 8, 9,14,15
Reduce emissions from LULUCF sector including effectively implementing the national REDD+ Strategy 2017—2027 and reducing the impacts of commercial logging, subsistence agriculture and oil palm plantations	Climate change 7.6.2 Forestry 6.4.1 Pollution	1, 2, 3, 8,15,16,17

Mechanisms for improvement	Theme/s and link	SDGs affected
Secure funding to transition to 100% power generation from renewable sources by 2050 through actions identified in the Revised NDC and the Energy Sector Roadmap. Accelerate implementation of energy efficiency initiatives, including through off-grid mechanisms. Require the oil and gas sector to reduce their overall emissions.	Climate change 7.6.2 Pollution Mining and gas	1, 3, 7,13
Build on and accommodate informal and semi-formal settlement arrangements in land reform	Land use planning 9.8.2, 9.8.7	1, 2, 3, 5, 6, 7, 10, 11, 13, 15, 16
Review, develop and update relevant land use planning legislation, policy and plans	Land use planning 9.8.5	5, 10, 11, 13, 15, 16, 17
Address corruption in dealings with land	Land use planning 9.8.6	8, 10, 16, 17
Apply (including retrospectively) a system for mine closure and site remediation including setting standards and calculating costs for setting bonds.	Mining and gas 11.6.1	3, 6, 8, 14, 15
Require tailings and other mining waste to be contained and managed rather than dispersed to the environment for all new mines and extensions of existing mines.	Mining and gas 11.6.1	3, 6, 9, 11, 12, 14, 15, 16
Require the mineral and gas industry to reduce and offset their greenhouse gas emissions.	Mining and gas 11.6.1	8, 9, 12, 14, 15, 16, 17
Ensure monitoring and compliance activities are undertaken by CEPA independent of funding from extractive companies. Consider using a third party 'assessor' to report on the environmental activities of mining companies and government, analogous to, or as part of the EITI program.	Mining and gas 11.6.3	8, 9, 16, 17
Monitor and enforce legislation and environmental conditions in existing mining approvals. Ensure implementation of periodic monitoring and reporting as per the environment permit and address all breaches. If the discharge to the environment is severe, impose a ban on the current discharge method and implement more effective methods.	Mining and gas 11.6.3	1, 3, 6, 9, 11, 12, 14, 15, 16
Ensure extractive industries such as mining, gas production, agriculture and forestry, as well as all infrastructure developers (pipelines, electricity, roads) embed good environmental engineering practices to avoid catalysing environmental impacts, such as large-scale sediment and rainfall runoff, landslides, and dam failures.	Disaster management 12.8.4	
Ensure 'those left behind' are not subject to further environmental harm through any development activity.	Those left behind 13.6.2	1, 2, 3, 5, 6, 7,11,16

14.4.3 Promote wise allocation of land and sea for conservation and sustainable use

Mechanisms for improvement	Theme/s and link	SDGs affected
Implement the National Sustainable Land Use Policy and ensure biodiversity is fully considered.	All topics	1,2,3,11,15,17
Define land and waters that are protected from major large-scale development projects, and ensure some form of legal protection in land use plans.	Biodiversity 4.8.2 Protected Areas Marine conservation Forestry Mining and gas	14, 15
Expand protected area network according to the Policy on Protected Areas. Provide regular updates of maps and of statistics including ecological representation.	Protected areas 5.9.3	14,15, 17

Mechanisms for improvement	Theme/s and link	SDGs affected
Progress World Heritage Area proposals.	Protected areas 5.9.3	14,15
Foster useful and relevant protected area management planning.	Protected areas 5.9.8	14,15
Establish and manage marine-protected areas.	Marine conservation 8.8hhhh`	14, 17
Plan for new urban areas and semi-rural settlements to cater for internal migrants.	All	1,2,3,11
Protect priority forests through appropriate conservation measures.	Forestry 6.7.6 Protected areas	14
Support local-level land use dispute resolution and planning.	All topics	11,16
Unsure there is no clearing of mangroves and other shoreline/ coastal vegetation that dampen the impact of cyclones, storm surges and cyclones. Ensure further development (including industrial and urban development) is not permitted in areas projected to be affected by sea level rise, minimising development of infrastructure in areas most vulnerable to disasters.	Disaster management 12.8.4, Climate change 7.6.3	
Use the best possible environmental and social standards in all reconstruction efforts, including green energy, accessible and safe sanitation facilities, and sustainable water use.	Disaster management 12.8.4, Climate change 7.6.3	
Implement strategies for waste management in disaster incidents to minimise long-term environmental impacts.	Disaster management 12.8.4, Climate change 7.6.3	

14.4.4Help build real capacity where it is needed

PNG's highly devolved model of environmental management means that capacity is needed at a number of levels: national government, provincial and local-level governments, community-based organizations and within local communities, as well as academic institutions and private enterprise.

Mechanisms for improvement	Theme/s and link	SDGs affected
Find ways to ensure communities have a full understanding of the implications of proposals (and their likely expansion) in order to provide or deny free, prior and informed consent. Ensure women as well as men are involved	Forestry 6.7.5 Mining 11.6.4	14,15,16, 17
Employ and support biodiversity staff at national and provincial level. Ensure high degree of transparency, accountability and anti-corruption measures for jobs related to aspects such as environmental approvals, forest operations and wildlife trade	Biodiversity 4.8.3 Protected areas Marine conservation	8,14, 15, 16
Support biodiversity research especially PNG-based organisations and researchers. Consider a formal system to mentor and support environmental scientists.	Biodiversity 4.8.3 4.8.7 Protected areas Marine conservation	4,14, 15,
Resource CEPA's protected area agency (SEP wing) and provincial governments for protected area management.	Protected areas 5.9.4 Marine Conservation	14, 15, 16
Support environmental efforts of civil society, especially PNG's national NGOs and CBOs that work for environmental and social benefits.	Biodiversity 4.8.4 All topics	1,2,3,4,5,6,7,8,11,14, 15,16,17
Improve capacity for on-ground (and water) management through protected area management committees.	Protected areas 5.9.5 Marine Conservation Vulnerability to disaster Those left behind	1, 11, 14, 15,16

Mechanisms for improvement	Theme/s and link	SDGs affected
Build capacity of field staff in protected area management through additional employment , resourcing and training opportunities. Support to develop network of a national Ranger network with community and protected area Rangers to undertake a range of tasks in rural areas, which could include enforcement of PA and biodiversity laws, invasive species control, maintenance of community and tourist facilities, environmental education and monitoring, and maintaining clean water and waste systems.	Protected areas 5.9.7 Biodiversity Marine Conservation Water, waste and pollution 10.7.3 Vulnerability to disaster Those left behind	1, 2,3,4,5,6,7,8,11,14, 15,16,17
Support and provide on-going capacity to support the National Forest Monitoring System and National Forest Inventory.	Forestry 6.7.2	15
Support development and maintenance of data and reporting of emissions and climate change actions to meet required verification standards and drive progress	Climate change 7.6.1 Pollution	13, 15
Build capacity in water systems, waste management and recycling, including through 'train-the-trainer' networks in remote areas	Water, waste and pollution 10.7.1, 10.7.3 Marine Conservation	1, 3, 6, 11, 12, 14, 15
Reinstate and improve a functional network of water monitoring stations with appropriate human resources	Water, waste and pollution 10.7.4	
Ensure CEPA undertakes monitoring and compliance activities that are independent of mining companies.	Mining Error! Reference source not found. Water, waste and pollution	11, 14,15,16
Consider a third party 'assessor', which is empowered to report on the environmental activities of mining companies and government, and to follow through on commitments to communities and customary landowners.	Mining Error! Reference source not found. Water, waste and pollution	1, 11, 14,15,16
Develop teams of capable responders at local-level.	Vulnerability to disaster 12.8.5	1, 2,3,17

14.4.5 Promote compensation, incentives and innovation for conservation

Consideration of community well-being and livelihoods cannot be ignored in environmental programmes, and need to be integrated into all plans and activities from the outset.

Mechanisms for improvement	Theme/s and link	SDGs affected
Payment for and consideration of ecosystem services, benefit sharing agreements and livelihoods, including: ▸ Payment for Ecosystem Services (PES); ▸ Incorporation of ecosystem services into national and subnational accounting; ▸ Livelihood projects; ▸ Ecotourism and research payments; ▸ Benefit sharing agreements.	Biodiversity 4.8.8 Protected areas 5.9.6 Marine conservation	1, 2, 5, 14, 15
Improve livelihoods for coastal residents	Marine conservation 8.8.4	1, 2, 5, 13, 15
Support marine and coastal tourism.	Marine conservation 8.8.6	1, 2, 5, 8, 13, 15
Respect and support tradition, tambu systems and local practices for conservation	Marine conservation 8.3.4	14
Implement programs to reach WaSH targets.	Water, waste and pollution 10.7.2	6, 11, 14,15
Assist customary landowners and affected communities including women and children to understand the full ramifications of proposed development (free, prior and informed consent).	Mining and gas 11.6.4 Forestry Protected areas	4,5,16
Enforce on-time compensation with fair distribution to those affected.	Mining and gas 11.6.4 Forestry	1, 16

Mechanisms for improvement	Theme/s and link	SDGs affected
Plan for future migration and increased mobility into rural and urban areas, likely to result from mining and gas exploration and extraction, forest operations, other industry, natural disasters and climate-change related issues such as sea level rise.	Mining and gas 11.6.4 Forestry Climate change Vulnerability to disasters	1, 2, 3, 6, 11, 14, 15, 16
Strengthen, resource and expand programs that address both 'those left behind' and environmental matters.	Those left behind 13.6.1 Biodiversity Protected areas	1, 2, 3, 4, 5, 6, 11, 14, 15, 16

14.4.6 Support responsive and thoughtful actions, with faster response times

It is imperative that plans are implemented in the field, with an increased emphasis on moving from 'trial' stages to broader application. Support for PNG's local community-based organizations is often an effective and efficient method of implementation.

Mechanisms for improvement	Theme/s and link	SDGs affected
Address invasive species in PNG, including environmental pests.	Biodiversity 4.8.6 Protected areas	1,2,14,15
Captive breeding and reintroductions where needed (last resort).	Biodiversity 4.8.10	14,15
Manage species sustainably, with species management plans if needed.	Biodiversity 4.8.7 Protected areas	1, 2, 14, 15, 16
Increase plantations and reforestation	Forestry 6.7.8	15
Continue and expand climate adaptation planning and implementation in all sectors and all parts of the country	Climate change 7.6.3	13
Implement a program of marine species conservation	Marine 8.8.2	14
Further explore and expand a range of 'blue carbon' and blue economy programs	Marine 8.8.3	13, 14
Continue to support and expand programs that contribute to both environmental protection and well-being.	Those left behind 13.6.1	All goals

14.4.7 Build partnerships, awareness and cooperation in environmental management and disaster management

Better outcomes can be achieved with a higher level of cooperation. Increased environmental awareness and understanding is needed at all levels, from senior executives to local communities.

Mechanisms for improvement	Theme/s and link	SDGs affected
Support tradition, tambu systems and local practices for sustainable management.	Biodiversity 4.8.9	1, 2, 14, 15
Improve and coordinate efforts to control invasive species.	Biodiversity 4.8.6	1, 2, 14, 15
Increase wildlife conservation awareness programs.	Biodiversity 4.8.5	2, 4, 14, 15
Enhance partnerships in protected area management.	Protected areas 5.9.2	14, 15, 17
Develop partnerships to support sustainable fisheries.	Marine conservation 8.8.5	14, 17
Engage with, and build the capacity of, customary landowners to negotiate with forestry, mining and other interests.	Forestry 6.7.5 Mining and gas	1, 5, 10, 11,15, 16, 17
Improve processes for identification of landowners who are beneficiaries of projects (mining, oil and gas projects, forestry) (i.e. through more detailed social mapping and landowner identification studies).	Mining 11.6.4	

Mechanisms for improvement	Theme/s and link	SDGs affected
Ensure that women as well as men are involved at all stages of project development (e.g. forestry and mine exploration, approval and closure). This includes effective engagement in discussions about benefit sharing arrangements, with the option that women are enabled to negotiate a separate benefits package, if required, and to be trustees of development funds to ensure that they receive a fair share of the benefits. Reporting on this engagement should be part of the mining approvals' processes.	Mining 11.6.4 Forestry	
Facilitate customary landowners' access to the PNG Ombudsman Commission, which can investigate complaints about government, the conduct of government officials and broad areas of public interest in relation to the mining, oil and gas industry and assist in dispute resolution.	Mining 11.6.4 Forestry	
Continue and increase coordination and communication in disaster risk management and in resilience strengthening. Continue support for the Disaster Management Team.	Disaster management 12.8.3	

14.5 Conclusions

As discussed throughout this report, the issue of 'policy dissonance' is a major problem in PNG as in many countries. It is very positive that PNG has so many policies and strategies that actively seek a 'green growth paradigm' (Department of National Planning and Monitoring, 2015a), support climate change action and commit to protected areas and marine conservation, but these aspirations are not yet fully considered in extractive activities, or in planning for future production and infrastructure development.

It is very challenging for development partners to support PNG in its development goals, while keeping sight of the urgent and important imperatives to reduce greenhouse emissions, protect biodiversity and make sure that the growth is ecologically sustainable, and delivers benefits to those most left behind. Hopefully a strong partnership approach and the breaking down of barriers between agencies can assist PNG's path toward sustainability goals. In particular, all agencies need to be highly aware of the potential negative environmental and social consequences of important development initiatives, especially:

- Habitat loss and fragmentation, such as through new dams in forested country, and linear infrastructure that divides forest into segments;
- Disruption of community dynamics and traditional ecological knowledge of customary landowners;
- Opening of avenues for unsustainable or illegal hunting and wildlife trade;
- Introduction of invasive plants, animals and pathogens, and the potential for wildlife diseases to affect humans; and
- The greater negative consequences of land alienation for women, girls and older people.

This review concludes that in the five years to 2022, the PNG Government and community, with the support of development partners including the UN, has made substantial progress in some areas including:

- Policy development, commitments, monitoring, reporting and adaptation plans in relation to climate change and forest loss
- Reduction in the rate of forest clearing and degradation
- Development of protected area plans, sustainable finance models, communication and training
- Increased transparency in reporting by extractive industry
- Increased government commitment to a higher level of environmental and social responsibility by extractive industry, including foreign companies.

However, limited progress has been observed in relation to matters such as:

- Proportion of people with access to clean water and sanitation
- Establishment and effective management of a representative protected area network on land and sea
- Sustainability of resource use including hunting, fishing and subsistence farming
- Status of biodiversity
- Reduction in greenhouse emissions from the energy and waste sectors.

Key strengths, weaknesses, challenges and opportunities in environmental management are summarised in Table 68.

Table 68: Strengths, weaknesses, challenges and opportunities in PNG's environmental management

Strengths	Weaknesses
► National and international commitments to sustainable development, climate change mitigation and adaptation, and conservation of biodiversity ► High level of remaining natural vegetation, land and sea ► Continuing good functioning of many ecological services ► Extremely high biodiversity values, including genetic material ► Rich and diverse culture and traditional ecological knowledge ► Many highly committed people in government and at local level ► Most land in customary ownership, and high level of stewardship commitment ► Commitments by current government to address governance issues ► Many international agencies willing to assist with funds and resources ► First objective and comprehensive State of Environment Report prepared (2020) ► PNG CBOs and NGO with a lot of promise in addressing both environmental and social issues ► Progress in preparing for REDD+ and reduction in forest clearing and degradation rates ► Strengthened transparency requirements implemented for extractive industries ► Commitments to end forest loss by 2030 and export of round logs by 2025	► Poor governance, especially relating to accountability, corruption and slow and opaque government functioning ► Unclear division or responsibilities with multiple levels of government, difficult system within which to work and achieve change ► Delegation of environmental responsibilities to provincial level is not matched by resources. Too many provinces to develop adequate capacity in environmental management ► Lack of current and effective legislation in environmental protection biodiversity conservation, protected area management and forestry ► Lack of good practical land-use planning and allocation to determine best locations for developments, infrastructure and conservation investments ► Very low coverage of formal protected areas both terrestrial and marine ► Weak involvement of women in most public spheres ► Weak environment impact and enforcement of rules and conditions ► Legacy of existing approvals for mining and logging operations, which may not have adequate environmental and social conditions.

Challenges, conundrums and threats	Opportunities
► High level of environmental threats especially climate change, forest clearing and the legacy of poorly managed extractive industries ► Disconnect between PNG policies and intention and actual outcomes ► Lack of accountability and demonstrated duty of care by some international companies relating to mining, land clearing and agriculture ► Challenges in determining customary landowners and other rightsholders ► Lack of security and violence with implications for field work and progress of all kinds ► High level of threat of gender-based violence with implications for involvement of women in environmental work ► Lack of gender equity and opportunities for women and people living with disabilities ► Geographical features and poor infrastructure and services in rural areas, leading to difficult market access, huge field costs ► Unplanned migration and urbanization ► Planned roads and other infrastructure not taking environmental considerations into account	► Opportunity to 'do development right' with green infrastructure, power and industry, given the low levels of development in much of the country ► Development of Biodiversity and Climate Fund ► Potential for environmental jobs to lead appropriate development efforts, e.g., community environmental rangers, tour guides, environmental scientists ► Modern technology supports more distributed development of power and communication services ► Opportunities for payments of conservation stewardship and ecosystem services ► Potential for tourism and research in natural areas (dependent on security and infrastructure) ► Potential for excellent reserve systems including community-based management ► Genetic diversity of important crop species has potential for high-value agriculture. ► Potential establishment of sustainable blue enterprises

Chapter 15.
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Attachment one: Threat ratings for PNG's environmental issues

Table 68: Threat ratings for PNG's environmental issues

Note: Left column lists *level one threat; right column has level 2 threat as headings, with specific level 3 threats shaded by risk level.*
Highest risk 'third level' threats are shaded pink; medium risk threats are shaded orange

Level one threat	Level 2 threat, hazards in PNG
1. Residential and Commercial Development *Human settlements or other non-agricultural land uses with a substantial footprint*	**1.1 Housing and Urban Areas** Urbanization, informal settlements in peri-urban areas *Urbanization without planned infrastructure or capacity to provide clean water or power, or dispose of waste.* Expansion of settlements in rural areas *Increased population in towns and villages, including coastal areas and new settlements.*
2. Agriculture and Aquaculture *Threats from farming and ranching as a result of agricultural expansion, intensification or practices; includes silviculture, mariculture and aquaculture*	**2.1 Annual and Perennial Non-Timber Crops** Conversion of forests to cropland for subsistence agriculture *Increased intensity of farming and clearing for new subsistence agriculture with increased population.* Conversion of forests to oil palm plantations and other commercial crops *Conversion of forests and gardens for plantations, especially oil palm. Clearing of forest for SABLs has been a major issue.* 1.4 **Marine and Freshwater Aquaculture** 1.5 Escape of feral species and pathogens *If not well managed, poses high risk of introduction of feral species and pathogens into waterways.*
3. Energy Production and Mining *Threats from production of non-biological resources*	**3.1 Oil and Gas Drilling** Fugitive emissions from gas drilling and production *Contributes to greenhouse gas.* **3.2 Mining and Quarrying** Large scale gold, silver, copper and nickel mines Small scale, artisan gold recovery *Mining with tailing and waste discharges into waterways; impacts of erosion, siltation.*
4. Transportation and Service Corridors *Threats from long, narrow transport corridors and the vehicles that use them including associated wildlife mortality*	**4.1 Roads and Railroads** Upgraded road system *Road construction needed for human well-being but creates numerous environmental issues. Planned major infrastructure corridors will potentially have major impacts on the environment.* **4.2 Utility and Service Lines** Pipeline etc from fields to production and export sites
5. Biological Resource Use *Threats from consumptive use of "wild" biological resources including deliberate and unintentional harvesting effects; also,*	**5.1 Hunting and Collecting Terrestrial Animals** Collecting native wildlife for trade Subsistence hunting/customary use *Unsustainable hunting of terrestrial species as increased populations seek protein and cash income* **5.2 Gathering Terrestrial Plants**

Level one threat	Level 2 threat, hazards in PNG
persecution or control of specific species	Collecting native wildlife for trade Subsistence gathering/customary use **5.3 Logging and Wood Harvesting** Logging of native forests *Forestry operations including logging at unsustainable rates.* **5.4 Fishing and Harvesting Aquatic Resources** Unsustainable harvest for subsistence needs Over exploitation of commercial tuna fisheries Collapse of commercial tuna fishery Illegal fishing *Unsustainable fishing a threat to marine species and coastal livelihoods. Threats from commercial vessels.*
7. Natural System Modifications *Threats from actions that convert or degrade habitat in service of "managing" natural or semi-natural systems, often to improve human welfare*	**7.1 Fire and Fire Suppression** Inappropriate fire management *e.g., people lighting fires in alpine areas* Wildfires *Severe fires in drought periods.* **7.2 Water management** Dam construction and expansion **7.4 Removing / Reducing Human Maintenance** Customary use is compromised *Loss of traditions and local laws.*
8. Invasive and Problematic Species, Pathogens and Genes *Threats from non-native and native plants, animals, pathogens/microbes, or genetic materials that have or are predicted to have harmful effects on biodiversity following their introduction, spread and/or increase in abundance or virulence*	**8.1 Invasive Non-Native / Alien Plants and Animals** Feral species *Invasive plants and animals on land and in water.* **8.2 Problematic native species** Crown-of-thorns starfish. 8.4 Pathogens **and** Microbes Diseases of fish and crops, and the threat of future pathogens e.g., myrtle rust, chytrid fungus.
9. Pollution *Threats from introduction of exotic and/or excess materials or energy from point and nonpoint sources*	**9.1 Household Sewage and Urban Waste Water** Untreated, poorly treated sewage and urban waste water. **9.2 Industrial and Military Effluents** Heavy metals mobilised from mine waste disposal including tailings. Mercury from small scale, artisan alluvial gold production. Sedimentation and increased turbidity. **9.4 Garbage and Solid Waste** Untreated, poorly treated solid waste. Marine debris from fishing fleets. **9.5 Air-Borne Pollutants** Vehicle and industrial emissions.
10. Geological Events *Threats from catastrophic geological events to the environment*	10.1 Volcanoes Eruptions. 10.2 Earthquakes / Tsunamis Major earthquakes . Tsunamis and inundation of low-lying areas. 10.3 Avalanches / Landslides Landslides.

Level one threat	Level 2 threat, hazards in PNG
11. Climate Change in climate patterns (e.g., those resulting from increased atmospheric greenhouse gases like CO2) and/or events outside the natural range of variation that could wipe out a vulnerable species or ecosystem	11.1 Ecosystem Encroachment Sea level rise. 11.2 Changes in Geochemical Regimes Ocean acidification. Sedimentation. 11.3 Changes in Temperature Regimes Warming coastal waters and ocean. Annual mean temperatures and extremely high daily temperatures. 11.4 Changes in Precipitation **and** Hydrological Regimes More extreme rain events and increase in average rainfall. Droughts. 11.5 Severe / Extreme Weather Events Tropical storms and cyclones.