Papua New Guinea's

Fifth National Report

to the

Convention on Biological Diversity

December 2017

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A LAND OF DIVERSITY

Considered as one of the world's biodiversity rich countries, Papua New Guinea ranks among the megadiverse countries and the last frontiers for biodiversity conservation. This land of diversity hosts 6-8% of the global species, hosts one-sixth of known languages, and rivals Borneo, the Amazon and the Congo in terms of biodiversity wealth. PNG comprises the eastern half of the largest tropical island on earth, along with hundreds of smaller outlying islands, and its land mass only occupying less than 0.5% of the world's total.

Its diverse interior consists of spectacular highland valleys, grasslands, vast expanses of rainforest, ancient swamps and mangroves. Primary rainforest covers around 75% of the country, its interior consists of undulating mountain ranges and grassy lowlands that rise to Mt.Wilhelm, the highest summit at 3,600m. Crisscrossing the country's surface, acting as a lifeline in terms of sustenance and access are a collection of thousands of waterways, the largest of which are Sepik, Purari, Markham, Strickland, Kikori and Fly Rivers.

With an indigenous population of primarily Melanesian ancestry that emphasises kinship and extended family bonds, the land is central to sustaining the livelihoods of the people. With a population of over 7 million , it is largely a rural based population with over 85% living scattered village-communities across the country. Much of PNG's interior remains remote, and the country's topography means that there are scattered communities that live in complete isolation.

Recognized as one of the mega-diverse countries of the world, PNG hosts 4.5% of the world's known land mammals including home to more than 800 species of birds, and 25,000-30,000 vascular plant species. A truly last frontier for biodiversity discovery, PNG continues to lead in new species discovery. Between 1998 and 2008, at least 1060 new species were discovered in New Guinea, including 218 plants, 580 invertebrates, 71 fishes,132 amphibians,43 reptiles, two birds and 12 mammals (WWF 2009).

Rich in natural resources, the mineral and hydrocarbon resources dominate the country's exports, with contributions from the agriculture, forestry and fisheries accounting for about one third. In the agricultural sector, PNG was the world's seventh-largest producer and third–largest exporter of palm oil in 2008, accounting for 1.3 % of global exports. The country was the 17th-largest producer of coffee in 2010 accounting for 0.7% of global production. In addition, according to figures from the national Fisheries Authority , total annual catches of tuna averaged around 482,000 tonnes between 2006 and 2010representing some 11% of the global catch.

Second in the agriculture sector to the palm oil industry in export value, Papua New Guinea's forestry sector continues to expand on the back of strong regional demand for raw materials. A very diverse range of tropical timber species are harvested from PNG forests, with no single species generally

representing more than 15% of production. This has propelled the country to its current status as the second-largest exporter of tropical timber I the world after Malaysia.

A vast majority of PNG's forestry products are currently destined for China, which retains a substantial appetite for wood as both an input to its own domestic construction industry as well as a raw material for the manufacturing of goods for export. In 2014, China imported 3.23 million m^3 of logs from PNG, up from 2.75 million m^3 in 2013 and 2.58 million m^3 in 2012.

Despite being recognized as one of the mega-diverse countries of the world and a host to 6% of the world's biodiversity, Papua New Guinea faces a growing threat to its mega-diverse status as rapid growth of economies and associated direct and indirect impacts on land use continue to cause significant erosion to its biodiversity wealth. Throughout, Papua New Guinea, therefore, maintaining forest resilience and hence its biodiversity richness poses huge challenges.

The porosity of its national borders, huge demands for cash windfalls among resource owners from logging companies, expanding population, growing demands for food and wildlife resources continues to threaten erosion of biodiversity.

Conservation of biodiversity in Papua New Guinea will always be challenging in view of enormous internal and external pressures.

Presently, industrial logging, subsistence agriculture and commercial agriculture and mining appear to be the major drivers of forest loss and thus remain as the greatest threat to biodiversity loss. Despite, the current trend, benefits from biodiversity conservation will largely accrue in the future ;in the meantime, maintaining species diversity is mostly an issue of preserving the wealth of nature for the benefit of future generations. Biodiversity is effectively a public good, which limits the scope for market-based approaches to management, requiring the customary landowners to play a leading role. In the face of growing challenges, there will be a growing need for awareness on the importance of biodiversity , particularly among traditional landowners who are the custodians as well as consumers of wildlife products. Creating innovative incentives to increase greater participation in the allocation of land for conservation purposes (e.g. biodiversity offsets, payment for ecological services) may be useful to maintain the integrity of protected areas and conserving biodiversity resilience in the future.

A NEW AUTHORITY

The transition from the Department of Environment and Conservation (DEC) to the establishment of the Conservation and Environment Protection Authority (CEPA) will see significant changes in the ways applicants for, and holders of, environment permits interface with the environment regulator. CEPA was established under the Conservation and Environment Protection

Act 2014 (CEPA Act) and takes over the role formerly undertaken by the Department of Environment and Conservation (DEC) as PNG's environmental regulator .

The basic regulatory framework remains largely unchanged but the establishment of a self-funded regulator should see the administration of application for, and enforcement of, existing permits made more efficient. With the workload of the regulator varying significantly depends on the number and ,more particularly , the scale and complexicity of new applications, the government has had significant practical challenges anticipating funding needs year by year. CEPA will be self-funded , with the legislation providing for environmental management fees of varying kinds.

While the basic regulatory framework under the Environment Act 2000 remains unchanged, the Act was amended in 2014 to provide for strengthened assessment and approval processes for activities requiring permits and for certain administrative matters. CEPA's permit approvals and regulatory processes include:
- Procedures for renewal of environment permits,
- Procedures for transfer of environment permits,
- Procedures for amendment of environment permits,
- Procedures for amalgamation of environment permits,
- Procedures for surrender of environment permits, and
- Reporting by permit holders

One area of the changes that will be welcomed by permit holders is the ability to amalgamate permits. This possibility is viewed as a win-win for business and the regulator in terms of reducing the regulatory effort required as well as a corresponding reduction in fees.

STATUS OF PAPUA NEW GUINEA'S BIODIVERSITY.

Historical Background   to the Status of PNG Biodiversity

Papua New Guinea acknowledged its biodiversity richness (wealth) and knowledge of the status is well established. The publication of two volumes of *Papua New Guinea Conservation Needs Assessment (PNGCNA)* in 1993. The PNGCNA assessment had a strong geographic focus , with mapping (where relevant at that time) of the following biodiversity aspects: (a) biologically unknown areas, (b) species richness, (c) distribution of rare and endemic forms, (d) ecologically critical areas, (e) ecologically fragile areas, (f) distribution of economically important species, (g) known threats, and (h) disposition of major wilderness areas.

The focus of Volume 2 of the Papua New Guinea Conservation Needs Assessment (PNGCNA) was on Biodiversity Analysis for Papua New Guinea and set the basis for development of our current knowledge of status of biodiversity in the country. Volume 2 of PNGCNA focused its emphasis on the knowledge of biodiversity during the 1990's and chapters written by experts and included the following thematic areas :

- Biodiversity and Conservation of the Native Flora of Papua New Guinea- *Robert J.Johns*
- Biodiversity and Conservation of the Warm-blooded Vertebrates of Papua New Guinea- *Bruce M. Beehler*
- Biodiversity and Conservation of the Fishes, Amphibians ,and Reptiles of Papua New Guinea- *Allen Allison*
- Biodiversity and Conservation of the Non-Marine Invertebrate Fauna of Papua New Guinea- *Scott E.Miller, with contributions by Robert Cowie, Dan Polhemus, and Lucius Eldredge*
- Biodiversity and Conservation of the Freshwater Wetlands in Papua New Guinea- *Patrick L.Osborne*
- A Preliminary Assessment of Biodiversity and Conservation for Coastal and Marine Ecosystems in Papua New Guinea- *M. Tundi Agardy and John Pernetta*
- Biodiversity and Conservation of Humid Forest Environments in Papua New Guinea- *Simon M. Saulei and Bruce M. Beehler*

Based on the PNGCNA at the time, the assessment of PNG's biodiversity status was summarized as follows:

- Papua New Guinea's native flora included at least 15,000 species of vascular plants, but both the vascular plants and the pteridophyte flora are poorly known and need further field and herbarium study,
- Papua New Guinea's warm-blooded fauna included 644 species of breeding birds and 214 species of breeding mammals. 76 bird species are endemic to PNG as are ca. 50 species of mammals. Birds are the best known animal group in PNG, while mammals are far less known due to their nocturnal lifestyle,
  - ➢ Current status (2015): 813 species of birds; 298 species of mammals .
- Papua New Guinea's cold-blooded vertebrates include ca. 785 species: 282 species of freshwater fishes, and 505 species of amphibians and reptiles. 46 % of these species are endemic to PNG. The fauna remains incompletely known , and additional surveys are needed to adequately document the species and their geographic ranges,
  - ➢ Current status (2015): freshwater fishes 314; 352 species of amphibians; 335 species of reptiles.
- Papua New Guinea's invertebrate fauna is exceedingly rich and only superficially enumerated. The butterflies and larger beetle taxa are well known, but majority of PNG's invertebrate fauna groups are poorly studied.
- Papua New Guinea is rich in freshwater wetlands, that includes more than 5,000 lowland and highland lakes, herbaceous swamps, savannah swamps, woodland swamps, and swamp forests.
- Papua New Guinea's coastal and marine ecosystems rival the terrestrial environments in diversity and richness. These ecosystems include; extensive coastal and estuarine mangroves; fringing , barrier,

and patch reefs; small and large island systems; atolls; seamounts; and deep water upwellings.

Current Status of PNG's Biodiversity Knowledge

Papua New Guinea is home to one of the world's frontiers of truly unspoilt tropical wilderness. This last frontier is among the leading 17 mega-diverse countries of the world. Occupying only less than 0.5% of the Earth's landmass but proud to be home to 6-8% of the world's biodiversity, PNG is home to more than 800 species of birds, 352 species of amphibians, 335 species of reptiles and 298 species of terrestrial mammals .

Papua New Guinea's vast coastline of approximately 20,197 km^2 accounts for almost 44% of the country's land area. Situated within the centre of the Coral Triangle, the reefs and marine ecosystems around Papua New Guinea is also home to over 600 species of corals that host up to 3,000 species of fish. The warm waters of PNG's EEZ also plays host to 32 cetacean species that 'winter-over' in the tropical waters.

Papua New Guinea also hosts up to 6% of the world's flora and is considered one of the most species-rich areas in the world with high levels of species endemism of around 60%. The general consensus among authorities is that the true size of botanical inventory for Papua New Guinea as a whole is unknown and open to considerable speculation . Estimates of vascular plant biodiversity for Papuasia currently range from 11,000 species to 13,858 based on species area relationships, or 16,204 to 20,000-25,000 species calculated on the basis of orchid and fern flora of the region. It has been estimated that PNG hosts about 15% of the world's fern species with around 3,000 species, including hosting around 2,800 species of orchids accounting for about 11% of the world's total orchid species.

Several groups of plants attain levels of species richness usually seen only on continental spatial scales. PNG hosts one of the extensive and species-rich mangrove forests that is home to up to 43 species.

Several authorities contend that no plant family in Papua New Guinea has been adequately inventoried , with many species known from only single specimens or from their type localities. PNG's flora is poorly known from the taxonomic, community, and ecological standpoint. While recognizing our forests host some of the species rich plants in the world, the diversity of flora is our wealth, and challenge for conserving these unique biodiversity rests with our rural majority.

During the past two decades biological field surveys have intensified reaching many of the remaining unknown or poorly known parts of Papua New Guinea. This has resulted in the discovery of literally hundreds of new species, including more than 200 species of frogs and the deposition of thousands of specimens in museums in Papua New Guinea and overseas.

Recent estimations suggest that around 200,000 specimens of amphibians and reptiles from the Papuan region, mostly from Papua New Guinea are housed in museums around the world.

Table 1: Species richness of PNG and World Higher Vertebrates

Taxa	World	PNG (2015)	% World
Amphibians	7,360	352	4.6
Reptiles	10,119	335	3.3
Birds	10,560	813	7.7
Mammals	5,416	298	5.5
Total	33,455	1,798	5.3

Key pressures on Papua New Guinea's biodiversity include:

- Loss and degradation of natural habitats in terrestrial, freshwater and marine environments
- Alteration of freshwater biota through pollution of freshwater environments as a result of riverine disposal of mine tailings waste and waste rock
- Alteration of marine biota through pollution of marine environment as a result of mine waste discharge
- Over-harvesting especially in marine environments, over-hunting in terrestrial environments
- Invasive alien species in terrestrial, freshwater and marine environments. Invasive plants have profound effects in terrestrial ecosystems which invasive freshwater fishes are gaining ground in freshwater systems
- Pollution of freshwater systems by mining is by far the greatest threat where they occur. Pollution through waste waters from municipal discharges are prevalent throughout urban centres
- Climate change poses additional challenges in ecosystem resilience, food security and sustaining livelihoods

Management

The custodianship of the environment for much of PNG lies with the landowners and those with user rights. How this is effected is very much a mosaic of preservation, sustainable use, exploitation and degradation, spatially and/or temporally. For areas of the highlands agriculture has been practiced continually for over 8,000 years defining an anthropogenic landscape whilst many coastal areas have been inhabited for 3,000 years or less. Over these many generations localised environmental use and management has evolved to what it is today with all its dynamic influences.

Ministry

Within Papua New Guinea the National Government Ministry for Environment & Conservation and Climate Change heads the two core Departments that oversea the implementation of the Convention on Biodiversity, UNCBD. The primary role is led by the Department of Conservation DEC which is in the process of transitioning to a Conservation and Environment Protection Agency CEPA by 2015 and a secondary role by the Office of Climate Change

and Development OCCD, whose primary role is the implementation of the UNFCCC.

DEC transitioning to CEPA

Within this reporting period there has been considerable dynamic change both in government and in the restructuring of the Department of Environment and Conservation and Office of Environment Climate Change and Development. This period has been one of consolidation and until this is fully effected with CEPA along with the national government's endorsement of policy such as the *Policy on Protected Areas 2014* the subsequent review of *NBSAP* and its implementation along with those of the *Aichi Targets* and *Millennium Development Goal on Environment* will follow.

National Government Development Plans

In 2010 the government set out a long term development plan for the country called *Vision 2050* which sets out an outline to achieve the aspirations of the goals of the *National Constitution 1975*. This did plan did not gain traction until the formation of the 9th National parliament in 2012 where the members who formed government agreed upon the *Alotau Accord,* which embraces the *National Plan 2030* and the *Vision 2050* in its five-year plan. Pillar 5 within the *Vision 2050* is *Environmental Sustainability and Climate Change*.

A development paradigm shift towards green development was also set out by the Department of National Planning and Monitoring with the *National Strategy for Responsible Sustainable Development for Papua New Guinea. The Strategy 2014*. When implemented this will be a positive shift towards future implementation of the CBD.

Policy

From these planning initiatives a series of policy developments took place during this reporting period. There has been a long consultative process in the development of policy, which is to direct, and be implemented by government line agencies.

These policies that relate to the environment and biodiversity, that will, when implemented have influence on the management of ecosystems and the species they contain. They are the *National Climate Compatible Development Management Policy 2014*, the *National Sustainable Land Use Policy 2014* and the *Policy on Protected Areas 2014*. These have filled long outstanding policy gaps and will guide future initiatives in mainstreaming sustainable biodiversity management and conservation across different sectors and as precursors to supporting legal reform. They will also help to mesh together the efforts of different National departments in future sustainable development by factoring in environment and biodiversity concerns.

Law review

Within this process it has also been recognised that national government legislation needs to be reviewed and wherever possible harmonised so that land use planning factors in and trades off, different land use options.

In 2014 the *Conservation Environment Protection Act 2014* was drafted, and the *Forestry Act 1991* and *Mining Act 1992* were discussed for the consideration of amendments. In the later the discussions relating to the system of riverine and deep-sea tailings disposal and deep-sea mining were raised and amendments in relation to these are still under consideration. The *National Cultural Property (Preservation) Act 1965* also is under revision led by the PNG National Museum and Art Gallery.

The year 2014 has therefore seen a broad mainstreaming of sustainable development planning that factors in environmental concerns across the sectors of Planning, Land Use, Forestry, Mining, Climate change and Environment.

CEPA

In response to the countries' development plans set out in the *Vision 2050* and projected strong economic growth the Department of Environment and Conservation is currently transitioning to a Conservation and Environment Protection Agency. It would maintain essential conservation functions but take on a greater role in regulatory functions. Notably the approval of environmental impact assessment of proposed development projects as per current legislation followed by the issuance of environmental permits and ongoing reporting and compliance of any major developments, environment plan.

As an agency it will be supported financially through annual National budget allocation, however sustainable financing of its operations will be received through the issuance of permits, the advancement of innovative self-financing initiatives from payments for ecosystem services and biodiversity offset derived from major development projects.

PNG NBSAP

As a result of all this dynamic policy, legislative and institutional change the *PNG NBSAP 2007* has been maintained pending these changes and has not as yet been reviewed from this first version. Many of the Development Plans and policies mentioned have taken on aspects of implementing the *NBSAP* and the objectives set out in the *Aichi targets* and *Objective 7* of the *Millennium Development Goals.* It is anticipated that the *NBSAP* will be reviewed in 2015 with this report being the basis of an informed evaluation of progress to date.

Strategic conservation planning has advanced with the initiation of a Marine Plan of Work Protected Areas (PoWPA) analysis across PNG's EEZ which is inclusive of both nearshore and deep sea ecosystems. It is anticipated that this will be combined with a review of the existing Terrestrial PoWPA leading to a complete overarching conservation planning framework from the mountain ridges to coast, to reef to deep sea, taking into account how these interact with each other, for the first time in a unified plan. It is hoped that this will play a major part in also having a more strategic approach in conservation

planning and implementation of initiatives, which has been missing up to this point.

Apart from the above policy and planning initiatives the sections of the *NBSAP* that have been well implemented are in capacity building, in collaboration and development of partnerships with government agencies, industry, NGOs, communities and donor agencies. This has led to a diversity of funded initiatives in advancing the NBSAP, however this has not always led to major advances in conserving biodiversity. The development threats to biodiversity have increased at a rate greater than PNG's ability to overcome them.

Threats to Biodiversity

Papua New Guinea biodiversity continues to face growing threats from a wide range of activities, including illegal and/or unsustainable logging, subsistence exploitation, monoculture palm oil, commercial mining, road construction, invasive and/or exotic species and unsustainable fisheries. These environmental threats are exacerbated by global climate change and increasing weather variability, which is increasing the incidence of fires within forests and savannas, flood events, erosion, and seawater incursion into coastal regions.

The primary threats to terrestrial biodiversity in PNG are deforestation and degradation (from logging and subsistence agriculture), mining (including pollution and waste runoff) and agricultural conversion (for oil palm). The main drivers of deforestation and degradation in PNG are logging (48.2%) and subsistence agriculture (gardening) (45.6%). Not only are forests impacted directly from these activities, but the secondary effects from improved road access makes previously inaccessible areas susceptible to ongoing clearing for agriculture and salvage logging. Recent spatial analysis suggested that the average annual rate of deforestation and degradation across all regions of PNG over the 1972-2002 period was 1.4%, almost twice the rate previously recorded. Current rates will become available with the *State of Forests* report from the PNG Forest Authority possibly later in 2014.

It is estimated that by the date of current *Aichi Targets* 2020, 83% of the commercially accessible forest areas will have been cleared or degraded if current trends continue. Much of the logging-related forest loss is concentrated in lowland forest areas; by 2002, lowland forests accessible to mechanized logging were being degraded or cleared at the rate of 2.6% annually. In particular, the islands region (New Britain and New Ireland) have been subject to intense logging activity; the majority (63%) of the 2.8 million ha of accessible lowland forests in these areas had been deforested or degraded by this date. Logging was initially focused in the islands region because of ease of access, fertile soils and good quality forest, more recently this region has been the centre of intensive oil palm plantation development.

The growth of subsistence agriculture is a pervasive threat to forest areas, linked closely to the high population growth (rural 2.3-2.6%), but this also reflects the needs of communities to develop increased cash crops in response to modern cash driven economic pressures. With almost all

remaining forest areas in the hands of communities, clearance and conversion for subsistence agriculture continues to be a strong underlying driver for forest loss. Along with the subsequent loss of associated biodiversity, with the added pressures of fauna loss from hunting in areas proximal to settlements, agriculture or access routes.

Large-scale mining for minerals such as gold and copper have resulted in both direct impacts from forest clearing (including for infrastructure, access roads and associated support) as well as sometimes-extensive indirect impacts from pollution and runoff of tailings. The best-known example of this is from the Ok Tedi gold and copper mine in the Western Province, where contamination from tailings discharge have damaged at least between 250,000 - 150,000 ha of forest in the lower Fly River catchment and discharge reaching the Torres Strait of Australia. Other important river systems, such as the Strickland have also been impacted by sedimentation and pollution, while a gold mining lease in the Brown River catchment was disallowed in 2008 due to concerns on potential impacts on the water supply for PNG's capital, Port Moresby.

Agricultural conversion has not yet had an extensive impact on forest areas compared with logging, however, the pace of conversion is increasing, driven partly by recent price rises for agricultural commodities, and demand for palm oil. The issuance and subsequent commission of enquiry into Special Agricultural Business Leases (SABLs) which accumulated 12% of the country from 2003 to 2011 as land clearance under the guise of oil palm. From recent assessments it is estimated that five plantations totaling 180,000 ha might be developed in the foreseeable future.

Other pressures on forest ecosystems include subsistence harvesting of non-timber forest products (eaglewood resin) and hunting and fishing. Subsistence harvesting was generally linked to the need for cash, while hunting and artisanal fishing are generally for personal consumption or local sale. The national government has supported a free education policy since 2011 and free health care delivery since 2014 taking this burden off of the rural communities to use their environmental capital to develop their social capital. Traditional hunting is the major threat to mammals such as the now endangered Tree Kangaroos often putting localized pressure on fauna. The need for cash and food protein are pressures that are closely correlated with population growth.

There is a low level of poaching with incidences discovered by Customs agents and National Agriculture Quarantine Inspection Agency (NAQIA) officers in border control. No highly organized poaching racket has been found at this stage.

Changes in Biodiversity status

Without a solid baseline and ongoing monitoring the current status and trends of many components of biodiversity under the threats outlined are not known for Papua New Guinea. The perception of local communities is therefore often

the basis of reporting trends. It is also anticipated that with increasing threat there is also increasing impact upon different species, their habitat and associated ecosystems and this is a precautionary principle status in the absence of scientific data.

Despite this generally accepted trend however there are initiatives that are occurring which have had a positive impact on biodiversity. There are site, species and ecosystem initiatives in sustainable use and conservation through bilateral support, the programs of NGO partners and by industry, in country. There are two flagship Tree Kangaroo projects, which have improved the security and status of species in two separate areas of the country. A process that has taken well over a decade of dedicated effort to achieve. The Coral Triangle Initiative enabled extensive conservation efforts across the countries' near-shore environment, which has led to the establishment of Locally Managed Marine Areas that whilst managing the environment, maintain communities food security. The regulating of export of CITES II species has maintained a controlled exploitation of listed species. Papua New Guinea's crocodile populations and exports have been maintained through sound management through this regulatory mechanism.

The *Nauru Accord* has put in place codes of practice, mechanisms and an observer program that if followed will maintain a sustainable tuna fishery across its range which includes Papua New Guinea waters. Recently however in 2014 the European Union gave PNG a 'yellow' card in regards to compliance within the tuna industry.

There are other developments from within other fisheries, forestry, mining and waste management, that also could be considered for a 'yellow' card from lack of compliance or adherence to best practice.

But as mentioned the extent and impact of increasing population, the majority of which rely directly upon the environment and a developing economy has been greater than the efforts to maintain biodiversity in a sustainable future.
Due to a lack of strategic direction, the protracted process of policy development and transitioning of the lead agency of the Department of Environment and Conservation to an authority, progress towards achieving our commitment to the *Aichi* and *MDG 7* targets has not been on track. There is now even more an urgent need to build upon our successes and get back on track.

Getting back on track
Despite the past challenges PNG and its government agencies are now better placed to move forward and get our targets on biodiversity within *Aichi* and *MDG 7* back on track, if done through support of a coordinated effort. The following are an overview of some of the suggested actions to get back on track.

NBSAP revision linked to sustainable development paradigm
Papua New guinea's National Biodiversity Strategy and Action Plan (NBSAP) was completed in 2007 and is currently in the process of being updated. The

NBSAP was supposed to be the roadmap for guiding biodiversity implementation programs within the country. A recent review of the NBSAP by (Kinch et al 2009) highlights many of the shortfalls that have hindered the progress of NBSAP. It is clear that much of NBSAP implementation was constraint by lack of institutional support and mainstreaming of resources within the focal agency mandated to lead the activities namely Department of Environment & Conservation. During the period ,(2010-2015), DEC was in transition to becoming an authority (CEPA) and much of the focus was on legal and policy framework for the establishment of the current Conservation and Environment Protection Authority (CEPA).

However, PNG has learnt lessons from the 2007 NBSAP and the recent review by (Kinch et al ,2009) will form the basis for the revision of the NBSAP. Lessons learnt from the 2007 NBSAP has provided the vision that include the need for greater realism about what is achievable in the time frame between each NBSAP reviews, particularly for mainstreaming activities; and the need to focused on activities that are achievable within the constraints offered by institutional resources.

The current Protected Areas Policy and new initiatives under the CEPA Marine Assessment Program including initiatives under the Coral Triangle will no doubt lend new dimensions to implementation of the revised NBSAP.

Progress towards the Aichi Targets and CBD Strategic Plan

In almost all cases the Aichi targets have been partially achieved in Papua New Guinea. Among the partially achieved targets , good progress has been made on Targets 4,11,13,16 and 19 with some promising progress on targets 2 and 14. Of the five Strategic Goals of the CBD, Papua New Guinea has made good progress towards Goal A,(mainstreaming), Goal C (in relation to increased protection) ,and Goal E (knowledge management and capacity building).

Papua New Guinea has progressed work on achieving targets particularly in the following programmes and cross-sectoral issues of the CBD:
- Programme of expansion work on Protected Areas
- Thematic programme of work on terrestrial biodiversity conservation
- Thematic programme of work on marine and coastal biodiversity
- Strengthening of regulatory work on environment impact assessment and monitoring of major projects
- Strengthening inter-agency collaboration work on invasive species
- Strengthening inter-agency work on access and benefit sharing
- Strengthening inter-agency work on communication, education and awareness
- Strengthening inter-agency collaboration on spatial data management and usage

Challenges and Lessons

Although some progress has been made by Papua New Guinea many challenges and obstacles remain. These among others include:

- Major shift in creating meaningful incentives for landowners to view their forest resources as sustainable long-term investment
- More networking and harmonization of national legal and policy framework across sectors to address biodiversity issues
- Limited human capacity. Much work in implementation delayed due to capacity constraints
- Limited financial resources. Protected area management, integration of biodiversity planning in light of landuse planning and mainstreaming biodiversity into a wider cross-section of the national development mechanisms. Networking with NGOs and other development partners to progress work on biodiversity conservation.

Lessons learnt over the last five years will be valuable to progressing the revision of PNG's NBSAP and a better vision for meeting future targets.

- The Protected Areas Policy (2014) provides CEPA with a clear direction for articulating PNG's biodiversity sector development and shifting the focus on strengthening partnerships with resource owners. Much of PNG's biodiversity wealth is 'locked in' by customary land tenure system. Institutionalizing effective incentive mechanisms for landowners with a view to release areas for biodiversity conservation may be a way forward.

- Harmonizing sectoral legal and policy framework across state agencies to drive biodiversity programs across provincial borders. For example with the porosity of national borders, there is a need for closer networking between NAQIA and CEPA to control illegal introduction of alien invasive species and/or export of wildlife across national borders.

- Mainstreaming institutional collaboration

  Mainstreaming biodiversity into other sectors requires institutional change, which generally takes up to 5 to 10 years. For example , annual recurrent budget allocation to CEPA is inadequate to implement any biodiversity management and planning programs. A long-term revolving financial mechanism is required to undertake a typical project beyond its lifecycle. Such donor-funded mechanisms through GEF/UNDP is time-bound and has greater success rate than funds sourced through recurrent budgets.

- Strengthening Partnerships to achieve Biodiversity Targets
- Spatial Assessment as an essential Tool for Biodiversity Planning

Papua New Guinea's knowledge base on spatial biodiversity assessment has greatly improved since the publication of *Conservation Needs Assessment for Papua New Guinea* in 1993. Further development in spatial biodiversity planning and assessment has been the foundation for PNG's success in predicting land use changes and thus assessment of biodiversity loss. The *State of Papua New Guinea's Forests 1972 -2000* followed up by the recent report *The State of PNG' forests 2010 to 2015* are testimony of the advancement of mapping and spatial assessment capacity for biodiversity and

other land use planning in PNG. The PNG BioRap program under DEC ,and FIMS mapping under PNG National Forest Authority and PNGRIS under Department of Agriculture and Livestock (DAL) are spatial planning tools that provide excellent land use planning for agricultural development purposes.

The biodiversity planning data are currently available and can be used at the ecosystems level , using ecosystems types as effective surrogates for biodiversity assessment. The identification of clear set of spatial biodiversity priority areas at the landscape level will thus provide a strategic string point for protected area planning and/or expansion including restoration of ecosystems. The only constraint in the utilization of spatial assessment and planning is the 'protectionism' aspect displayed by individual state agency over ownership of data sets etc.

- Realignment of National Institutional mandates to achieve CB Strategic Goals and Aichi Targets

The first action is to revise the *PNG NBSAP 2007* taking into account the changes in policy and the current state of implementation, ensuring that these are considered and linked to the Aichi and MDG targets and the countries' new direction under the *Sustainable Development Strategy 2014*.

The revised *NBSAP*, the *Policy on Protected Areas 2014* to then be implemented by the Department of Environment and Conservation and socialised with other line departments and government agencies for inclusion in their work plans.

Governance
Laws that relate to biodiversity and the environment need to be reviewed and harmonised wherever possible such that they reinforce and compliment each other.

Data
The current Species Information Management System (SIMS) database housed within DEC to be upgraded to a database that has sections that are publically available and user friendly and others, which are secure for internal use only. This database is to be linked to others within the country and to databases outside the country that contain information on PNG biodiversity wherever possible. Having a biodiversity database in place will inform the department in planning, directed implementation of initiatives and evaluation of development and compliance.

A Spatial Conservation Planning Blueprint
The Terrestrial and Marine PoWPA evaluations to be combined into a single Papua New Guinea Conservation Priorities Planning Map with supporting data layers. This will be supported through an outline of the process followed and a defined logic of decisions made including *Aichi* area based targets. This process to be refined by CEPA on a regular basis with new information and broadened to include the customary and social values of biodiversity.

Ecosystem Services Development

An assessment of ecosystem services across the country and their value/replacement value to be researched. These ecosystem services to then be linked to human wellbeing and or poverty reduction. An example being the provisioning services of fresh water and its relative importance to domestic water use or hydropower that can be determined in a multivariate analysis. Another example is the provisioning, regulating and cultural services of the rainforest through the development of REDD+ pilot studies.

Valuing Environmental/Ecosystem Services in Local and National Accounting

The value of environmental/ecosystem services needs to be incorporated into National Accounting. In this way the costs of changes in the environment can be considered to inform development plans and any associated permits or offset requirements. In this way the costs of development that impact upon the environment can be recognised and recompensed. Also there is a policy gap on the payment for ecosystem services that needs to be addressed. This would also determine legislative requirements and the outline of a mechanism to achieve PES.

Biodiversity Offset

Biodiversity Offset to become a future best practice to offset impact from development projects. This needs to be formalized by the government to facilitate conservation of biodiversity and ecosystems that are affected by development. The experiences gained by the PNG LNG Biodiversity Offset can be used to advance this process.

Investing income from resource extraction in responsible development

The PNG LNG project is a game changer for the country and the economic growth that it drives along with other current and future resource extraction projects must also fund activities to implement the new responsible development strategy that lead to sustainable ecological and biodiversity management. This will require political will, a clear implementation plan and a fully resourced and capable agency to lead a collaborative effort of implementation in partnership with all stakeholders.

Mainstreaming Conservation

Reaching all areas of the country with 'on site' environmental initiatives has been shown to be complex. With the current rates of environmental change we will run out of time and money to achieve conservation through this method alone. Innovation through use of audio-visual and interactive materials on conservation issues for education, awareness and advocacy needs to be developed.

Part I   Biodiversity status, trends and threats and implications for human well-being

Throughout this report, New Guinea refers to the entire island of New Guinea and its satellite islands; in broader terms, PNG refers to Papua New Guinea including its island archipelagos (Bismarck and Admiralty) to the north. The entire region from New Guinea to the Solomon Islands is referred to as the Papuan region.

1   *Biodiversity importance in PNG*

1.1 Human well-being

Papua New Guinea is a land endowed with a diversity of cultures ,whose people speak an equally diverse living languages that number over 800. These languages and traditions of each community and of each culture, are strongly influenced by the local environment, its ecosystems and species. Each language and culture is both shaped by the environment and describes it. Peoples' identity and customs are linked to the place from where they come from and/or by where they live. The natural environment therefore has a strong influence on the majority of Papua New Guineans who live within and rely upon it to maintain their way of life and standard of living.

Papua New Guinea is dual economy comprising a formal public- and corporate sector and largely informal subsistence farming based rural population that accommodates 80% its population, whose livelihoods depends on the goods and services provided by their environment. Their environment is the foundation for provisioning of services that include among others; food, water, fuel, materials and medicines, regulating services of climate and water, cultural services of sense of place and supporting services such as soil formation. Although many rural communities are cash poor they are rich in environmental capital. Many use this environmental capital to support the development of their social capital. However with a *National Free Education Policy* in place since 2011 and free health care delivery from 2014 this has helped to take pressure off of exploitation of the natural environment previously used to generate income to pay for these social services. Nonetheless environmental capital, both natural and agricultural is a major driver of socio-economic status of rural Papua New Guinea

The formal sector is the other element of the dual economy. This is dominated and driven by the public and corporate sector dominated by mining and petroleum industries. From 2014 onwards with exports from the PNG LNG project, this sector will become even more dominant for sustaining the national economy. The renewable resources sector remains significant and generates income across much of the country through agriculture which is predominantly the export of raw products, along with forestry, a large proportion of which is round log export.

As a developing country, PNG has its share of urban drift that also puts pressure on the delivery of goods and services to support the growing economies in urban areas including strains on urban sanitation and waste management. The provision of water, food and energy to large towns is a

developing issue. Again there is dualism in the major centres, such as the capital Port Moresby and Lae, which have greater than 40% of the population living in squatter settlements. Traditional knowledge and links to the natural environment also tend to be eroded with urban-style living and some peoples are becoming detached from their traditional lands.

1.2   Socio-economic development

Papua New Guinea is driven by a dual economy that is typically characterised by the formal and informal sectors. The latter economy is primarily based on subsistence agriculture for communities on the mainland PNG, while artisanal fisheries based on exploitation of marine resources is more prevalent for coastal and island-based rural communities. Previously, the informal sector was primarily rural based; however, today it is the main driver of the urban-based informal sector that is largely driven by 'buai' (betelnut) trade. The formal sector is largely driven by industry-based corporate sector and commodity-based industry based on mining, petroleum, agriculture, forestry and fisheries. Presently, much of PNG's economy is borne on the shoulders of the booming mineral and petroleum-based industry.

Papua New Guinea is characterised by high cultural and linguistic diversity, a constitutionally-guaranteed customary land ownership and resource tenure, a land of diversity of sorts, that supports a growing population, 90% of which live on customary land whose livelihoods depend on the retention of traditional belief systems and resource management practices . From the coastal and island dwelling communities reliant on fishing and marine resources to the mainland far-interior highland communities reliant on the forests and freshwater resources, PNG is a culturally diverse community that has a traditional classification and nomenclature system for the biodiversity that its communities and their ancestors have depended upon for survival. The key determinants are totemic value, conspicuousness to the human eye, and utilitarian value. The greater the utilitarian value, the more fine-scale classification. A globally threatened reptile will not be identifiable in local eyes from the dozen or more other species on their land. A totemic freshwater crocodile, on the other hand, will be readily identifiable and have existing local value to a particular tribe or clan. Totemic value can be very important, as members of the clan believed to descend from the totem may not kill or eat the totemic animal. For this reason, any consideration for biological diversity or protected area prioritization must take into account general patterns of human perceptions of biodiversity in PNG cultural context if conservation or resource development efforts are to have any meaning at all to the land-owing tribes and clans in rural Papua New Guinea.

Livelihood

The forests of Papua New Guinea are endowed with countless numbers of plants, mammals, birds, and insects and are home to 5-6% of the world's biodiversity. However, these forests have been under serious threat during the past three decades from activities such as industrial logging, subsistence and commercial agriculture, mining and urban development.

However, from an ecological point of view, the state of forests is not simply a matter of their extent; more important are their health and resilience that provides a myriad of services to the peoples that live and thrive within the realms of its goods and services. The forests and its biodiversity constitute the most important working component of a natural ecosystem. The forests of PNG help maintain essential environmental services. It maintains ecological processes, creates soils, recycles nutrients, cleanses the water,   has a moderating effect on climate, degrades wastes, controls diseases and above all provides an index of health of an ecosystem.

For PNG's rural majority, it provides food, medicines, and a wide range of essential products; it is the natural wealth that exists on land. Plant and animal diversity within its realm offer   more than just food security and healthcare, for the rural majority whose livelihoods depend on the environmental services provides by the forests. The forests and the environmental services meet almost 90 per cent of their material needs.

Medicine

Medicines derived from both the terrestrial and marine environment by local communities along with knowledge of these is either commonly shared or is known by a select few. These are used mainly in their raw form, with some sold in local markets. There has been some eco-botanical work done in PNG that has been published and some bio-prospecting which led to debate on intellectual property rights. Although no major pharmaceutical company has developed any commercial drug from local species this remains a potential prospect.

Tourism

Tourism is at low levels in PNG despite the generally unspoilt environment and cultural dimension that is found in here. This is due to many factors such as the high costs of air travel around the country and accommodation. The two major tourism packages that relate to the environment are the trekking of the *Kokoda Track* which also has a WW2 history and dive tourism. There is also expeditionary tourism on live-aboard vessels of the coastal environment and the Sepik River, whilst there are more informal travellers on private yachts that sail through different destinations. There are also select birding groups that target endemic species. Of these the Kokoda Track has led to a major conservation initiative that is outlined further in this report. Sport fishing in both estuarine and marine species is a small but rapidly growing niche market. There are opportunities for eco-tourism as many local people have strong cultural ties to their natural environment that is an experience that many tourists are attracted to.

Cultural Enterprise

Cultural enterprise is evident across the many cultural shows that occur around the country. This is a development where customary regalia and items/inspiration that come from the environment are brought into dances and cultural shows in urban centres. This is often with the combined intent of maintaining culture and developing a tourism event to generate income. Other

enterprise is the production of an array of artefacts created from products from the environment and art works.

Ecosystem Services REDD+

The payment for ecosystem service, which is the most advanced in PNG, is the current research into REDD+ with the Office of Climate Change and Development (OCCD) earlier known as the Office of Climate Change and Carbon Trade (OCCCT 2009). Many of the forest types and some tree species across PNG have been evaluated for carbon storage through the work of the Forest Research Institute, PNG Forest Authority and NGOs. This is an ongoing program of research. PNG has not however yet set up a law, defining policy or mechanism to trade in carbon credits in a compliance market. In association with this work the OCCD has calculated the GHG emissions and footprint by sectors within PNG.

Ecosystem Services Water catchment

Much of the electricity of PNG is generated from hydropower from two major dams within the country. These are the 62MW Rouna in Central province and the 77MW Yonki in the Eastern Highlands. The watershed management of these catchments is ongoing. In 2010 a feasibility study was initiated by PNG Power for the 80MW Naoro-Brown River hydro scheme and a feasibility study on socio-economic and environmental impacts of the catchment is ongoing. The proposed 2,500MW Purari Delta project that has the capacity to generate power for PNG and Australia was again put on hold in 2014. There is potential for the development of small hydroelectricity around the country. Papua New Guinea's water resources thus provide an essential service to its rural majority but importantly the provision of much needed source of energy and utility services for the growing urban population.

1.3 Biodiversity and ecosystems of PNG

Papua New Guinea has been recognized as one of the mega diversity countries of the world (Mittermeier et al.1997; Mittermeier et al. 1999). The country's biodiversity wealth has been highlighted throughout this report. The origins of, and processes shaping ,this exceptional diversity are of great scientific interest, both for improved understanding of the drivers of biological diversity (Polhemus 1996) , and for understanding how these highly diverse biotas will be affected by land use change and anthropogenic climate change (Freeman and Class Freeman, 2014). Two broad paradigms to explain high diversity in tropical mountains have been advanced (Baldwin et al, 2012;Toussaint et al, 2014; Oliver et al. 2014;) and one of this pertains to mountain uplift and climate change to have driven local speciation (the 'cradle' hypothesis);(Toussaint et al al,2014). The tropical island of New Guinea as a whole has arguably the 'most complex orogeny in the world' (Baldwin et al. 2012). The collision of the leading edge of the northwards-moving Australian plate with the westwards–moving southern edge of the Pacific Plate has uplifted a high Central Cordillera (>4,000m a.s.l) extending nearly the length of the island. It has been postulated that beginning in the Miocene, and continuing with the ongoing rapid uplift of the Huon and Finisterre Ranges (Figure 1), additional smaller and more isolated montane regions scattered

along the northern New Guinea are uplifted remnants of island arcs that have accreted onto the northern edge of the Australian plate (Polhemus, 1996).

The biota of New Guinea has been profoundly shaped by this complex orogeny. The uplift of the Central Cordillera has largely isolated biotas of lowland regions to the north and south of New Guinea (Polhemus 1996;Georges et al 2014).Such studies (Baldwin et al, 2012;Toussaint et al, 2014; Oliver et al, 2017) suggest that orogeny and climatic oscillations have been the major drivers that have interacted to generate high montane biodiversity in New Guinea via both localised diversification within montane habitats and periodic dispersal across lowland regions (Figure 1).
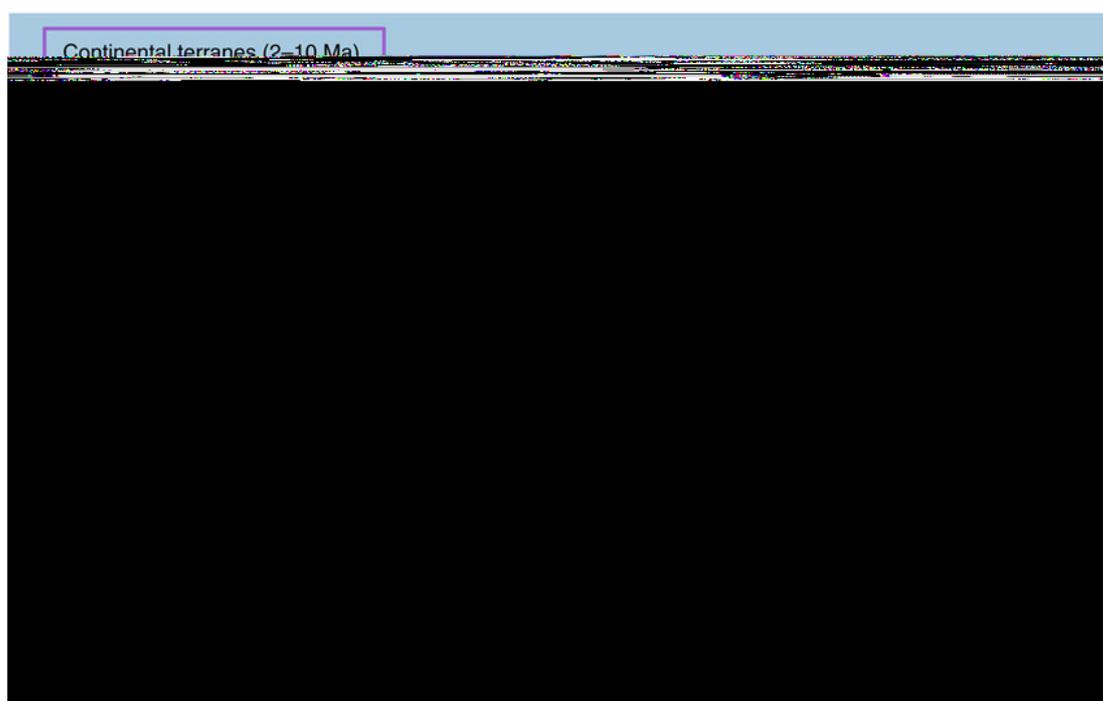
Figure 1: Tectonics and orogeny that may trigger radiation of PNG's megadiversity (after Toussaint et al, 2014).

1.3.1 Terrestrial Biodiversity

Botanical Diversity in PNG.

PNG is considered one of the most species-rich flora areas in the world with high levels of species endemism (estimated at about 60%) (Kreft & Jetz 2007, Mutke & Barthlott 2005; Takeuchi 2007a), and is among the world's most ecologically distinctive forest regions (Allison, 2009;Brooks *et al. 2006;Olson et al. 2001; Shearman et a. 2008).* PNG's forests consist of diverse lowland (57% of total forest cover) and montane (29%) rainforest, swamp forest (10%),dry evergreen forest (2%) and mangrove (2%)(Shearman et al.2008).However, the true size of the botanical inventory for New Guinea as a whole (PNG and Papua),is unknown and open to considerable speculation(e.g. Damas 1998, Davis et al. 1995, Stevens 1989,Takeuchi 2007a, 2007b). Estimates of vascular plant biodiversity for Papuasia currently range from 11,000 species (Collins et al. 1991), to 13,858 based on species

area relationships (Roos, et al. 2004), 16,203 (Govaerts, 2001),, to 20,000-25,000 species calculated on the basis of the diverse orchid and fern flora of the region in proportion to overall floristic diversity (Johns 1993).About 6% of the world's flora is found in Papua New Guinea (Hoft, 1992).

The general consensus among authorities is that no plant family in PNG has been adequately inventoried, with many species known from only single specimens or from their type localities (Conn 1994; Takeuchi 2007b). The flora is poorly known from the taxonomic, community, and ecological standpoint (e.g. Johns 1993; Shea et al. 2007. Because baseline data for species abundance and distribution are lacking, little is known about the current rates of extinction (Stevens, 1989.

Several groups attain levels of species richness in New Guinea usually seen only on continental spatial scales. Examples include the most extensive and species-rich mangrove forests (33-43 species) (Gilman et al. 2006); estimates of at least 3,000 fern and lycophyte species (about 15% of the world's fern spp.) (Johns 1995); and estimates of 2,800 species of orchids (about 11% of the world's orchid flora) (Schuiteman & de Vogel 2006). Approximately 100 *Bulbophyllum* species await descriptions, along with another 100 species in other genera (Schuiteman and de Vogel, 2008).

Despite the growing knowledge on PNG's flora, loss of the country's forests through degradation or the effects of climate change may have a significant impact globally in terms of the carbon budget, as they play a substantial role as a massive carbon sink. For example, it has been estimated that about 4,730 million tons of carbon are stored in PNG's forests and between 63.6 and 73.2 million tons of carbon was released in 2007 due to deforestation and degradation (Shearman et al. 2008). Fires further exacerbate global warming by releasing CO_2 into the atmosphere. Forests are also home to PNG's rich assemblage of vertebrate fauna.

Due to the patchy and imprecise knowledge of the forests, policy makers, managers, and conservationists have not had comprehensive information to guide decision making, resulting in inadequate and ineffectual forest governance and management (Shearman et al.2008; Takeuchi & Golman 2001).

Nonetheless, our rich biodiversity is our inherited wealth, and a detailed knowledge of the extent and condition of this resource is essential for its wise and sustainable exploitation (Gideon,2014). Recent work by Bishop Museum on PNG plants is nearing completion and the checklist has 10,313 species, comprising around 2.5% of the world's total (Allison and Tallowin, 2014). A collection intensity map is shown in Figure 10.

Mangrove Ecosystem and Diversity

The value of the ecosystem services provided by mangroves is well documented (Gilman et al.2008; Raga, 2006; Lugo and Snedaker,1974) . In Papua New Guinea, mangroves have been recognized as 'fragile ecosystems' and commercial logging within mangroves is prohibited. However, subsistence exploitation of mangroves continues unabated. A FAO Global Forest Resource Assessment (2005) suggested that at the country level Papua New Guinea was among five countries (Indonesia, Mexico, Pakistan and Panama) that recorded the largest losses of mangroves in the 1980s.This report suggests that a total of some 1 million hectares were lost in these five countries. While the figure for loss of mangroves in PNG during the 1980s remains contentious, the latest estimation by FAO (2015) indicates a positive trend for PNG with an increase in extent of mangroves. This report indicates PNG's mangrove area in 2010 as covering 516,000 hectares and a positive growth trend in 2015 of 650,000 hectares (FAO,2015).

In Papua New Guinea, the area changes are primarily caused by human pressures for rural livelihoods, commercial activities and overexploitation of the resource. The extraction of fuel wood for domestic cooking is significantly high in the Central (Raga,2006) and Western Provinces. Overexploitation and conversion to other uses, including coastal development, have caused the majority of the losses over time. Their degradation continues, despite efforts to legally protect the forests as 'fragile' ecosystems in PNG. Unfortunately, these ecosystems have minimal legal protection, and they are still threatened by increased sediment loads from upland logging, commercial agriculture expansion, mining waste streams and local pollution from urban areas. Despite the challenges, PNG mangroves are among the most species rich and productive ecosystems in the region (Figure 2).
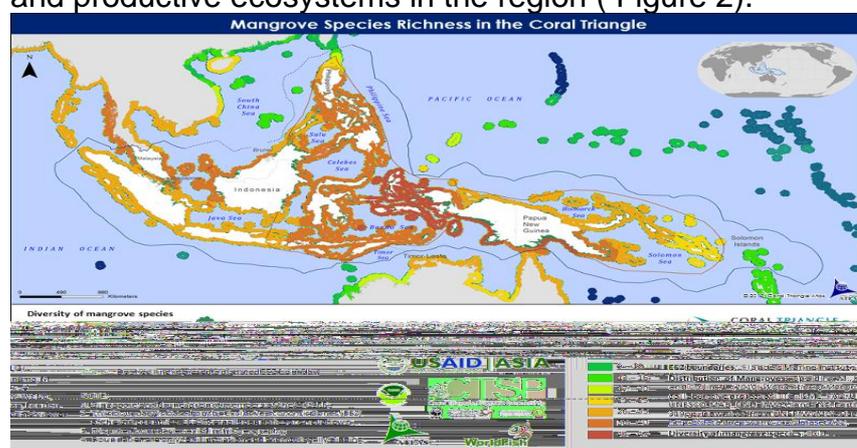
Figure 2. Mangrove species richness (source from 2005 UNEP-WCMC)

Globally, seagrasses have five centres of high diversity (Figure 3), all of which occur in the eastern hemisphere and four of which occur in the Tropical Indo-Pacific bioregion; the fifth south-western Australia, occurs in the adjacent Temperate Southern Oceans bioregion. Papua New Guinea lies within the Tropical Indo-Pacific Bioregion with the highest species diversity globally with four of the five areas of high seagrass diversity worldwide located in this bioregion (Short et al. 2007). There are around 24 species of seagrass recorded within the Tropical Indo-Pacific region that stretches from east Africa

,south Asia and across tropical Australia to the eastern Pacific. The region is home to the largest and highest diversity of tropical seagrasses that are predominately found on reef flats but also in deep waters, many commonly grazed by mega-herbivores and also subject to climate change effects (Short and Neckles,1999). Papua New Guinea hosts up to 12 species of seagrasses.

Seagrasses are highly productive ecosystems that provide significant role in fisheries production, sediment accumulation and coastal inshore ecosystem stabilization. They also contribute to the function of ocean ecosystems and have direct value to rural coastal communities across the tropical region including PNG.
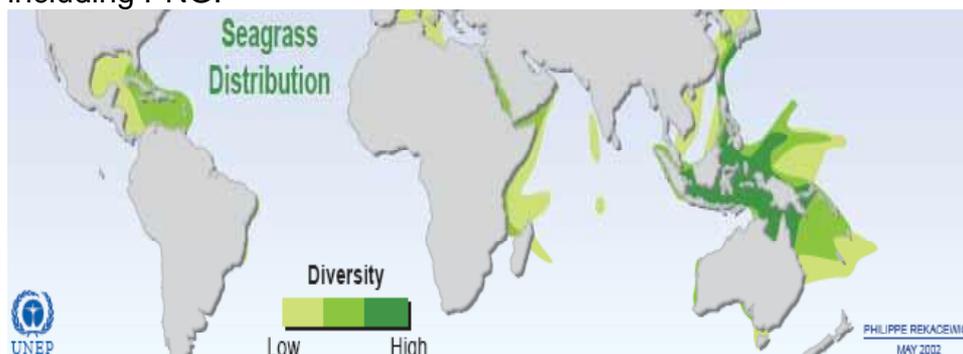
Figure 3. Seagrass species richness. (Source from 2005 UNEP-WCMC).

Terrestrial Vertebrate Diversity

PNG's geological history has played a great role in shaping the island's rich biodiversity particularly its terrestrial vertebrate fauna. Orogenic events have created a mosaic of new habitats and preserved relict ones ,facilitating speciation on a grand scale (Flannery 1990; Baldwin et al.2012;Toussaint et al.2014; Georges et al. 2014). Papua New Guinea and its nearby islands have the highest endemism of all fauna. PNG's birds account for the largest group with endemism among birds being the highest in the world with over 330 species (Clements,2000). Amphibians are well represented with 352 species and are richly represented on the mainland but poorly in the nearby islands (Kraus and Allison, 2002). It has the highest level of endemism among the New Guinea fauna groups. The reptiles feature next with 335 species, although endemism among reptiles are obviously much lower than those of amphibians, mammals and birds. The terrestrial mammalian fauna account for around 298 species (Allison and Tallowin ,2014),with 89.5% endemism out of the 813 species recorded, this endemism being highest in the nearby island archipelagos.

Among the mammals, the murid fauna is by far the most abundant and diverse and one of the most species rich found anywhere on earth (Flannery,1990).

The terrestrial vertebrate species richness particularly mammals is highest along the eastern central Cordillera from the upper Strickland River to the mountains in the vicinity of Wau and extends along the south-eastern peninsula to Mt.Dayman. Principal faunal elements (6) endemic species

found along the Strickland-Wau bioregion are *Austrochaperina archibolidi and Liophryne allisoni* (Microhylidae-Genyophryninae), *Antechinus naso tafa, A. naso misim* (Dasyuridae), *Dendrolagus goodfellowi buergersi and D. dorianus notatus* (Macropodidae) , *Phalanger sericeus sericeus* (Phalangeridae), *Pseudochirulus canescens canescens* (Pseudocheiridae) and *Abeomelomys sevia and Crossomys moncktoni* (Muridae).

The south-eastern central cordillera stretches from the mountains southward of the vicinity of Wau to the Mt.Dayman in the southeast peninsula. Because the ecoregion includes coastal, lowland and montane areas that encompass the Mambare and Angabanga Rivers along the east and west coasts, the number of terrestrial vertebrates are quite large. The non-volant and volant mammals number up 138 species, of which 28 are endemic or near-endemic (Flannery 1995, Flannery and Groves 1998). The bird species found within the bioregion number up to 510 species, of which about 40 are endemic or near endemic to the bioregion.

Mammalian richness peaks trace the Central and southern Owen Stanley mountains periphery, with lowest richness in the trans-Fly and Sepik lowlands (see Figure 6). Conversely, the trans-Fly regions accounts for the highest species richness with 102 species with 58 being shared with Australia. Around 30% of the trans-Fly reptiles are endemic to New Guinea and only 3 (3%) are endemic to the trans-Fly region (Allison, 2006).

Recent studies by Tallowin et al. (2016) assessed the species richness, cross-taxon congruence and environmental correlates of PNG's terrestrial vertebrates. This study reveals that elevational range strongly correlates with PNG amphibian, bird and mammalian species richness at coarser spatial resolutions. They provide evidence for the existence of elevational-based mechanisms promoting species richness through high levels of persistence and speciation in PNG amphibians, bird and mammal groups. In contrast, reptilian species richness was strongly constrained by elevation, with peaks in the warmer lowlands, suggesting that these are central regions for reptile diversification and persistence.
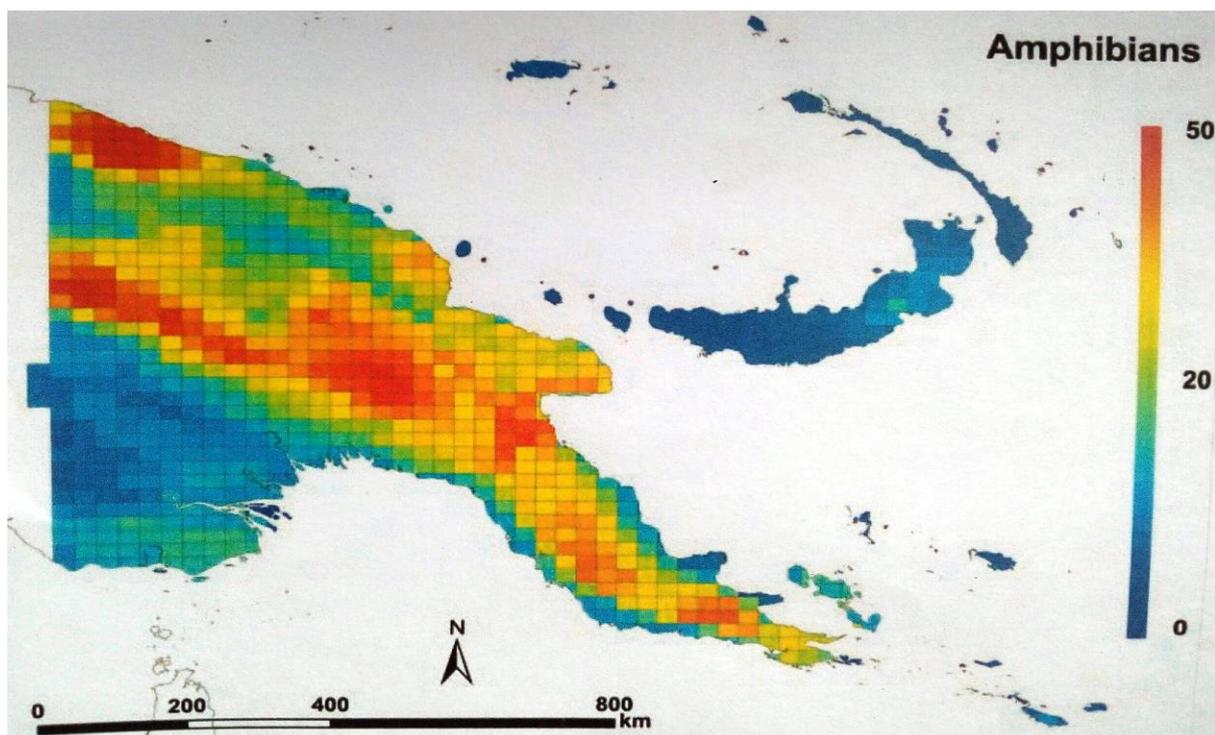
Figure 4   : Amphibian species richness in Papua New Guinea
                (after Allison & Tallowin 2014)

Amphibian richness peaks within the Central Highlands and north-western Bewani and Torrecelli mountain ranges, with less pronounced peaks on the south-eastern Owen Stanley mountain ranges. Lowest amphibian richness occurs in the south-western Fly, north–western Sepik, and coastal lowland areas. Bird richness reveals a strong affinity to the Papuan peninsula, with greatest richness bordering the Owen Stanley mountain ranges and lowest within the interior of the Central High lands, south-western Trans-Fly and north-western Sepik lowlands (Figure 5).
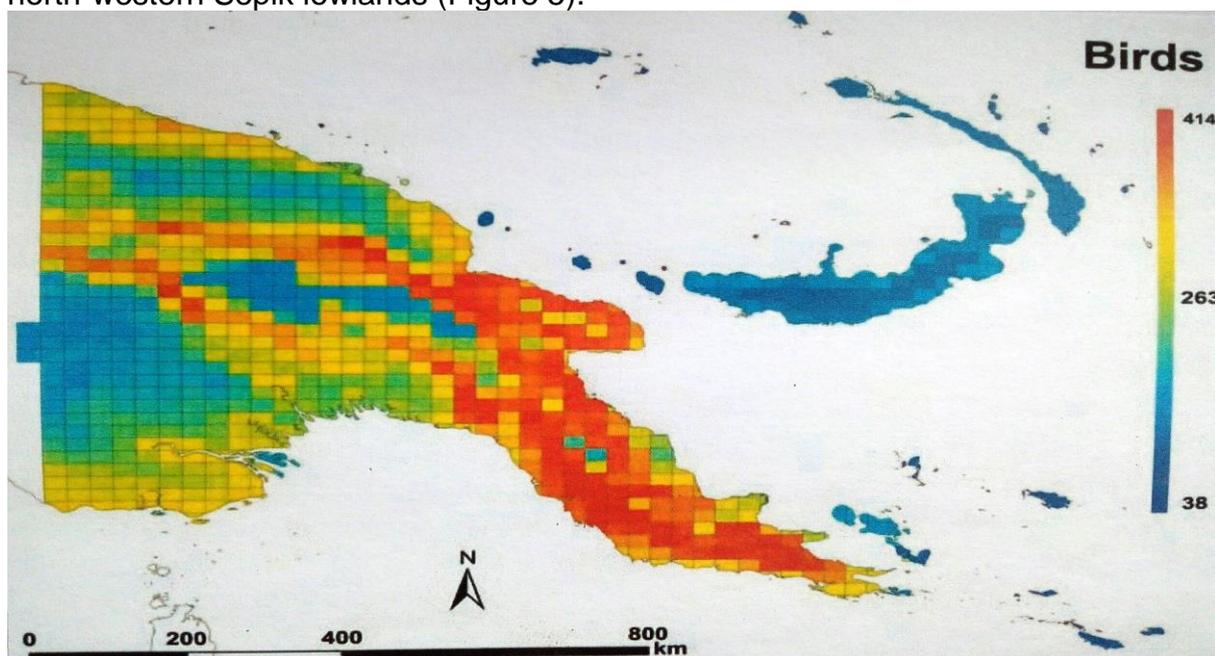
Figure 5   : Bird species richness in Papua New Guinea. (after Allison & Tallowin, 2014).
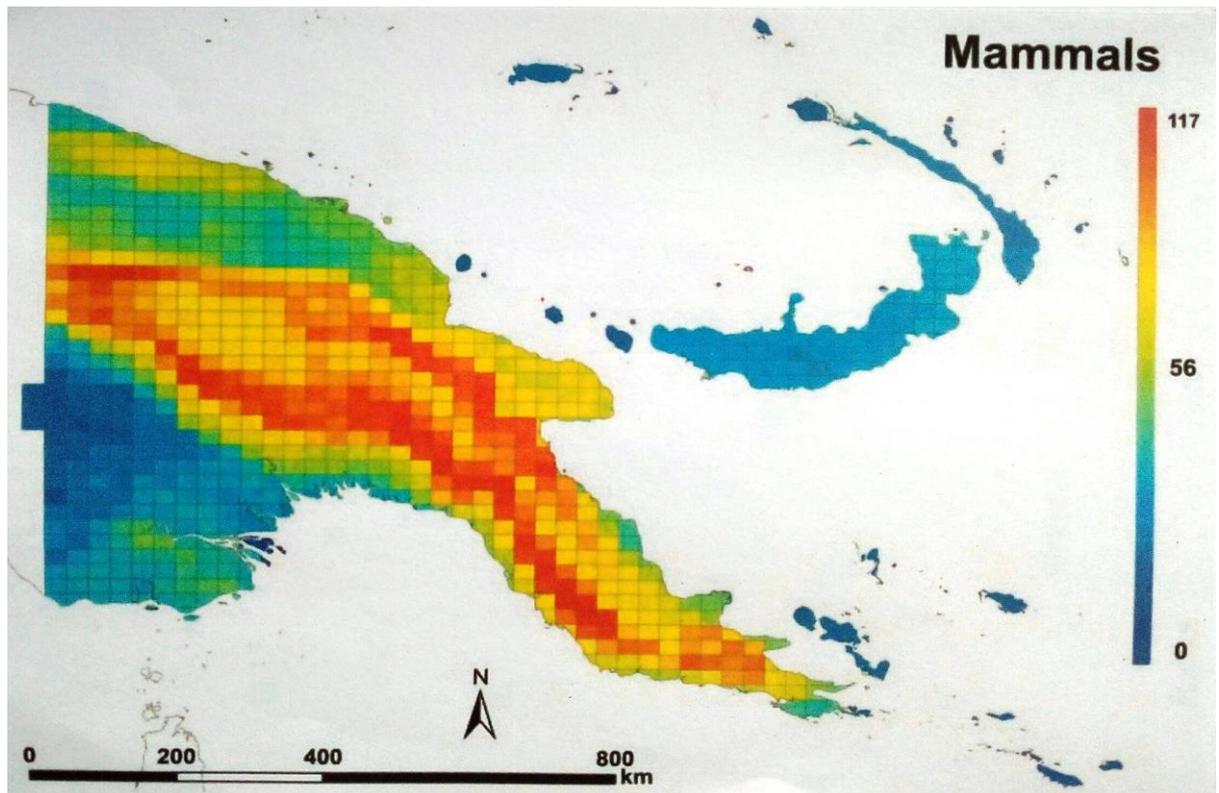
Figure 6: Species richness for PNG mammals. (after Allison & Tallowin 2014).
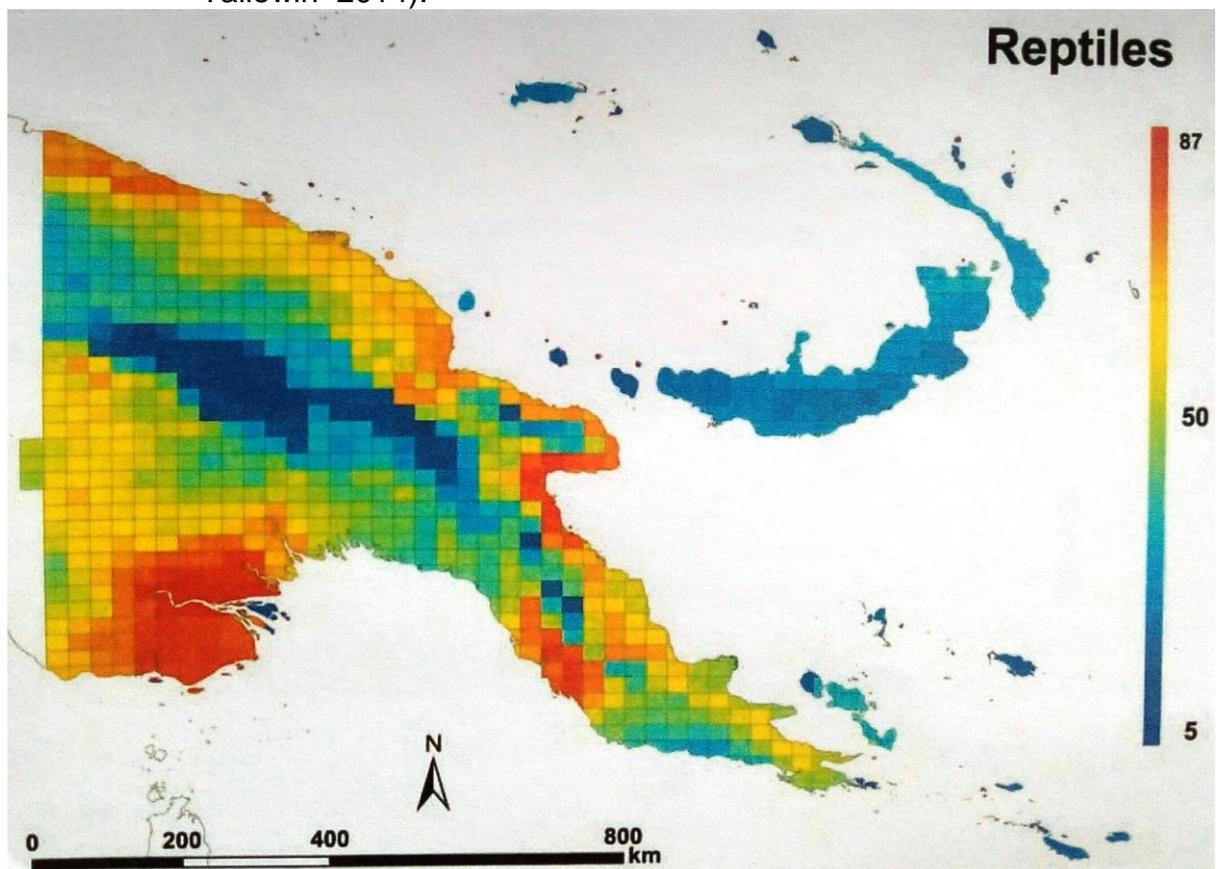
Figure 7: Species richness for PNG reptiles. (after Allison & Tallowin 2014).

Reptile richness tends to peak in the lowland areas and hill forest, tapering off to fewer species above 3000m in montane forests. Recent RAP surveys in the Kainjede Range reported the presence of 2 species (Richards,2007a), and 12 species in the upper catchment of Strickland River (Richards and Dahl, 2011) . The highest peaks for reptile richness are the savannah areas of the Trans-Fly and Central Province including coastal regions along the north coast of Oro and Huon Gulf including representation among the north coast ranges comprising the Prince Alexander, Torricelli and Bewani Ranges. The species richness declines along the south-eastern peninsula with richness decreasing towards the west along central cordillera into interior of the country. Dividing PNG reptiles into lizards and snakes reveals strikingly different richness, with lizard richness showing peaks in northern lowland areas along the Huon Gulf and north-west West Sepik, whereas snake richness peaks in the lowlands of the Trans-Fly and south-central Papuan peninsula (Tallowin et al. 2016).

The Mammals occurring in Papua New Guinea, of which almost 200 are endemic, are rich in marsupials and rodents. The tree kangaroos *Dendrolagus* are a major group with 60 per cent found in Papua New Guinea. The skins of some tree-kangaroos are used by some groups within PNG as a part of customary ceremonial dress. Five species are unique to PNG and a further 2 are shared with Indonesia of the currently recognised 12 species. Another genetically distinct endemic is the long beaked echidna *Zaglossus* of which two of the three species are shared between PNG and Indonesian New Guinea. Many of the mammal species are a protein source for the local people of PNG.

Of the 42 recognised species of Birds of Paradise (Frith and Beehler, 1990), two species are endemic to Australia, two are endemic to the northern Moluccan islands of Indonesia, ten are endemic to Papua New Guinea and 38 species are found in New Guinea (Papua province and PNG). Ten species of the Birds of Paradise are unique to PNG and a further 20 are shared with Indonesian New Guinea and a further 2 species shared with Indonesia and Australia of the currently recognised 39 species. The plumes of many birds of paradise area an important part of customary head-dress of many cultures used for traditional cultural events.

1.3.2   Marine Biodiversity

The marine biodiversity in Papua New Guinea of corals, reef fish and molluscs is among the highest species richness in the Coral Triangle and is therefore of global importance. There are 430+ species of corals (Figure 9). There are near 1000 species of molluscs and 1100+ reef fish species (Figure 10). Papua New Guinea therefore has some of the highest biodiversity richness in the world.
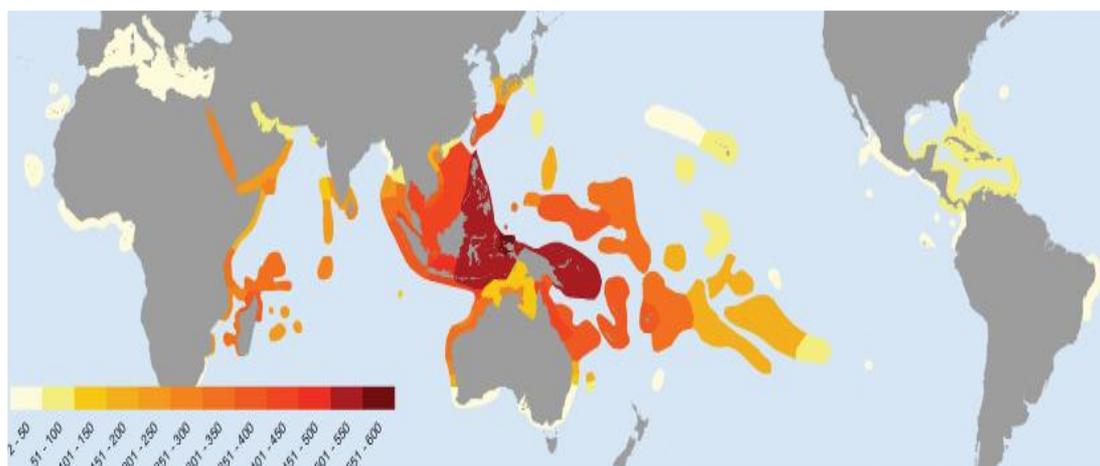
Figure 8: Biodiversity of reef building corals, showing the location of the Coral Triangle (>500 species in each ecoregion: Vernon et al.2015). Colours indicate total species richness per ecoregion (after Vernon *et al.2015*).
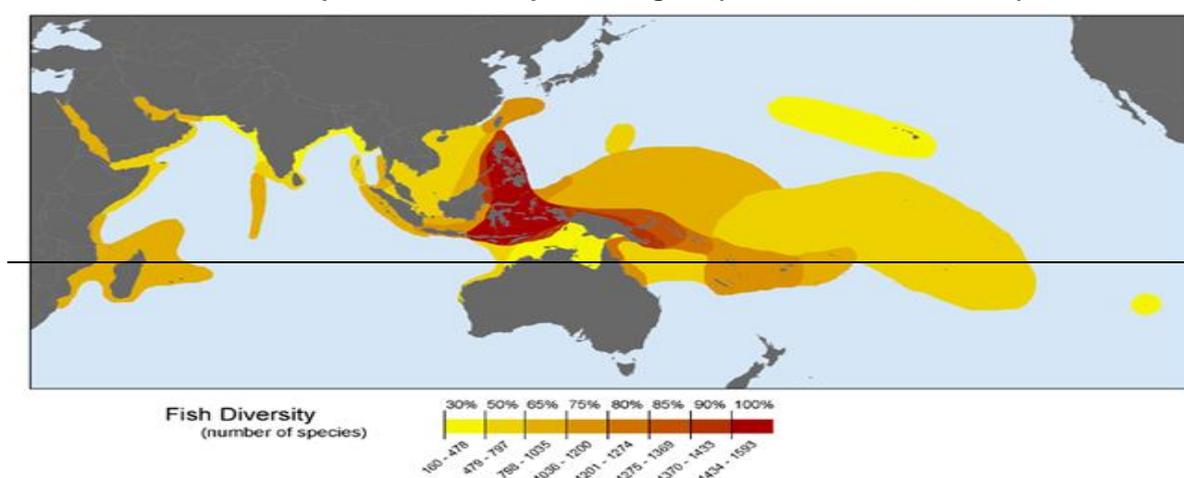
Figure 9: Biodiversity of coral reef fishes, showing location of the Coral Triangle (where more than 85% of the species in the Indo-Pacific region can be found (after Allen,2008)

2   *Major changes in the status and trends of biodiversity in PNG*

2.1   Biodiversity Status

Biological collection in Papua New Guinea across PNG's coastal and interior regions started during the early 1900's with many of the collections destined for private collections, and natural history museums across Europe, US and Australia. Details of the historical expeditions organized by various collectors and institutions are given by Allison and Tallowin(2015). Our knowledge of the distribution and ecology of the numerous biota only began to emerge after research efforts were intensified during the late 1980s. Currently, Bishop Museum, Honolulu holds the largest collection of botanical and zoological specimens from PNG. During the three decades, collaboration among foreign researchers affiliated with notable museums has intensified field surveys into many remote regions of the country. Collaboration among international NGOs; Conservation International, WCS, WWF, TNC including Bishop Museum have also expanded our knowledge of the wealth of our biodiversity.

A Rapid assessment Program (RAP) initiated by Conservation International has contributed much to our biodiversity knowledge with field surveys focused on remote biodiversity rich parts of the country during the last two decade. Recent RAP field surveys into the remote Hindenberg Wall, the Muller Ranges, Kaijende Ranges, Bewani and Torrecelli in the north coast including Nakanai in the Bismarck Archipelago have added much to PNG's biodiversity status. Recent RAP surveys have also expanded emphasis on terrestrial invertebrates (butterfly, odonata, ants, spiders etc.). Despite recent advances in our biodiversity knowledge, many regions of the country still remain unsurveyed (Figure 10).
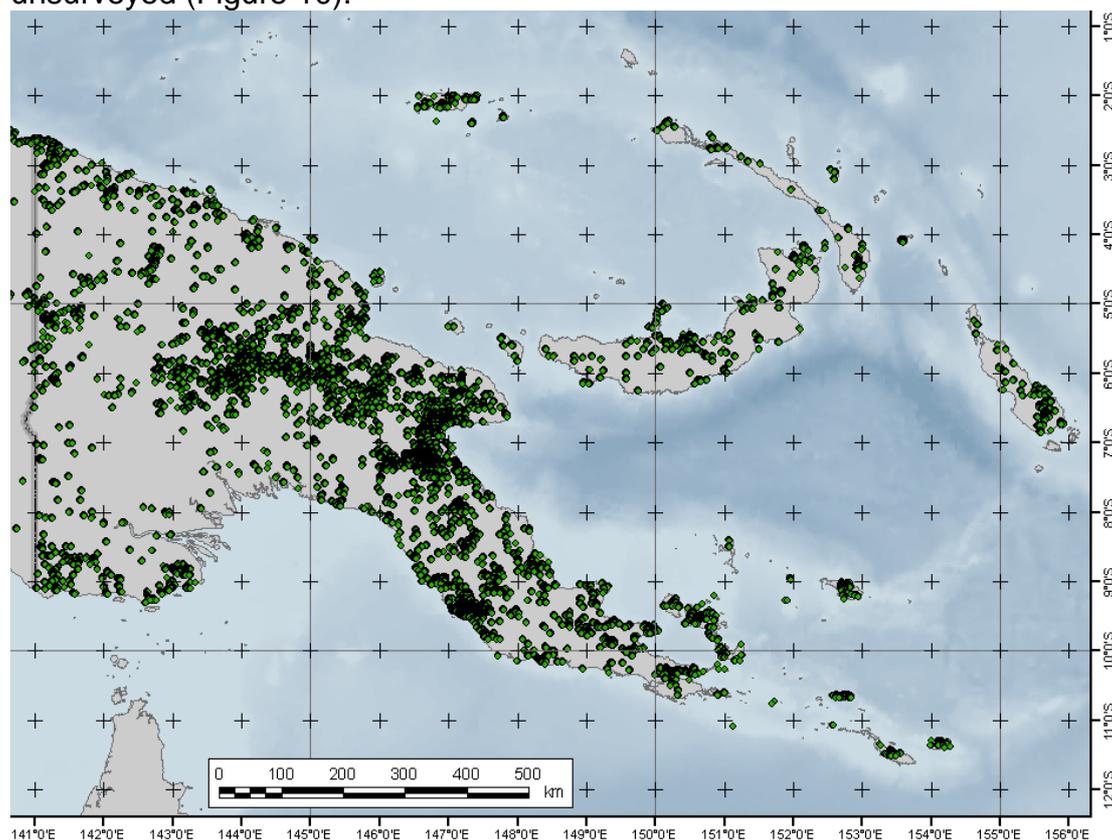
Figure 10. All survey and *ad hoc* locations based on compiled taxa records with acceptable spatial accuracy (after Allison and Tallowin, 2014)

There are also areas surveyed but only for limited taxa. What biodiversity is found is also often dependent upon the time of year and weather during collection. This is a major issue in relation to the reporting of the status and trends of biodiversity for Papua New Guinea.

A Rapid Assessment Program (RAP) initiated by Conservation International in collaboration with museums around the region has made many inroads into expanding the status and knowledge of PNG's biodiversity. During the past two decades, the RAP has involved field surveys of putatively important biodiversity areas of the country thereby uncovering PNG's biodiversity wealth. The RAP field survey efforts have reached many of PNG's remaining unknown or poorly known parts of the country. These field surveys have led to the discovery of literally hundreds of new species including more than 200 species of frogs. The RAP field survey of 2008 and 2009 into the far interior montane grasslands and forests of PNG, reaching elevation of over 3,000m

a.s.l have shed light on vulnerability of many restricted-range species and species extensions of some bird species. For example, The RAP field surveys of 2008 in the Kainjede Ranges and 2009 survey in the Muller Ranges in the Central Cordillera of PNG shed much light on the status of many terrestrial vertebrate species that indicated signs of shifts in range extensions due to climate change (Beehler & Sine 2008). The Muller Range RAP field survey is of significance as it reached the upper catchment of the Strickland River that drains both the Fly and Sepik Rivers. The Strickland catchment forms much of the central cordillera of the Owen Stanley Ranges reaching Mt.Dayman in the south-eastern peninsula. The RAP surveys have also expanded PNG's current knowledge of lesser known species particularly invertebrates such as insects, dragonflies and damsel flies (Odonata), spiders, ants and katydids. PNG Medical Research Institute has also recently joined the RAP surveys focusing its efforts on zoonotic diseases.

As a case in point, due to RAP efforts, in the decade from 1995 to 2005 the number of known frog species in PNG increased by nearly 100% from 200 described species to the present 342 species (Figure 11a). The more recent RAP field surveys (2007-2015) in the Muller, Strickland, Kaijende and Hindenburg Ranges have also yielded many more species that are new to science. It is still anticipated that with increased survey effort of both previously surveyed areas and new unsurveyed areas more new species will continue to be found (Figure 11b). It is difficult to report species population trends when new species are being found of which very little natural history is known or the range and total population is an estimate. Most species records are based on varying techniques including voucher specimen collections, sight, acoustic, or camera trapping records. The camera trapping techniques are particularly useful for elusive nocturnal mammals.
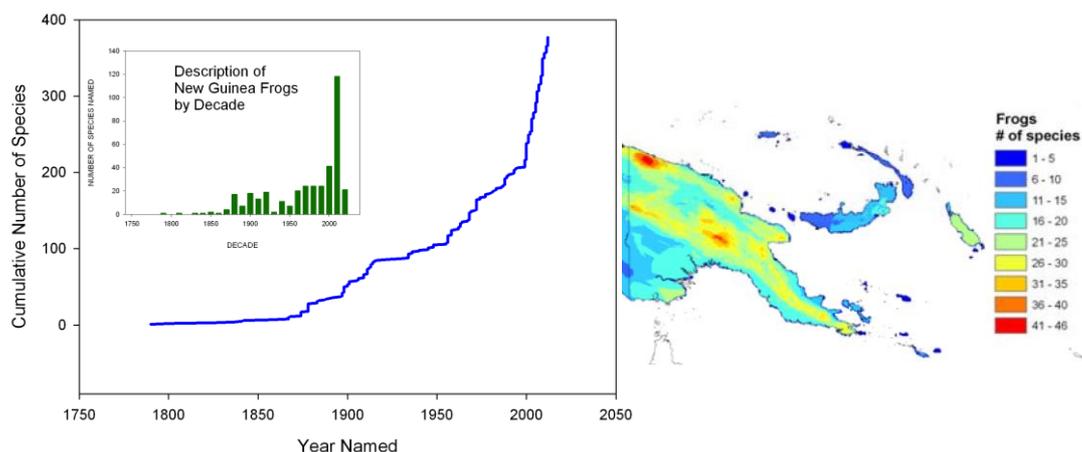
Figure 11a. Cumulative description of new frogs   Figure 11b. Species richness of frogs

Although many mammal species have been named, there are few for which the natural history is well known and for which the effective and total populations are known. Even less has been monitored over time to reveal trends in population. This is compounded by the often inaccessible and rugged terrain and scattered distributions of many species. The Global Mammal Assessment has assigned IUCN categories to most mammals

however the status often changes with improved species information rather than a reasoned change over time.

Through well directed discussions with hunters their views on hunted species spatial and temporal trends over time can be collected. Often they will hold views that will explain these trends. Within PNG there is no formally organised citizen science collection to bridge the knowledge gap we have on the vast number of species found in Papua New Guinea.
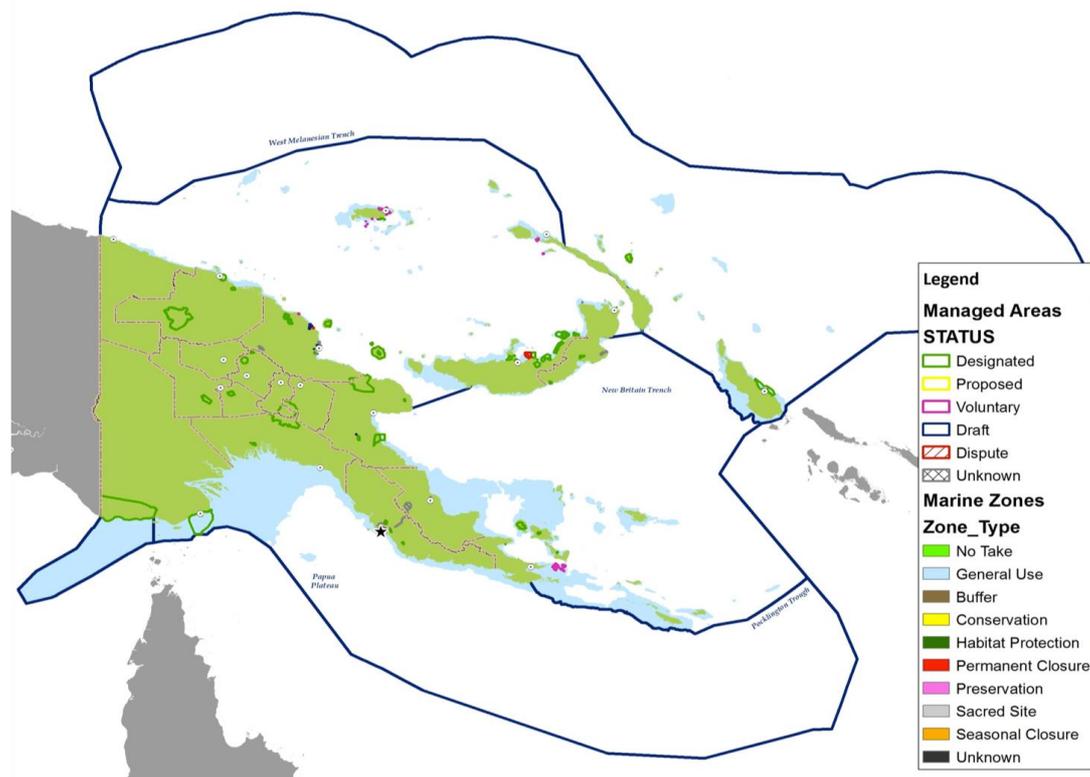
Figure 12. PNG's Terrestrial and Marine Protected/Managed Areas

2.1.1 Protected Areas Status

Within Papua New Guinea the number of Terrestrial Protected areas remains the same with the gazettal of proposed new Wildlife Management Areas WMAs on hold pending the transition of DEC to CEPA and the approval by cabinet of the *Policy on Protected Areas 2014* to direct the way forward in the protected area system. Within the policy there is indication that using the information from the Terrestrial and now Marine PoWPA along with field assessment, the current status and effectiveness of the current protected area network for conserving biodiversity will be evaluated.

Also from the work of the Coral Triangle initiative several community initiatives have established Local Marine Areas (LMMAs). These have a range of different management restrictions and level of protection through the use of no take zones (Figure 12). A list of these different levels of conservation appears in the following Table 2.

Table 2. Number of Areas under Conservation in PNG

Status	Designation Level		Marine
	Terrestrial		
	National	Local	
Designated (Gazetted)	39		9
Designated (Local)		21	12
Proposed		3	
Voluntary		16	16
Draft	1	9	4
Unknown	9	9	9
Dispute		3	3
	49	61	55

The total land area of PNG under formally recognised conservation is 1,897,595ha, 91% of which is within Wildlife Management Areas (WMAs) and 4% within the current Conservation Area (CA). This represents approximately 3.8% of the countries land area. Within the *Policy on Protected Areas 2014* it indicates that the status of these protected areas must be determined as part of the process moving forward as some of this area has been degraded through development projects. Under RAPPAM assessment many areas were no longer under any form of active management.

The approach to marine conservation has to date been quite different to that of historical terrestrial conservation. Several WMAs were previously established in marine areas, though in recent years the trend has been the establishment of Local Marine Management Areas around the country. These combine zoning as well as rules in their management with conservation as a fisheries management tool.

2.1.2   Species Status

Papua New Guinea is a high biodiversity country. This high biodiversity richness is expected with PNG lying in the tropics and containing many ecosystems across both altitude/bathymetry gradients and latitude. These ecosystems often have high biodiversity richness and with so many species, so few are well known.

The IUCN Red List of 2008 indicates an estimated number of all species described including plant, animal taxa of 26,381 with number assessed to be 2,316. Among the taxa that are well assessed are the birds, mammals and amphibians at 100% followed by reptiles, fishes ,plants and invertebrates.

The Mammals have been assessed under the Global Mammal Assessment and likewise the frogs under the Global Amphibian Assessment and all birds have been assessed. However the gaps in taxonomic group assessment are Plants, Reptiles, Reef Fish and Molluscs, which represent important elements of our tropical vegetation and marine biota (Figure 13). The invertebrates are a very large group that are also have estimates of a large number of still undescribed species.
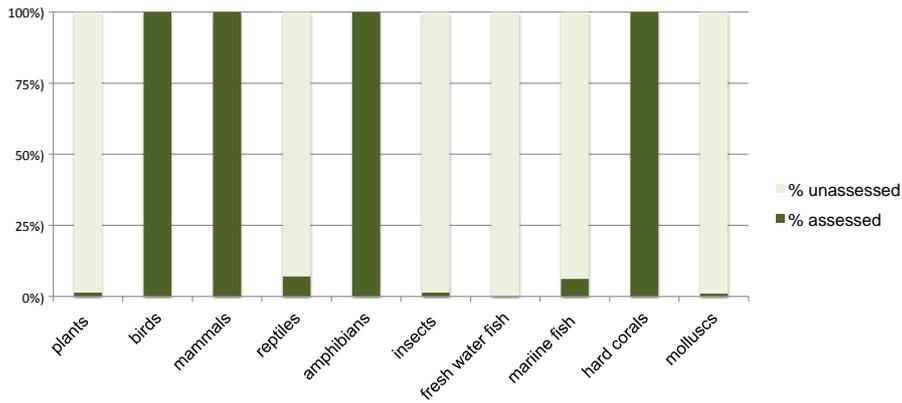
Figure 13. Percentage Assessed and non-assessed described species for selected taxa for PNG IUCN 2014.2.
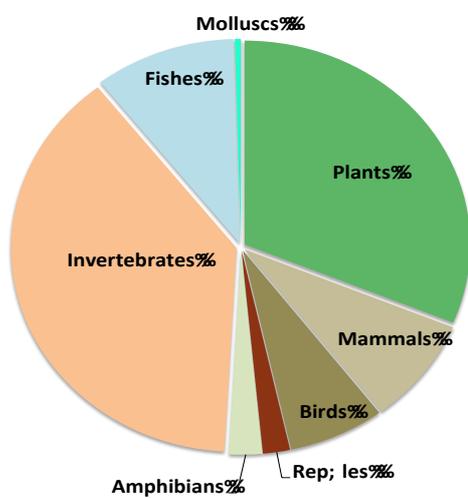
Figure 14. Number of threatened species by taxa IUCN 2014.2
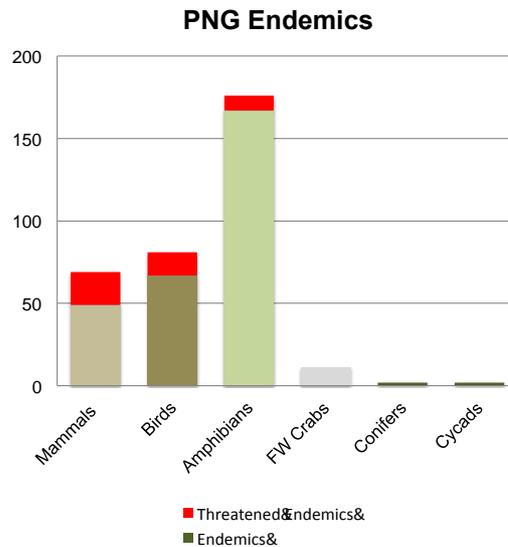
Figure 15. PNG Threatened Endemics for selected taxa IUCN 2014.2

From Figures 14 and 15, it can be seen that the PNG mammal endemics are the most threatened as per the IUCN red list, of the taxa assessed,. followed by birds and amphibians. The total animal species threatened are 319 and plant species 133 in 2014 (Table 3 and Figure 15)

Table 3: PNG Red List species (2014.2)

Red List	Animals	Plants	2015	20
EX	1	0	0	0
EW	0	0	0	0
CR	20	13	15	17
EN	42	14	12	18
VU	257	116	117	11
NT	251	38	38	38
LR/cd	3	0	0	0
LC	1970	302	313	313

Total Species 2959

- EX)
- EW)
- CR)
- EN)
- VU)
- NT)
- LR/cd)
- LC)
- DD)
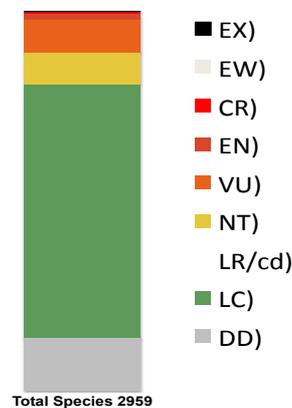
DD	415	36	36	36
TOTAL	2959	251	531	539

Figure 16: PNG Red List Category Animals (IUCN 2014.2): EX Extinct; EW Extinct in the wild; CR Critically Endangered; EN Endangered; VU

Despite Papua New Guinea being among the megadiverse countries of the world and its current economy being driven by industrial scale mining, its largely rural population embraces a very much subsistence lifestyle revolving around subsistence gardening and hunting. Subsistence agriculture has been identified as the second most important drivers of deforestation and forest degradation in the country. Traditional hunting and subsistence gardening play significant roles in sustaining rural livelihoods. Both activities contribute to the increasing threats to loss of biodiversity. By comparison with other tropical forests of the world, PNG's forests are largely absent of large game animals. The forests of PNG host only several large-bodied marsupials whose average biomass is just around 20 kg. Hunting efforts are therefore expanded to cover a wide range of species, from birds with biomass of less 100g to the tree kangaroo with an average biomass of 15 kg.   With a rapidly growing rural population, increasing demand for food security, and industry-driven logging, commercial agriculture and ever-expanding mining sector, the challenges for maintenance of forest ecosystem services and environment resilience for biodiversity conservation is ever more challenging for PNG in light of its obligation to CBD and global MEAs.

Table 4. Change of IUCN Red list Category of Species that occur in PNG or its EEZ 2010-2014

Scientific Name		Common Name	IUCN Redlist year		Version
Species changing IUCN Red list Status (2013-2014)			**2013**	**2014**	
Paradisaea	*decora*	Goldie's Bird of Paradise	NT	VU	2014.2
Species changing IUCN Red list Status (2012-2013)			**2012**	**2013**	
Gouria	*victoria*	Victoria Crowned pigeon	VU	NT	2013.2
Lepidodactylus	*mutahi*	Bougainville's scaly-toed gecko	LC	DD	2013.2
Agathis	*labillardieri*	New Guinea Kauri	LC	NT	2013.1
Lagarostrobos	*franklinii*	Huon Pine	LR/lc	LC	2013.1
Dermochelys	*coriacea*	Leatherback Turtle	CR	VU	2013.1
Parapistocalamus	*hedigeri*	Bougainville Coral Snake	LC	DD	2013.1
Species changing IUCN Red list Status (2011-2012)			**2011**	**2012**	
Pyrrhura	*vulturina*	Vulturine Parrot	LC	VU	2012.1
Species changing IUCN Red list Status (2010-2011)			**2010**	**2011**	
Thunnus	*alallunga*	Albacore Tuna	DD	NT	2011.2
Thunnus	*albacares*	Yellowfin Tuna	LR/lc	NT	2011.2
Xiphias	*gladis*	Swordfish	DD	LC	2011.2

CR Critically Endangered, EN Endangered, VU Vulnerable, NT Near Threatened, LR/lc , LC Least Concern, DD Data Deficient

2.2.1 Trends in Terrestrial Biodiversity

Primary forests in Papua New Guinea continue to be degraded through land use changes as indicated below. It has been estimated that PNG lost around 13.71 million hectares of primary forest over a 25-year period (1990-2015)(Morales-Hidalgo et al. (2015) years. According to the IUCN Red List (2014), a total of 448 species were listed as Threatened. Of these 39 were mammals, 39 birds, 11 amphibians, 11 reptiles,49 fishes, 2 molluscs, 149 invertebrates and 151 plants (Table 5). Two additional species were added to the list in 2015 (Table 5).

Table 5 : IUCN RED LIST of PNG Threatened Species

Year	Mammals	Birds	Reptiles*	Amphibians	Fishes*	Molluscs*	Other Invertebrates*	Plants*	TOTAL
2014	39	38	9	11	49	2	149	151	448
2015	39	39	9	11	49	2	149	152	450

Marsupials comprise about half of the assemblage of Endangered and Critically Endangered PNG mammals. Because many of them are relatively large, they are important sources of bush meat and threatened with over-hunting particularly in the Central Highlands region of the country, a hotspot for restricted-range endemic mammals.The twin effects of forest loss and over-hunting has already caused the localized extinction of relatively widespread species such as the eastern long-beaked echidna, (*Zaglossus bartoni)* and Goodfellow's tree kangaroo (*Dendrolagus goodfellowi)* and may very well lead to the extinction of some of the restricted-range species(Allison and Tallowin,2015).

There are 39 species of terrestrial mammals listed as Threatened on the IUCN Red List(2015-2). Eleven species are listed as Critically Endangered (CR) and include a monotreme, *Zaglossus bartoni,* 6 species of marsupials ;*Spilocuscus rufoniger, Phalanger matanim, Petaurus abidi, Dorcopsis atrata, Dendrolagus scottae and D.pulcherrimus,* a murid, *Solomys ponceleti,* and three species of bats,*Pharotis Imogene, Aproteles bulmerae* and *Pteralopex flanneryi.*

The Endangered (EN) mammals include 9 species of marsupials; *Thylogale lanatus,T.calabyi, Phalanger lullulae, Echymipera davidi, Peroryctes broadbenti, Dendrolagus notatus, D.matschiei, D.goodfellowi and Dactylopsila tatei* and four species of rodents; *Paramelomys gressitti, Paraleptomys rufilatus, Melomys matambuai, Solomys salebrosus,* and the Bougainville monkey-faced bat (*Pteralopex anceps).*

The remaining 14 species of mammals listed as Vulnerable (VU) on the IUCN Red List are a mix of relatively widespread but uncommon species and narrow-range endemics.

A total of 39 species of birds are also listed as Threatened in PNG, of which 34 are considered as Vulnerable, four as Endangered and one as Critically Endangered . The single critically endangered species is a seabird,

Pseudobulweria becki known from PNG-Solomon Islands area, now locally common in the sea between New Britain and New Ireland (Allison and Tallowin,2015). Four species considered to be endangered include *Otidiphaps insularis, Pitta superba, Actenoides bougainvillei* and *Aplonis brunneicapillus.* The latter two, a kingfisher and a starling are restricted to the Bougainville island group, while *O.insularis* is restricted to the Fergusson Island in the D'Entrecasteaux group in Milne Bay Province. The superb pitta (*P.superba*) is restricted to the Manus island group. The remaining 34 species listed as Vulnerable are still represented by reasonably large population in PNG ,with some facing extreme pressure from over-hunting, e.g. two species of cassowary (*Casuarius casuarius* and *C.unappendiculatus),* the Vulturine Parrot (*Psittrichus fulgidus),* a number of large raptors and a large number endemics from the Bismarck Archipelago.

In this reporting period one species of Bird of Paradise, the Goldie's found on two satellite islands of PNG has been upgraded to Vulnerable due to loss and fragmentation of its habitat from subsistence farming, commercial logging and mineral exploration within its habitat. The Vulturine Parrot with a patchy distribution in the foothills across the Island of New Guinea has also been upgraded to Vulnerable (Table 4).

Trends in PNG Forests

Papua New Guinea including its island provinces of the Bismarck Archipelago covers a total land area of about 46.3 million hectares. Approximately two-thirds of the country is covered in forest, the majority of which is classified as tropical rainforest. The extent of the country under forest has been contentious(Filer,2011), but the two most recent estimates have stated Papua New Guinea contained between 28 million hectares of 'tropical rainforest' (Byran and Shearman 2015) to 33.6 million hectares of 'forest areas' (FAO 2015).

As a young developing country, PNG's forestry sector is one of the major foreign revenue contributors to the country's economy and thus becomes one of the major drivers of deforestation and forest degradation. While PNG still retains a large proportion of its natural forests, there is considerable loss of primary forests and forest degradation and widespread small-scale clearance for gardens and subsistence agriculture. Commercial logging is primarily focused in the lowlands and island forest areas while subsistence agriculture is prevalent throughout the country. However, the subsistence agriculture sector in the Highland provinces accounts for a major part of the industry and urban-driven economy.

At the global level, some 234 countries reported increases in primary forests areas, with the Russian Federation, Canada, the Democratic Republic of Congo, United States, Peru and Indonesia together accounted for 75% of the global reported primary forest area in 2015 (Table 4). However, PNG was among tropical countries that reported overall decline in primary forest areas between 1990 and 2015. Morales-Hidalgo et al. (2015) cited PNG was among the top 15 countries that reported largest losses of primary forest over the 25-year reporting period (1990-2015).This report showed that Brazil reported the highest loss of primary forest of 15.5 million hectares followed by PNG on

13.7 million hectares , with Indonesia ,the fourth largest with 3.4 million hectares in the period (2000-2015), (Table 6).

Table 6 : The 15 countries reporting largest primary forest area (in 1000 ha) to FRA 2015 (representing 90% of the global primary forest area reported to FRA, 2015)

Country	Primary forest area (area '000 ha)						
	1990	2000	2005	2010	2015	% of total (2015)	Cumulative %
Russian Federation	241,726	258,131	255,470	273,343	272,718	21.4	21.4
Canada	206,638	206,359	206,225	206,062	205,924	16.13	37.5
Brazil	218,240	210,359	206,578	202,691	202,691	15.9	53.4
Congo	105,189	104,455	104,088	103,387	102,686	8.0	61.4
USA	70,012	72,305	75,709	75,294	75,300	5.9	67.3
Peru	69,632	67,684	67,148	66,524	65,790	5.2	72.5
Indonesia	-	49,453	48,310	47,167	46,024	3.6	76.1
Venezuela	-	-	-	46,568	45,746	3.6	79.7
Bolivia	40804	39046	38164	37164	36164	2.8	82.5
Mexico	39,443	35303	33826	33168	33056	2.6	85.1
PNG	31,329	25,837	23,091	20,345	17,599	1.4	86.5
India	15,701	15,701	15,701	15,701	15,701	1.2	87.7
Suriname	14,986	14,742	14,590	14,422	14,019	1.1	88.8
Gabon	20,934	17,634	15,984	14,334	12,804	1.0	89.8
Mongolia	12,534	11,714	11,305	13,038	12,552	1.0	90.8

Table   7 : The 15 countries reporting to FRA 2015 with the greatest loss of primary forest area between 1990 and 2015 (area '000 ha)

Country	Primary forest area (area '000 ha)		
	Primary forest area change 1990-2015	% of the change at country level (1990 baseline	% of Global primary forest area (1990 baseline year)

			year)	
Brazil	-15,549		-7.1	-1.3
PNG	**-13,730**		**-43.8**	**-1.1**
Gabon	-8130		-38.8	-0.7
Mexico	-6387		-16.2	-0.5
Bolivia	-4640		-11.4	-0.4
Peru	-3842		-5.5	-0.3
Guyana	-3000		-31.7	-0.2
Congo	-2503		-2.4	-0.2
Ecuador	-2119		-14.5	-0.2
Central African Republic		-1912	-49.0	-0.2
Guatemala	-1617		-54.8	-0.1
Nigeria	-1536		-98.7	-0.1
Suriname	-967		-6.5	-0.1
Malawi	-882		-51.1	-0.1
Canada	-444		-58.0	0.0

Annual

deforestation rates in PNG are reported as around 0.49% for most provinces within the country according to recent estimates of Byran & Shearman (2015) as shown in Table 8.

Table 8: Change in PNG's rainforest area (km^2) 2002-2014

PROVINCE	RAINFOREST AREA 2014			RAINFOREST CHANGE 2002-2014				
	TOTAL (KM^2)	UNLOGGED (KM^2)	LOGGED(KM^2)	DEFORESTED(KM^2)	LOGGED(KM^2)	DEFORESTED(%)	LOGGED (%)	TOTAL CHANGE (%)
WESTERN	45,167	38,161	7,006	583	1,476	1.3	3.2	4.5
GULF	23,311	18,465	4,946	360	1,474	1.5	1.5	7.7
CENTRAL	19,541	17,332	2,209	89	409	0.5	2.1	2.5
MILNE BAY	9,125	8,079	1,046	135	40	1.5	0.4	1.9
ORO	15,369	14,423	946	226	45	1.4	0.3	1.7
MOROBE	20,783	19,644	1,140	182	38	0.9	0.2	1.1
MADANG	19,573	18,380	1,193	376	455	1.9	2.3	4.2

EAST SEPIK	20,196	19,223	974	273	532	1.3	2.6	3.9
WEST SEPIK	26,955	23,159	3,796	329	1,394	1.2	5.1	6.3
MAINLAND COASTAL REGION	200,021	176,865	23,156	2,553	5,864	1.3	2.9	4.2
SOUTHERN HIGHLANDS + HELA	18,574	18,051	74	196	1	1.0	0	1.0
ENGA	7,989	7,989	0	90	0	1.1	0	1.1
WESTERN HIGHLANDS + JIWAKA	4,941	4,941	0	39	0	0.8	0	0.8
CHIMBU	3,596	3,596	0	42	0	1.1	0	1.1
EASTERN HIGHLANDS	5,687	5,617	70	39	0	0.7	0	0.7
HIGHLANDS REGION	40,787	40,643	144	406	0	1.0	0	1.0
MAINLAND TOTAL	240,809	217,508	23,301	2,960	5,864	1.2	2.4	3.6
MANUS	1,213	911	303	27	86	2.1	7.0	9.1
NEW IRELAND	6,363	3,384	2,979	105	385	1.6	5.9	7.6
EAST NEW BRITAIN	11,126	8,018	3,108	259	577	2.3	5.1	7.3
WEST NEW BRITAIN	14,661	7,449	7,212	330	793	2.2	5.3	7.5
BOUGAINVILLE	4,597	4,597	0	70	0	1.5	0	1.5
ISLANDS REGION	37,961	24,359	13,603	790	1,842	2.0	4.8	6.8
TOTAL PNG	278,767	241,866	36,902	3,752	7,705	1.3	2.7	4.1

Source: Bryan and Shearman (Eds.) 2015: The State of PNG Forests (2014,UPNG)

Shearman *et al.* (2008) and Bryan and Shearman (2015) both report industrial logging as the primary driver of tropical rainforest loss and

degradation in PNG, and this practice being widespread throughout the lowlands of PNG mainland and throughout the island provinces.

Further, intensive deforestation and forest degradation also occurred in PNG under Special Agriculture Business Leases (SABLs) during the past decade. SABLs are fundamentally concessions allocated to private companies under a lease-leaseback scheme with customary landowners. It has been estimated that from 2003-2010 as much as 5.1 million hectares or 12% of PNG's total land area was leased to foreign companies under the SABL scheme (Nelson *et al.* 2014). Most SABL agreements were signed for palm oil estate development; however, experience has shown that logging was the primary activity with little effort put into palm oil estate development.

It has been reported that industrial logging followed by subsistence agriculture, commercial agriculture, and mining are the major drivers of deforestation and forest degradation in PNG (Shearman *et al. i2008; Bryan and Shearman, 2015).* The most important direct impacts on biodiversity are habitat destruction (Bawa and Dayanandan 1997; Laurence *et al. 2001;Tilman et al. 2001).* Loss of habitat area through clearing or degradation is currently the primary cause of range of declines in species and populations. While major drivers of forest loss and forest degradation in PNG have been identified (Shearman *et al. 2008; Filer 2011; Nelson* et al. *2014; Sam* et al. 2014; *Bryan & Shearman 2015; FAO 2015*), a major issue in habitat and land use change is habitat fragmentation. Human-induced fragmentation appears to be the primary driver of biodiversity loss in Papua New Guinea. Fragmentation affects all biomes, including, in particular forests. Globally over a quarter of the tropical rainforests biomes have become fragmented, or removed by humans (Bawa and Dayanandan, 1997) and PNG is no exception (Sam et. al.2014).

2.2.2 Trends in Marine Biodiversity

Papua New Guinea has a valuable and extensive fisheries sector ranging from inland river fisheries and aquaculture to coastal reef fisheries and deep water tuna fisheries.

Over 90% (2010) of coastal and near shore resources are under customary ownership. Much of this is impacted by the tragedy-of-the-commons where with increasing populations, food requirements and needs for cash income; fishers exploit the entire marine resource. This leads over time to its loss of resilience and subsequent degradation of the marine ecosystem. Also the selective targeting of top predator shark species and detritus feeder, sea cucumbers for cash income by fishers has to an unknown degree, impacted upon the ecological integrity and balance of the marine ecosystem.

The trends of impacts to the marine environment from subsistence and artisanal fisheries based on participatory rural appraisal usually finds a decreasing resource, especially where no proactive sustainable management is in place.

Biodiversity studies in the Milne Bay waters (Kinch et al. 2000) indicated that the reef condition index was robust. However with riverine tailings disposal, deep sea tailings disposal, potential sea bed floor mining and runoff from other land based developments this will be increasingly impacted especially in localised areas of activity.

The *State of the Corals Report 2012* stated that a significant loss of coastal fisheries is very evident along the coastline of PNG. Major populated provinces that have depended heavily on their marine resources to sustain their livelihoods have become under stress from fishing pressure and the methods of fishing while other factors including easy access to distant or protected fishing grounds by outboard powered engines and fiberglass boats.

Many reefs in PNG are close to shore and sensitive to terrestrial influences. A limiting factor in determining trends in marine biodiversity is that the research and monitoring capacity in PNG is relatively low with most programs run by NGOs, with few long term datasets for PNG reefs. There are also few Locally Managed Marine Areas LMMAs in PNG and awareness and support for marine resource management is mostly limited to areas where NGOs have active programs, such as in Manus, Kavieng, Kimbe Bay, Madang, Milne Bay and Central.

Trends of marine resources use in the LMMAs in Kimbe Bay where management is in place indicate that there is some improvement. This however is based on resource managers perceptions rather than on hard empirical data. LMMAs in Milne Bay have been monitored but only over two years, therefore there are insufficient data available to ascertain that trends are correlated to management actions.

There are growing concerns on the status of the turtle species whose migration patterns brings them to PNG for foraging and nesting. The trend in leatherback turtle harvest by local fisherman is not known. Although leatherback turtles status has changed from Critical to Vulnerable within PNG the main nesting beach is under mineral exploration.

2.3 Case Studies

2.3.1 Tree Kangaroo Conservation Program

The Tree Kangaroo Conservation Program (TKCP) after two decades of effort and experience , shaped the concept of community-based conservation in PNG. Together with the YUS Conservation Area, PNG's first and only nationally-recognised Conservation Area and serves as a benchmark and national model for community-based conservation in PNG.

"In every province, there is logging

Figure 17: Tree Kangaroo Conservation Program's Flagship species, *Dendrolagus* matschiei

The Tree Kangaroo Conservation Program (TKCP) is the Woodland Park Zoo's signature international conservation program, focused on conserving the endangered Matschiei's tree kangaroo (*Dendrolagus matschiei)* (Figure 17) and its habitat in PNG's Huon Peninsula. From its beginnings in 1996 to determine the status of the endangered Matsciei's tree kangaroo in the wild, TKCP has evolved into a holistic program supporting habitat protection for a wide range of threatened species, as well as initiatives to enhance local community livelihoods and access to government services. Over the course of two decades, the program has grown from its mountainous roots to embrace a broad landscape encompassing marine and coastal reef ecosystems, lowland and montane rainforests, alpine grasslands, and the agricultural areas and settlements belonging to more than 50 villages within the Yopno,Uruwa and Som (YUS) watershed areas in the Huon Peninsula.
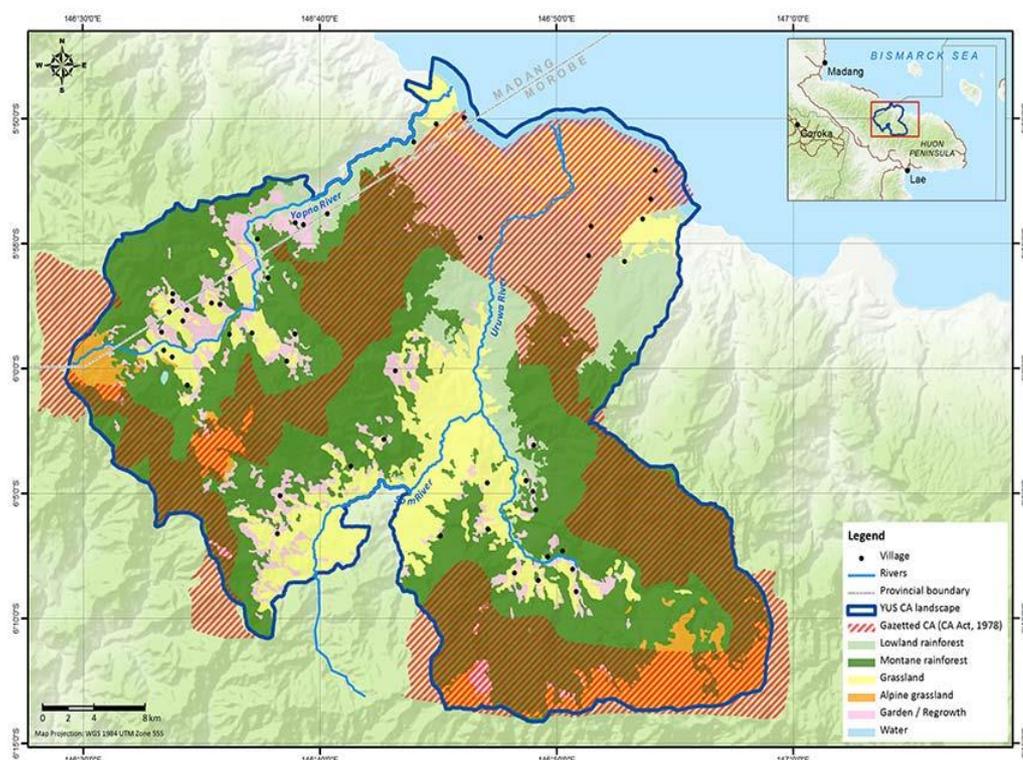
Figure18   : Map of YUS Conservation Area ,in the Huon Peninsula, Papua
            New Guinea

Together with the local landowners in YUS, PNG government, Conservation International, and many other supporters, TKCP helped to establish PNG's first nationally–protected Conservation Area in 2009. A category VI IUCN Protected Area, the YUS Conservation Area (Figure 18), is the first and only protected area of its type in PNG-providing protection at the landscape scale, wholly owned by local people, and with the support of the PNG Government for long-term protection. The YUS Conservation Area provides the highest level of land protection in PNG and encompasses core land parcels pledged by clans to conservation and buffer areas of mixed use, covering an area of over 78,700 hectares in and around YUS Local Level Government area. The YUS Conservation Area extends from the coast of the Bismarck Sea to 4,000m peaks in the Sarawager mountain range, preserving a complete altitudinal spectrum of Huon Peninsula habitats free from resource extraction.

With two decades of effort and experience, TKCP has shaped the concept of conservation for PNG. The YUS Conservation Area sets a benchmark for which national protected area can aspire. To encourage the creation of other nationally-protected conservation areas in PNG, TKCP and Conservation International published *Lessons Learned from the Field: Achieving Conservation Status in Papua New Guinea* to serve a guide for other practitioners of community-based conservation in Papua New Guinea.

Figure 19: TKCP Conservation strategic manager (Karua Kuna) receives the prestigious Whitely Award from HRH Princes Royal in London, 2016   for advancing conservation programs in YUS CA..

TKCP's Achievements Timeline

1996 - Tree Kangaroo Conservation Program begins its work in YUS
- First land pledged for conservation by YUS Landowner Mambawe Manaono
- First tree kangaroo research in Dendawang, Sibidak and Pum Pum areas

2002 - TKCP receives the AZA International Conservation Award

2004 - First YUS Teacher's Scholarship students graduate and return to teach in YUS communities
- First radio-collaring of tree kangaroos in Wasaunon
- TKCP's efforts amplified with support of large grants from Conservation International (2005-2014) and the German Development Bank (KfW) (2008-2014)

2009 - YUS Conservation Area formally gazetted by PNG national government , protecting 78,000 hectares of wildlife habitat
- Local landowner association is formally incorporated as the YUS Conservation Association
- YUS communities host an international celebration of the YUS CA gazettal
- First National Geographic Society's Crittercam[R] deployed on tree kangaroo

2011 - First export of YUS organic Coffee to Caffe Vita in Seattle
- Team of 12 YUS Conservation Area Rangers commissioned
- YUS Ecological Monitoring Plan developed
- Elevational Research Transect created by Conservation International in the YUS CA

2012 - The YUS Conservation Endowment is established at the Woodland Park Zoo

2013 - TKCP-PNG is registered as a local nongovernment organization in PNG

2014 - Community-led Land-use Planning is completed across all wards in YUS
- TKCP receives the United Nations Equator Prize and its second AZA International Conservation Award

- YUS Conservation Area Bylaws gazetted by PNG national government

2015 - TKCP and YUS CA are selected by Global Environment Facility (GEF) and the government of PNG to serve as a national model for community-based conservation

- YUS Conservation Coffee initiative expands across Yopno, Uruwa, and Som;exports to Caffe Vita increase more than 100%

- Protection is expanded for marine ecosystems in YUS with the launch of a community-based marine monitoring program in coastal villages.

2016 - TKCP Conservation Strategies Manager, Karua Kuna wins a prestigious Whitely Award, presented by HRH The Princes Royal in a London ceremony in April 2016.

2.3.2 Tenkile Case Study

Background

The Tenkile Conservation Alliance (TCA) is a non-government organization (NGO) established in 2001. The organization's overall objective was to protect the possible extinction of PNG's two most endangered tree kangaroo species in the Torrecelli Mountain Ranges (TMR); the Scott's tree kangaroo, locally known as the Tenkile , (*Dendrolagus scottae*) and the Golden-mantled Tree kangaroo,locally known as Weimang, (*Dendrolagus pulcherrimus*). The two species distribution has been reduced by 70-80% within the last 30-50 years due to hunting.

The project's overall aims were to conserve the biodiversity of the Torrecelli Mountain Ranges (TMR) through:

- Protection of Tenkile and Weimang habitat through the establishment of a Conservation Area
- Cessation of hunting tree kangaroos (Tenkile,Weimang and Yongi) through hunting moratoriums
- Providing food security for local communities ,through the introduction of alternate sources of protein therefore alleviating hunting pressure on wildlife in the TMR
- Providing communities with tangible benefits for adhering to hunting moratoriums and the protection of their natural resources
- Assisting communities in their sustainable development with project that act for the greater good of the natural environment and the surrounding communities

- Raising awareness of the significance of the tenkile,Weimang and other wildlife within local community schools and villages, enabling them to make informed decisions on the use of their natural resources
- Developing local capacity to manage their natural resources sustainably, through education and training
- Population monitoring and research to assess future changes in the Tenkile and Weimang populations and other wildlife within the project area
- Conduct biodiversity studies using camera traps
- Monitoring social impacts within the communities including effects of rabbit, chicken and fish farming, on hunting patterns, workloads and health status
- Establish TMR as a legislated Conservation Area of approximately 185,000 hectares

Achievements to date by the TCA include:

- Continuation of the hunting moratoriums for all participating villages,which is 20 "Tenkile" Villages and 30 "Weimang" Villages. There has been no significant hunting of any fauna within the Tenkile habitat since 2004 or in the Weimang habitat since 2007
- Landowner agreements made to establish a Conservation Areas within the Torrecelli Mountain Range with the 50 villages. All 50 villages have designated hunting areas from non-hunting areas and written their own rules and penalties for the long term management of the protected area
- Established research sites-for sampling & camera trapping
- Training manual produced and workshops held to build capacity among local Research Officers and Distance Sampling Officers in point transect distance-sampling techniques. Training conducted on camera trapping
- Significant capacity building implemented to ensure local ownership and management of Tenkile ,Weimang and other wildlife in the research sites across the TMR
- Results from distance Sampling Research indicate a significant increase in the population of Tenkile. Population of Tenkile was approximately 160 in 2004 to 307 in 2008
- Conservation Area Management Committee established in all tenkile and Weimang villages and significant capacity building conducted for all committee members in scientific knowledge and natural resource management
- Successful breeding of rabbits in Tenkile villages has led to TCA employing a 'Rabbit farming trainer'.
- Complete handover of rabbit and chicken farming projects to local stakeholders
- Local capacity built with the training and supervision of seven Project Officers and eight facilitators, implementing Water Supply and Sanitation projects
- A total of 350 x1000 gal. Tuffa tanks installed throughout 50 villages

- VIP toilets installed throughout entire project area resulting in one toilet per household in all 50m participating villages
- Delivery of Health and Hygiene Education Program to all 50 villages
- Delivery of Water and Sanitation project management course focusing on managing attitudes and behavior among participating villages to ensure project success
- Significant improvements to TCA Base-Lumi including community accommodation, staff accommodation and a research station

This program is a success story of a stand-alone model of how effective conservation outcomes may be achieved and assessed in developing communities when they are coupled with development of sustainable resource and economic alternatives. To further promote and meet its long term conservation outcomes, the Tenkile Conservation alliance (TCA) was recently registered as a Company Limited by Guarantee in Australia (CAN-607526 465) in August 2015 with the purpose of relieving hunger, poverty, disease and lack of education of disadvantaged people living in rainforest communities in Papua New Guinea through supporting Tenkile Conservation Alliance in its pursuit of its benevolent objectives.

Figure 21 a &b : Local landowners engaged in Tenkile field surveys

Red line indicates actual area mapped using GPS in consultation with Landowners. Green shaded area indicates Tenkile habitat at 900 meters above sea level.
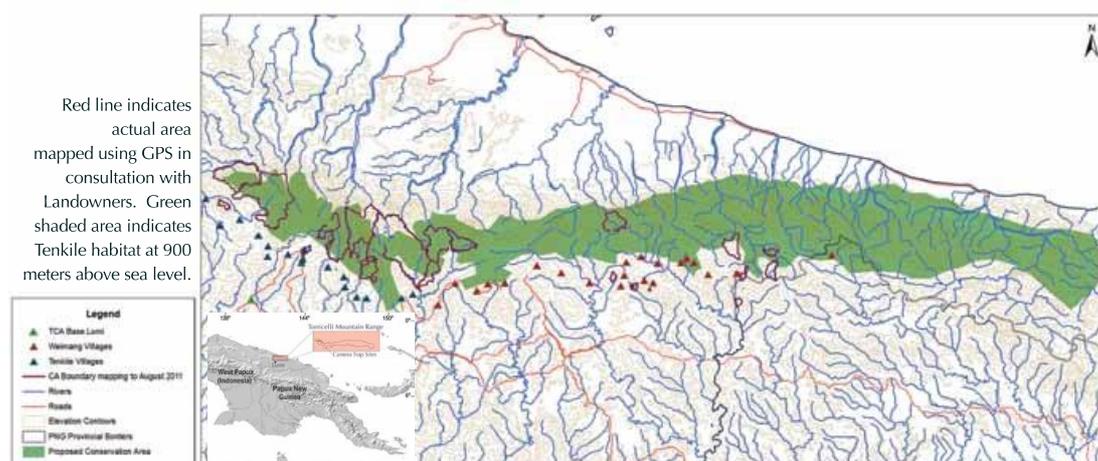
Figure 22. *Tenkile* Range ~150km^2, Areas under conservation and villages

The Torricelli Ranges hosts some of PNG's rare and endemic mammals besides the Tenkile and the Weimang and these include the extremely rare Black Spotted Cuscus (*Spilocuscus rufiniger)* and the Northern Glider (*Petaurus abidi).* Both species are listed in IUCN Red List as Critically

Endangered. TCA has secured funds from the UNDP(Small Grants Program) for a 5-year partnership program that ultimately aims to work toward the establishment of the Torricelli Mountain Range as a Conservation Area through the PNG's Protected Area policy. The grants will also enable TCA to implement various community development projects including fish farming, ranger training and the completion of GPS mapping.

2.3.3 Netuli Local Managed Marine Area

A case study on increasing populations based on local perspectives with initial trend survey data

The community on Netuli Island in Milne Bay Province (Figure 23a) used their own initiative to set aside an area of their reef (Figure 23b) and set their own rules. They had received awareness on sustainable management principles and from this applied them to their situation. Their reefs had been exploited through a typical 'tragedy of the commons' and they made the decision to set aside areas of reef (Figure 23c) and spawning aggregation sites in what was effectively a community marine management area in 2012.

Anticlockwise from Bottom left
Figure 23a. Inset Map of Milne Bay Province , PNG
Figure 23b. Wialoki Island Principal Landowners with their LMMA Map
Figure 23c. Panabala Rock outcrop and associated reef No-take-zone.

From this decision the community have seen the recruitment of Giant Clam including Southern Giant Clam VU A2cd and Giant Clam VU A2cd within the No-take-zones of the LMMA and that Humphead Wrasse EN A2bd+3bd *Mami* now have higher numbers of different ages compared to previously. Also other species such as the Bumphead Parrotfish VU A2d *Belabela* numbers are recovering.

Conservation International established monitoring transects and trained local community members in 2012/13 (Figure 24a) to record any changes in the

fish fauna and reef as a result of the communities' management decisions. Initial survey trends for giant clams (Figure 24c) indicate that recruitment of new clams in protected areas has occurred (Figure 24b).

Anticlockwise from bottom left
Figure 24a. Local Wialoki Islander recording biodiversity on transect
Figure 24b. Giant Clam species Mean Abundance one year after initiation of no take zones
TC *Tridacna crocea,* TM *T. maxima* TS *T. squamosal*, TD *T. derasa*, TG *T. gigas*, HH *Hippopus hippopus*
Figure 24c. Giant Clam *Tridacna gigas*
Taken from Wialoki, Nataoli & Panabala CMMA Marine Resource Monitoring Program Reports

This process and results are shared within the PNG Learning Training Network and through the CLMA Community Local Management Area network throughout Papua New Guinea.

2.3.4   Sustainable Wildlife Trade-   CITES Crocodile Skin Trade

Wild populations of PNG's freshwater crocodile (*Crocodylus novaeguineae*) and saltwater crocodile (*C.porosus*) have been subject to management programs designed during the early 1980's. The aim of the management programs in Papua New Guinea was to regulate harvests of wild skins and eggs or small juveniles for ranches at sustainable levels, while providing equitable economic incentives to indigenous landowners. Both species of crocodiles can be legally harvested by landowners for personal use (food and ritual) , but commercial sale and export are regulated under CITES, where export hides are restricted to the size range of 18-51cm belly width, which corresponds to around 0.9-2.1m total length.   Trade in crocodile skins continued since then with wild harvest figures fluctuating over the years. Wild harvests declined from over 20,000/year in 1977-1980 to 12,000-20,000/year in 1980-1989, then fluctuated between 10,000-20,000/year (1997-2005) (Solmu and Sine 2009). Currently, the crocodile skin trade continues to sustain the livelihoods of rural villagers, through harvests from the wild, trade in live juveniles and eggs. A large commercial ranch (Mainland Holdings) presently farms both species of crocodiles in large holding pens. Mainland Holdings also buys live juveniles and eggs from indigenous landowners. Today it is a thriving commercial operation that exports up to 25,000 skins per year (Solmu *et al.* 2014). The commercial crocodile skin trade for the period

(2005-2014) and egg production (2002-2014) respectively are shown in Tables 9 and 10.

Table 9: Commercial crocodile skin trade for the period 2005-2014.

(figures are for wild and ranched species of both freshwater

and saltwater crocodiles).

Year	Wild C.nov	Wild C.por	Ranched C.por	Total
2005	17726	3862	6549	28,137
2006	20,773	3,762	6,453	30,988
2007	15,904	4,128	7,629	29,243
2008	16,955	4,683	9,211	30,849
2009	21,548	3,893	9,434	35,282
2010	17,605	5,526	13,139	36,270
2011	11,365	3,399	8,921	23,685
2012	12,364	2,949	8,500	23,813
2013	15,189	3,335	4,836	23,360
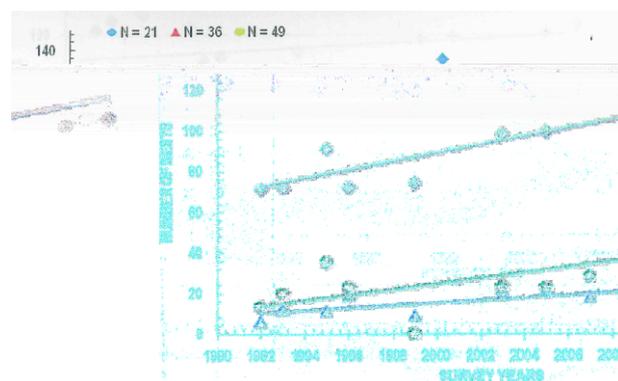
Figure 25: Nesting Trends (1992-2014) from three sites

Table 10: Wild crocodile egg harvest and production for the period 2002-2014

HARVEST YEAR	NESTS HARVESTED	% OF NESTS SURVEYED	TOTAL NO. OF EGGS	VIABLE EGGS	INFERTILE EGGS	% VIABLE EGGS	AVE.CLUTCH SIZE	HATCHINGS	HATCHABILITY %
2002	78	-	4381	3465	916	79.09	56.17	3098	89.4
2003	159	76.2	9508	7817	1691	82.21	59.80	5832	74.6
2004	215	46.5	12756	10261	2495	80.44	59.33	8901	86.7
2005	205	-	12327	9787	2540	79.39	60.13	7926	81.0
2006	291	-	17006	13491	3515	79.33	58.44	9157	67.9
2007	215	59.07	133	109	2444	81.7	62.28	9019	82.4

			90	46		5			
2008	268	-	12733	11790	943	92.59	47.51	9672	82.0
2009	195	22.0	11297	8977	2320	79.46	57.93	5370	59.8
2010	185	27.5	10411	8270	2141	79.44	56.28	6504	78.6
2011	181	32.0	10193	7980	2213	78.29	56.31	5871	73.6
2012	228	36.0	12798	10972	1826	85.73	56.13	8693	79.2
2013	304	48.0	18026	15060	2966	83.55	59.30	12459	82.7
2014	288	-	16401	13066	2525	84.6	57.26	9682	69.3

SOURCE: Solmu *et al.* (2014)

2.3.5 PNG WILDLIFE TRADE- CITES INSECT TRADE

The demand for and availability of PNG insects steadily increased after World War II. Expatriate entrepreneurs engaged indigenous collectors with little income, supplied insects to Western collectors. The trade was largely unregulated especially with regard to the collection and sale of Birdwing butterflies. In 1968 the Australian government declared seven species of *Ornithoptera* to be protected under the Fauna Protection Act of 1965. This piece of legislation later evolved into the current Fauna Protection and Control Act 1965.

It was in the 1970's that saw the official introduction of systematic farming ,or more accurately the ranching of butterflies that culminated into the formation of Insect Farming and Trading Agency (IFTA). IFTA was set up in Bulolo in Morobe province and has been located there ever since. It began to act as the sole agency to purchase insects on behalf of PNG government and to act as middleman between local farmers and collectors in rural areas and overseas buyers. The legacy of IFTA's trading and its contribution to development of insect trade in PNG is provided by a detail study by Small (2004).

In the late 1990's, Department of Environment & Conservation (DEC) began issuing permits for the export of CITES II listed butterflies to IFTA and several other insect traders. IFTA also received DEC endorsement to commercially ranch all of the CITES II listed butterflies in PNG .

Today the insect trade continues to sustain livelihoods of local collectors spread across the country. The income generated through the insect trade especially for local farmers and collector has been highly variable and trade in some province has declined over the years despite CITES II permits being issued to many traders. Small (2004) gives a detailed overview of the insect trade in PNG. According to Cranston (2009) , IFTA sells about $400,000 worth of insects yearly to collectors scientists, and artists around the world, generating an income for a society that struggles for cash.

2.3.6   Beche-de-mer, processed Sea Cucumber

A case study of a 'boom and bust' fisheries despite being regulated but overfished population based on export figures, with subsequent industry closure and follow-up monitoring to determine rates of species recovery .

The National Fisheries Authority NFA manages this resource under the National Beche-de-mer Fishery Management Plan. Within the marine ecosystem twenty one species of this detritus feeder are exported to overseas markets.

A National Management Advisory Committee was formed and includes stakeholders from across the country. It provides advice to the Managing Director of the National Fisheries Authority on most of the key management measures as well as the need for revisions to the plan.
Management measures prescribe the type of licenses, license eligibility, license requirements, export requirements, prohibitions, closures and reporting requirements. Licensees are closely monitored by the NFA to ensure they comply with all management measures.

A Total Allowable Catch (TAC) is set for both the higher value species and the lower value species, as the more valuable species are more heavily fished. Once the TAC of a value group has been reached, the NFA closes the whole fishery as it is too difficult to monitor the harvest of just one value group. Trade in undersized (Figure 26) or broken beche-de-mer is banned to protect the population. A closed

Figure 26: Beche-de-mer measurements

season applies for the whole country during part of the spawning season from 1st October to 15th January. The fishery in each province closes when the TAC of a value group is reached.

Despite management plan being in place for this fishery, this resource was harvested unsustainably leading to a closure of the harvest by NFA since 2009. This was based on the premise of 'Economic sustainability is dependent upon ecological sustainability' of this resource.

Since the closure NFA has conducted surveys by monitoring of the stocks of sea cucumbers by species in various maritime provinces. The results of these surveys are unavailable to the public due 'sensitivity' value of the fishery and will only reopen when stocks have recovered.

2.3.7 Particularly Sensitive Sea Area (PSSA)

A case of heavy international shipping route is given special protection due to its high biodiversity and socioeconomic significance.

A Particularly Sensitive Sea Area (PSSA) is defined by the International Maritime Organization (IMO) as an area that needs special protection because of its ecological, socio-economic or scientific significance or which may be vulnerable to damage as a result of international maritime activities. The IMO's Maritime Safety Committee approved the Jomard Entrance in the Louisaide Archipelago Islands group in the Milne Bay Province as PNG's first PSSA in June 1 2015 (Figure 27). The approval by IMO followed a joint proposal made by Papua New Guinea's National Maritime Safety Authority (NMSA) and the Australian Maritime safety Authority (AMSA). AMSA joined PNG in the submission as majority of shipping through Jomard Entrance is from or bound for ports on Australia's Queensland coast. Based on the latest available data, an average of 27 large commercial ships pass through Jomard Entrance each day. Four two-way routes and a precautionary area will be established at the Entrance. These new two-way routes will separate north and south bound traffic and ensure ships keep well clear of reefs in the area, making navigation safer and easier and reduce risks of collisions(AMSA,2016).

When an area is approved as a PSSA, internationally agreed measures may be used to manage shipping in that area beyond what would be normally be permitted under international law. For the Jomard Entrance these measures include:

- Pilotage requirements
- Ship routing measures (i.e. two way routes, areas to be avoided etc.)
- Shipping fairways
- Ship reporting requirements and Vessel Traffic Services (VTS)

Associated Protective Measures

While a PSSA can itself signal to mariners that an area has recognized ecological, socio-economic or scientific attributes, the current guidelines provide that the designation of an area as a PSSA must identify at least one measure with an identified legal basis that can be adopted by IMO to prevent, reduce or eliminate risks from International shipping activities.

The nomination for Jomard Entrance to be recognized as a PSSA was based on its unique ecological, socio-economic and scientific attributes. The marine life surrounding Jomard Island is extremely diverse. The beaches and its fringing reefs support a number of globally endangered species. The island has been identified to have the largest turtle-nesting rookery in the southern part of Milne Bay Province. Of the world's seven species of marine turtles, six are be found in the region; Hawksbill, Green, Leatherback, Flatback, Loggerhead and Olive Ridley. Of the six, the first three are commonly found in

the vicinity of Jomard Entrance. All six species may be found in the region are currently listed in Appendix I of the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) as species threatened with extinction, and are also listed in Appendix I and/or II of the Convention on the Conservation of Migratory Species of Wild Animals (CMS). The IUCN Red List of Threatened Species currently lists the Loggerhead, Leatherback and Olive Ridley turtles as Vulnerable; the Green turtle as Endangered; and the Hawksbill as critically Endangered.

Papua New Guinea is located in the 'Coral Triangle', an epicentre of rich marine biodiversity (Figure 8), and is home to 76% of all known coral species, 375 of all known coral-reef fish species, and 53% of the world's coral reefs. The Conservation International 200 Rapid Marine Biodiversity Assessment (Allen et al. 2003) of the Milne Bay province listed Punawan Island at Bramble Haven as the fifth most coral diverse of the 57 sites surveyed, with 107 coral species observed. The assessment also listed both Punawan and Jomard Islands as among the best sites in Milne Bay with a rich combination of coral and fish diversity, as well as being relatively free of damage and disease.
Marine resource use in the Louisaide Islands is artisanal in nature, providing for subsistence needs as well as limited small-scale commercial production. Most marine products sustaining the livelihoods of the island communities are high-value invertebrate products such as sea cucumbers for beche-de-mer and trochus. Traditional shell money locally known as 'bagi' is made from *Spondylus* shell is also extensively extracted and manufactured in the island group. The 'bagi' flow along the Louisiade Archipelago and are eventually fed into the Kula Ring.

The scientific and educational criteria for supporting Jomard Entrance as a PSSA site was based on baseline studies conducted by CSIRO Division of Marine Research, PNG National Fisheries Authority and Conservation International in 2001. The joint-marine survey assessed the abundance of reef resources and sustainable use of beche-de-mer. This survey included the islands of the Jomard Passage.

Papua New Guinea is experiencing a significant growth based on recent LNG project. Since June 2014, LNG has become one of the primary commodities exported by PNG and there is a marked increase in the volume of ship traffic passing through its waters. It is predicted that around 110 LNG ships will call into Port Moresby each year for the first three years, with this number to double by 2020. All LNG ships will use Jomard Entrance as their primary route to/from Japan, which is contracted to import around 85% of PNG's LNG.

The cruise industry sources also reveal that PNG's marine tourism will also attract up to 100 ship calls per year. This growth is estimated to experience a further growth of 34% for the next five years. All cruise ships will also use the Jomard Entrance.

Australia is the world's largest exporter of coal, and North Queensland accounts for 75% of coal exported from the Australian eastern ports. Australian coal cargo are transiting through the waters of PNG primarily

Jomard Entrance on the way to Asian markets. It is estimated that around 3,000 voyages per year and 300 voyage rotations are attributed to the Australian market. On any given day, it is estimated that up to 20 large commercial ships transit through Jomard Entrance on north or south bound traffic.

PNG's shipping routes can be categorised as i) international through traffic, ii) coastal traffic between the major in-country ports and ,iii) small vessels traffic servicing the numerous minor ports.

The international through traffic that transit PNG's water follow four major routes all transiting through Jomard Entrance:
- Jomard Entrance –Vitiaz Strait for vessels heading northwest to Hong, China and Philippines
- Jomard Entrance-Vitiaz Strait ,west of Manus for vessels heading to Republic of Korea and southwest Japan
- Jomard Entrance-Saint Georges Channel for vessels enroute to Japan
- Jomard Entrance-Rossel northeast of New Ireland for vessels enroute to Japan and eastern Russian ports

Figure 27: MAP SHOWING THE FOUR PROPOSED TWO-WAY ROUTES AND PRECAUTIONARY AREA AT JOMARD ENTRANCE
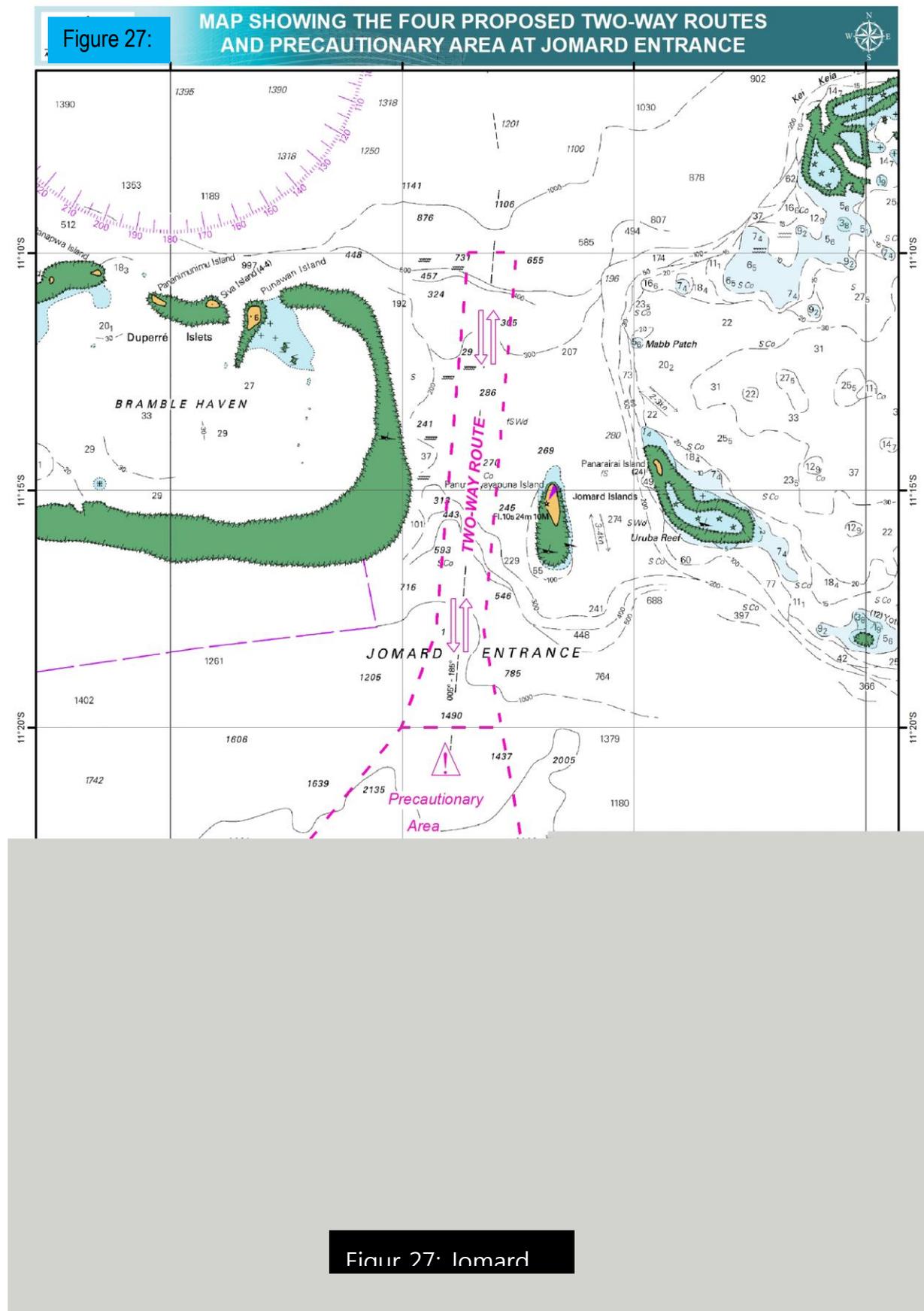
3 *Main threats to biodiversity in PNG*

Current changes and threats to biodiversity in PNG stem from the anthropogenic activities of PNG's rapid growing population. The primary threats to terrestrial biodiversity in Papua New Guinea are deforestation and degradation (from logging, and subsistence agriculture), mining (including pollution and waste runoff), and commercial agricultural conversion (e.g. palm oil). Not only does forest loss result directly from these activities, but the secondary effects from improved road access makes frontier areas susceptible to ongoing clearing for subsistence agriculture, oil palm estate development and salvage logging. Recent spatial analysis suggests that the annual rate of deforestation and degradation across all regions in Papua New Guinea over the 1972-2002 period was 1.4% (Shearman et al. 2008). Although the interactions between different drivers are often complex and synergistic, in PNG's context it is important to distinguish among the main causes (drivers) of threats to biodiversity loss in order to identify and implement effective conservation strategies. Land use change (logging, subsistence agriculture, commercial agriculture and mining), fire, climate change, direct exploitation, biotic exchange, pollution and ocean acidification appear to be major drivers or threats to biodiversity in PNG. The most important direct impacts on biodiversity are habitat destruction, habitat fragmentation, introduction of alien species and over-exploitation followed by pollution and climate change.

3.1 Land use change

Papua New Guinea retains significant and intact areas of forest, with an estimated 34 million hectares of forest in the country in 2014 (Bryan and Shearman 2015;FAO 2015b). The actual estimation of the extent of forest within the country is contentious. According to Bryan and Shearman (2015), forests in PNG are declining at a rate of around 0.5% per year, although this figure is contradicted by FAO (2015) figures for PNG. While FAO (2015) report no major change in forest area, their data does indicate an annual decrease of 2.3% in the area of primary forest.

A number of major drivers of deforestation and forest degradation have been identified and include large-scale industrial logging, large–scale clearance for agricultural commodities, and small-scale clearance for gardens and subsistence agriculture (Bryan and Shearman, 2015). While the debate about the rates of deforestation and forest degradation continues, PNG's standing among the global community as one of the leading 17 mega-diversity countries of the world (Mittermeier et al. 1999; Mittermeier et al. 1997) is gradually being eroded. Given the complexity of understanding the causes of deforestation and degradation, it is essential to seek the contribution of a wider community to have a more quantitative approach to identifying the drivers of biodiversity loss.

The key direct drivers of biodiversity loss considered to be of relevance to PNG include; *commercial logging, subsistence agriculture, commercial agriculture, fires, mining and climate change .*

3.1.1   Commercial Logging

Large-scale commercial logging is the highest-ranking direct driver of deforestation and forest degradation in Papua New Guinea (Shearman *et al.2008;* Bryan and Shearman 2015*)* accounting for 48.2% of forest change in PNG and hence primary driver of biodiversity loss in the country. Shearman *et al.*(2008) estimates that 0.9 million hectares of forest were deforested and a further 2.9 million hectares degraded during the period from 1972-2002. A more recent study by Bryan and Shearman (2015) found that between 2002 and 2014, a further 0.8 million hectares and 3.6 million hectares were deforested and degraded respectively. Local and foreign logging companies operating primarily in mainland lowland and island regions of the country are the agents and hence drivers of forest change. Logging involves use of mechanized machinery for extraction of round logs for export and occur in old growth native forest. Logging operations result in significant impacts to the forest as a result of poor logging practices (Shearman *et al.*2008). Such poor logging practices result in significant loss of forest biomass and substantial alteration in forest composition and structure.

Forest fragmentation and reduction of forest density continues to threaten erosion of biodiversity. Most of PNG's vertebrate biota is found in rainforest, so any loss of that habitat can potentially cause the loss of species (Allison and Tallowin 2015).

3.1.2   Subsistence Agriculture

The second most significant driver of deforestation and forest degradation that leads to reduction in biodiversity richness in Papua New Guinea is subsistence agriculture (Shearman *et al.* 2008; Bryan and Shearman, 2015). Subsistence agriculture largely driven by PNG's growing rural population accounts for 45.6% of forest change. The agents of this driver are majority of PNG's rural population who practice shifting agriculture to sustain their livelihoods. For generations, local people have practiced shifting cultivation that results in clearing primary forest patches to cultivate a diverse range of food crops. Cropping periods are generally short , usually with a time frame of around two to three years followed by longer fallow periods (10-15 years). Shifting agriculture practices gradually eat away at a forest and over time can result in the clearance of large tracks of lands without subsequent regrowth (deforestation).   Gardening can also result in the clearance of isolated patches of forest less than a hectare in size (degradation) The underlying indirect drivers that promote subsistence agriculture are population growth, low food security, and poor socioeconomic conditions (Shearman *et al.* 2008).

The increase in population and population density is the major underlying cause of deforestation and forest degradation from subsistence agriculture. At low population densities , gardens developed using traditional shifting

cultivation practices revert to secondary forest after cultivation. However, at higher population densities, particularly in the highlands of PNG, more intensive gardening is required to meet local and industry-driven demands for food. The latter is particularly prominent in the face of current booming mining and petroleum industry sectors. Local and industry-driven demands for fresh food translates to increasingly shorter fallow periods and the formation of contiguous garden patches and land conversion to permanent agriculture use. Deforestation from subsistence agriculture is the primary driver of deforestation in the PNG Highlands. The current population of the highlands contains around 3 million people accounting for 43% of PNG's population that is accommodated within only 13.5% of PNG's land area (Shearman *et al.*2008).

In PNG, the impact of subsistence agriculture is quite significant. From 1972 to 2002, subsistence agriculture has been identified as the second largest cause of deforestation, with 45.6% of forest change attributed to it, while industrial logging accounted for 48.2 % of forest change (Shearman et al.2009). Further, Papua New Guinea, presents a unique situation that explains this pattern. With 80% of the population based in the rural communities, much of the subsistence farming occurs in the highland areas, where the terrain is suitable for this type of farming. Subsistence agriculture in the PNG highlands can also be termed as 'industry-driven' . The growing population in towns and cities, including mining towns present high demands for fresh   vegetables. In industry-driven deforestation (e.g.logging), subsistence farmers often opt to move into new forest areas along the roads corridors rather then wait for the traditional fallow period. New gardens field higher crops and thus sustains their livelihood.

3.1.3   Commercial Agriculture

Papua New Guinea is endowed with abundant natural resources to support a robust agricultural sector. The agricultural sector is incredibly diverse, including a wide variety of traditional 'food crops' that feed the largely rural population and 'commodity crops' such as coffee, cocoa , copra, rubber, spices and palm oil that put cash into their pockets. Along the value chain of each crop, there is opportunity cost for loss of environmental values and commercial agriculture is considered as the third significant driver of deforestation and degradation in PNG. Agricultural intensification driven by such commodities as oil palm appears to be gaining momentum across the country and according to Shearman *et al.* (2008), an estimated 93,000 hectares of forest was cleared from the period 1972-2002 primarily in West New Britain (58,467 ha), Milne Bay (12,234 ha), East New Britain (7,828 ha) and Oro Province (6,771 ha) The agents of oil palm agricultural intensification being local and foreign oil palm companies.

Commercial agricultural crop development activities result in complete removal of native vegetation to cultivate commercial crops (e.g. oil palm and rubber). Expansion and intensification of agriculture is the greatest current threat to biodiversity (Fitzherbert et al. 2008; Koh and Wilcove 2008; Rands et al. 2010). Expansion of oil palm plantations across PNG poses a significant

threat to biodiversity. As with other crops (Edwards et al. 2010), it is difficult to quantify the extent to which oil palm has a direct cause of deforestation because of a lack of data on land-cover change and incomplete understanding of its complex causes. However, oil palm expansion in PNG could in principle contribute to deforestation in four often indistinguishable ways: (i) as primary motive for clearance of intact forests;(ii) by replacing forests previously degraded by logging or fire,(iii) as part of a combined economic enterprise, such as logging profits to offset the high costs of plantation establishment; or (iv) indirectly through generating improved road access to previously inaccessible forest or displacing other crops into forests.

An understanding of how much biodiversity oil palm can support is essential to direct conservation action. If plantations have been shown to be consistently depauperate relative to forests, the focus should be on stopping deforestation. Alternatively, if the management of plantations can be adapted so that they support a substantial proportion of forest species while maintaining high yields, conservation effort should focus on ways to enhance biodiversity in plantations (Edwards et al.2010).

Various studies conducted elsewhere have shown that other crops such as rubber, cocoa, coffee and *Acacia* had higher species richness than oil palm (Edwards et al.2010). In other words, oil palm has been shown to be a particularly poor substitute for either primary or degraded forests, and whereas any conversion of natural forest is inevitably damaging to biodiversity, oil palm plantations support even fewer forest species than do most other agricultural options.

Unless PNG government becomes better at controlling logging, protecting forests and ensuring that crops are planted only in appropriate areas, the impacts of oil palm expansion on biodiversity will be substantial across PNG.

For biodiversity ,oil palm plantations are a poor substitute for native tropical forests. They support few species of conservation importance, and affect biodiversity in adjacent habitats through fragmentation, edge effects and pollution. There is enough non-forested land (grasslands) suitable for plantation development to allow large increases in oil palm production without further deforestation, but political inertia, competing priorities and lack of capacity and understanding , not to mention high levels of demand for timber and palm oil from wealthy consumers, often make it cheaper and easier to clear forests.

3.1.4 Mining

Large-scale mining for minerals such as gold and copper have resulted in both direct impacts from forest clearing (including for infrastructure, access roads, and associated processing infrastructure) as well as extensive cross-boundary indirect impacts from pollution and runoff of tailings. The best known example of this is from Ok Tedi gold and copper mine in the Western Province. The Fly River features as the most polluted river system in PNG. Not only does it receive pollution and toxic contaminants from Ok Tedi , it also

receives huge loads of toxic waste streams from the Porgera Mine in Enga Province through the Strickland river.

Mining contributes nearly three quarters of export revenue and 17 per cent of Papua New Guinea 's gross domestic product (GDP). It is the most important sector in the country's economy after overtaking from agriculture. Five mines ranking among the world's top producers of gold and copper provide the majority of PNG's mining production. Two of these mines are scheduled to close in the next five years. Notwithstanding these mine closures, the country is considered to be vastly under-explored and the importance of mining revenue to central government coffers has mad discovery of new deposits a high priority (GoPNG 2003).

Habitat destruction is the most important cause of biodiversity loss, especially in the humid tropics (McNeely,et al. 1995). The most obvious impact on biodiversity from mining is the removal of vegetation, which in turn alters the availability of food and shelter for wildlife. At a broader scale, mining may affect biodiversity by changing species composition and structure. Current assessment of the vulnerability of ecosystems in PNG where most of the mining takes place, reveals the following:

- Most of the active mines and exploration sites in PNG are located within primary forest areas
- Most of the active mine and exploration sites in PNG are located within intact areas of forests of high conservation value
- Nearly all active mines are located in stressed watersheds
- All active mines and exploration sites in PNG are located in areas deemed by Conservation Assessment Needs for PNG to be of high conservation value.

Such challenges are particularly apparent in PNG's mining environmental footprints. In PNG, more than one third of the country's forests and nearly half of the country's mangroves have already been allocated in oil, gas, or mining concessions. More than one quarter of forests classified as 'fragile' in Papua New Guinea government data overlap oil, gas, and mining concessions.

An analysis of forest cover within mining concessions in PNG revealed that all of the active mining concessions except Misima and Lihir overlap with fragile or intact forests (Figure 28). The Kainantu concession contains both fragile and intact forests , albeit in a smaller proportion than Porgera, Tolukuma and Ok Tedi. This appears to contradict ABN AMRO's forestry policy, suggesting that even though financial institutions have policies relating to environmental and social risks , these policies may not yet apply to every area of practice within the organization.
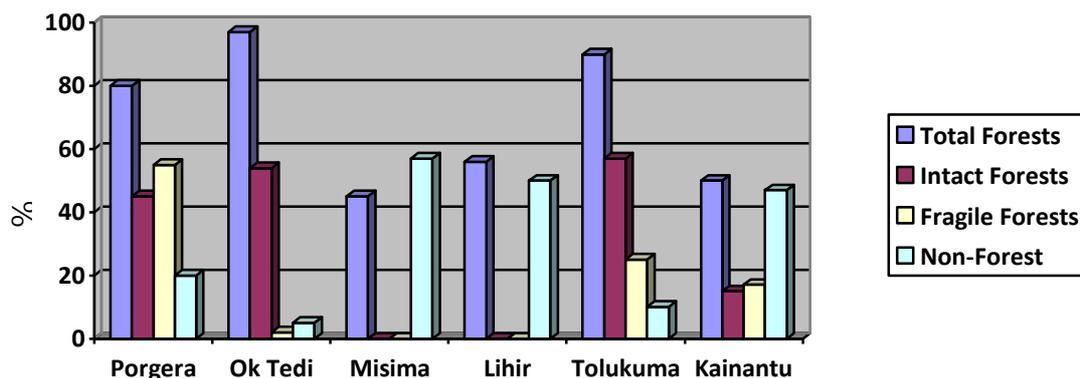
Figure 28 : Ecological Vulnerability of Forest Types in Papua New Guinea due to current Mining Operations.

The Porgera and Ok Tedi mines demonstrate the danger of dealing with multiple hazards by adopting environmentally risky alternatives particularly where governance and capacity for informed decision are weak. Generally all active mines and exploration activities in PNG are operating with high environmental and social costs.

Mining and extractive industries while being the major driver of the economy in Papua New Guinea are also major agents of deforestation and pollutants of water resources. The development of mines embodies the clearing of forests for the construction of road and mining facilities. While mining is recognised as one of major direct drivers of deforestation and degradation, there are any underlying indirect drivers associated with mining and extractive industries.

According to Bryan and Shearman (2015), commodity prices and policy, institution and governance issues such as corruption, weak law enforcement, and poor transparency and participation are the underlying causes of deforestation and degradation from mining. Mining can cause intense local impacts. Most damaging impacts of mining in PNG, has occurred in Western Province. The agent of deforestation, degradation and loss of biodiversity and livelihoods is OK Tedi Mine. Direct disposal of mine tailings and associated sediments in the Fly River have raised the river bed resulting in forest dieback of around 48,000 hectares in 2002 and it has been predicted the dieback will increase in extent to between 127,800 and 272,500 hectares (Velasquez,2006)

Table 11 : Active Mines in PNG with type of waste (tailings) disposal and annual tailing waste discharged into receiving water bodies.

Mine	PNG/Location Province	Mineral	Open	Life	Type of disposal	Tailings disposal/year
Ok Tedi	Western	Gold, silver and copper	1984	To 2016	Riverine Discharge	>22million tonnes
Porgera	Enga	Gold and silver	1989	30+	Riverine Discharge	>5 million tonne
Tolukuma	Central	Gold and silver	1995	?	Riverine Discharge	>160,000 tonnes

Lihir	New Ireland	Gold and silver	1997	30+	Marine DSTP	>5 million tonnes
Simberi	New Ireland	Gold and silver	2008	20	Marine DSTP	>1 million tonnes
Hidden Valley	Morobe	Gold and silver	2009	15+	Riverine disposal	>5 million tonnes
Ramu Nickel	Madang	Nickel and cobalt	2012	20+	Marine DSTP	>5 million tonnes

All studies to date on impacts of mining operations in PNG have shown that the environmental and socio-economic costs have been very high for communities living in the vicinity or downstream of mining activities. These studies have all shown disturbing trends in mine-derived impacts on ecosystems and communities ; e.g. Ok Tedi mine (eg. Hettler et al. 1997; Swales et al. 1998; Bolton 2008; Storey et al. 2009), the Hidden Valley mine (e.g. Powell and Powell, 2000; Mudd, 2012; Mudd and Roche 2014), the Lihir mine (e.g. Mckinnon 2002; Brewer et al. 2007; Haywood et al. 2016), the Tolukuma mine (Watson and Barnett,2008).   Exactly how local communities fare from exposure to toxic wastes from remains largely unknown and many may have inevitably lost lives. In most cases, mining companies do not make data available on tailings disposal to the government or the public. Regulatory mechanisms of state authorities mandated to oversee the operations are often beset with lack of technical expertise and resources. While the government remains content as its coffers are constantly filled with the exploits from the mining industry, the environmental and social costs are largely ignored despite of many well defined policy 'lip service'.

3.1.5   Fire

Wildfires are not a common natural phenomenon in tropical rainforest regions. Yet, in 1997-1998 , fires raged through 150,829 hectares of forest in the Western Province (Shearman *et al. 2008)*. Tropical forest fires are thus increasingly recognized to be significant drivers of forest change that results in habitat loss and degradation. According to Shearman *et al.2008,* total forest loss due to fire between 1972 and 2002 was 347,079 hectares accounting for 4.4 % of land area. A large proportion of the forest lost to fires was during the 1997-98 *El Nino* that raged through almost 160,000 hectares of forest.

At high altitudes, burning was the most important driver of forest loss between 1972 and 2002. 13% of PNG's upper montane forests were destroyed over this period. In almost all cases, fires are lit by people usually associated with clearance for subsistence gardening that frequently involves burning, which commonly spreads into adjacent forest vegetation.

Selective logging throughout the lowlands of PNG has primed the forest areas' susceptibility for conduction of fire through forest fragmentation.

Fires, while recognised as one of the major drivers of D&D, is also a significant driver of biodiversity loss particularly in many parts of PNG where species richness among vertebrate biota is highest. For example, species richness for mammals and birds are highest along central mountain ranges and mountain slopes respectively (Figures 5 and 6). For reptile species

richness in PNG (Figure 7) is in respect the inverse of frog species richness, with the highest concentrations of species in the savannah regions in Western and Central provinces and in coastal regions, particularly along the north coast, including the Huon Peninsula (Allison and Tallowin,2014). A El Nino induced fire in 1997-98 that raged through 150, 829,hectares of forest in Western province will undoubtedly have had a significant impact on the reptilian biota.

3.2 Climate Change

Climate change is real and has already impacted on PNG's diverse coastal and marine ecosystems by warming, acidification, rising sea levels, and in the terrestrial systems causing shifts in cloud forests on its highest peaks.

3.2.1 Terrestrial Ecosystems

Understanding the complex interrelationship between forests and climate change in Papua New Guinea is not well developed and thus is currently insufficient for informed policy-decisions and management strategies. Results of studies from the region (Taylor and Kumar,2016) indicate that high altitude (montane) forests will be among the most vulnerable to climate change, in part because , being distributed at high altitudes, they have a limited altitudinal range to 'shift' into. The high peaks in PNG interior are regularly enveloped by trade-winds-derived orographic clouds, resulting in the presence of unique and diverse floral assemblages (James, 2008). These cloud forests are adapted to high precipitation and high winds, and their lower limits are determined by moisture availability, with clouds contributing up to one-third of the moisture budgets of these habitats (Bush et al. 2004). Climate change simulations suggest an upward shift in the cloud layer, which may exacerbate the effects of longer and more variable dry seasons in these areas (James, 2008). Increases in air temperatures associated with climate change implies increases evapotranspiration by vegetation which, in combination with reduced cloud contact, could lead to drying out of cloud forests, with serious implications for biodiversity (Still et al. 1999).

Terrestrial birds have high body temperatures and metabolic rates and little capacity for fat storage ,and they generally exist on thermal physiological margins; thus any changes in temperature may push them over their physiological limits (Mack 2009). The physiological boundaries for tropical are much narrower than in temperate birds, limiting their ability to cope with changing climate (Mack 2009).

Papua New Guinea is home to many restricted range species from a variety of families including the Paradisaeidae (birds of paradise) (Stattersfield et al.1998).The majority of the species have evolved in isolation and have altitudinal or spatial habitat restrictions, their preferred habitat type generally being forests. Mountain-top restricted bird species with narrow elevation ranges are particularly susceptible to the impacts of climate change since they have a much smaller area of occupancy (Skercioglu et al. 2012; Williams et al. 2003; Shoo et al. 2005). Species that may be less vulnerable to impacts of climate change, will be those with broad elevational breadth and thus have

greater plasticity in their habitat requirements .Climate may impact on PNG's high elevation-species.   For example, increasing temperature may reduce many montane species' ranges, causing them to shift to higher elevations or to become locally or globally extinct, particularly in the case of endemic species restricted to tropical montane highlands (Shoo et al. 2006; Hilbert et al. 2004; Colwell et al. 2008; Gasner et al. 2010).

Papua New Guinea is home to many endemic terrestrial mammals are composed mainly of echidnas , marsupials, bats and rodents. The Bismarck archipelago hosts many species of endemic mammals (Carvajal & Adler 2005). Mammals are directly affected by changes in climate, particularly extreme temperatures (Mickleburgh et al. 2002) and indirectly through extreme weather events such as tropical storms. Large number of deaths from hyperthermia has been reported in flying foxes (*Pteropus spp.)(Carvajal and Adler 2005).* In PNG, the long-and-short-beaked echidnas which are restricted to montane environments (Allison and Tallowin, 2014) will face the prospect of habitat loss as increasing temperatures destroy montane ecosystems (Laurance et al. 2011).

It has been predicted that high-elevation ecosystems such as cloud montane forests may disappear by year 2100, with corresponding global losses of their endemic biodiversity. Sea level rise has already threatened restricted range species on outer lying islands in PNG .Shifts in distribution may be possible for generalist species, but range shifts will be difficult for species with small distributions, specialized habitat requirements, slow dispersal rates, and species at high elevations. Accurate assessments of climate change impacts on PNG's biodiversity remains challenging because of lack of baseline data on species' ecology and distributions, many species continue to be discovered and many are still unknown to science. Furthermore, synergistic interactions of climate change with other threats like habitat loss and invasive species have not been comprehensively assessed.   Addressing these knowledge gaps will be difficult for PNG due to limited financial resources and expertise.

3.2.2   Marine Ecosystems

The coral reefs of PNG lie within the epicentre of marine biodiversity called the Coral Triangle (Allen, 2008;Vennon et al. 2015). The country is home to over 1500 species of coral fishes and at least 514 species of corals (5). These reefs face threats at multiple scales, ranging from global increases in oceanic temperature (6), and ocean acidification, to local factors such as point and non-point source pollution, increased disturbance, and fishing pressure (Drew et al.2015).

A recent report by SPC (2011) provides extensive coverage on the vulnerability of Pacific fisheries to the impacts of climate change and variability. It has been suggested that changes to ocean currents and ENSO signals due to climate change will impact productivity and migration of tunas in the western Pacific region. PNG's tuna fishery has been also shown to be subject to impacts of climate change including overfishing.

In addition to pelagic fishes, such as tunas, climate change is expected to have severe impacts on reef fishes and coral reefs, through coral bleaching and ocean acidification (Church et al. 2010, Reid et al. 2010). If the temperature and acidification conditions projected by the IPCC (2007) for PNG are close to accurate, corals and coral reefs will be severely stressed by the end of the 21st century, and phase shifts to algae-dominated reefs ,or even degradation to rubble and sand in the worst case scenario, will be likely throughout PNG's outer islands in the maritime Milne Bay province, and island groups in the Bismarck Archipelago. The combined impacts of coral bleaching and acidification on coral reef structure will undoubtedly be accompanied by changes in the structure of reef fish assemblages, with reduction in species diversity, abundance or trophic complexicity (Sheppard, 2006).

Ocean acidification may also have negatively affect fish in their larval stages, leading to greater impact upon fish assemblage structure and abundance on reefs and near-shore systems. Coastal communities in Papua New Guinea are often heavily dependent upon resources associated with coral reefs (Drew et al. 2015). Thus , it is likely that significant aspects of coral reef ecosystem function and services will decline or even, in some cases , be lost to communities and other users.

It is very important to recognize that coral bleaching and/or ocean acidification effects on reefs will not operate in a vacuum. Any consideration of the effects of climate change upon reef fish diversity and abundance will also factor in additional impacts from other intrinsic and extrinsic factors. The latter factors include pollution, poor land use practices leading to sedimentation, physical destruction (i.e. coral mining and storm effects). Severe localized impacts on coral reefs and reef-based fishery are expected to proceed at a pace dictated by growing PNG's coastal and island-based communities. Recent studies by Drew et al. 2015 provide evidence of already stressed habitats and resources in island communities.

3.2.3 Coastal Ecosystems

Papua New Guinea is endowed with forest diversity and mangroves host a large number of species which play an important role in sustaining productivity of the coastal ecosystems including wetland communities dotting the extensive coastline. The mangrove forests cover around 162,000 -200,000 hectares (Alongi,2007). The largest expanse of mangroves in PNG occur along the southern coast, especially bordering the Gulf of Papua into which many large rivers ,including the Fly, Kikori, and Purari ,discharge via extensive deltas.

Several studies (Bualia, 1990; Chappell,1990;Hughes and Bualia,1990; Pernetta & Osborn,1990) have offered predictions in regard to the possible effects of climate change on wetlands in Papua New Guinea. These same studies also predicted that mangrove habitats fringing the Gulf of Papua are likely to undergo substantial reduction in area, with compression of existing zones as a result of sea-level rise. This impact would lead to a reduction in

the diversity and abundance of estuarine fish communities, and a possible decrease in nursery areas for penaeid prawns, which could impact this commercial fishery. Clearly, any climate-mediated impacts to such important systems, which serve as both buffers to shoreline erosion and critical nursery grounds for food fish species, would have profound ecological, social and economic consequences. All of the scenarios present the prospect of adverse effects on native freshwater and estuarine species due to loss of habitat. Lowered water levels in major rivers may also serve to concentrate locally harvested species such as catfishes, rendering them more vulnerable to overexploitation by subsistence-based fisheries.

Small-scale modifications to the physical structure of mangroves can lead to significant effects on the diversity and abundance of macro-benthic organisms in mangrove habitats (Skilleter & Warren, 2000). Such modification has the potential to cause cascading effects at high trophic levels, resulting in deterioration in the value of these habitats as nursery and feeding grounds.

In addition, any climate-mediated reduction of mangrove areas in the Gulf of Papua could also potentially impact on thousands of migratory shorebirds that 'winter over' on the extensive mudflats for up to 8 months of the year.

Figure 29: Distribution of mangroves in Papua New Guinea (after PNG Marine Assessment,2014)

3.3 Direct Exploitation

Direct exploitation is often missing from the lists of drivers of biodiversity loss (e.g. Sala et al. 2000) but this could be because direct exploitation in terrestrial systems is often addressed as part of land use change. In the marine ecosystem, where overfishing is concerned, direct exploitation has a much higher profile, because overfishing is considered to be one, if not *the most serious driver of biodiversity change (*Millennium Ecosystem

Assessment, 2005). It has been estimated that about 25% of the world's commercial marine fisheries are overexploited and a further 50% are fully exploited (Millennium Ecosystem Assessment,2005).   In PNG, direct exploitation of resources is also one of the major drivers of biodiversity loss in terrestrial and marine environments largely involving subsistence hunting and artisanal fishing respectively.

3.3.1 Overfishing

Overfishing is considered to be one, if not *the most serious driver of biodiversity change (*Millennium Ecosystem Assessment, 2005). It has been estimated that about 25% of the world's commercial marine fisheries are overexploited and a further 50% are fully exploited (Millennium Ecosystem Assessment,2005).   In PNG, direct exploitation of marine resources is also one of the major drivers of biodiversity loss either as unsustainable direct catches (e.g. tuna, prawn and sea cucumber) or by-catch in purse-seine and prawn fishery. For example, the sea cucumber fishery is the second –most valuable capture-based fishery in the Papua New Guinea , but sustainably managing these fisheries has proven to be difficult over the years (Carleton et al. 2013). Experience of the sea cucumber fisheries management in the Pacific and globally has been reviewed and summarized by Kinch et al. (2008), Anderson et al. (2011) , Purcell et al. (2013). Despite PNG having a management plan for beche-de-mer fishery since 2006, the recent review by Purcell et al (2013) on management issues pertaining to the fishery better summarizes the current situation in PNG. Milne Bay as a largest maritime province in PNG has been in the forefront of the 'boom and bust' beche-de-mer fishery (Figure 30). The fate of other marine invertebrates (e.g. trochus, giant clams etc.) are the same as the beche-de-mer fisheries.   The following issues related to the beche-de-mer fishery continue to impact on fishers across the Pacific including PNG :

- Significant problems associated with managing sea cucumber species, with many or most showing signs of overexploitation. According to Purcell et al. (2013), 38 % of sea cucumber fisheries globally are currently overexploited and many of these are in the Pacific;
- Regional assessments have revealed that population declines from overfishing occurred in 81% sea cucumber fisheries, average harvested body size declined by35%, harvesters moved from near to offshore regions in 51% and from high-to low-value species in 76% of sea cucumber fisheries;
- 38% of sea cucumber fisheries remain unregulated, and illegal catches are of concern in most Pacific countries;
- Pressure on fisheries has been increasingly intense due to improved market access and high prices, increased accessibility to remote areas by use of boats, poverty coupled with income generating aspiration, results in an incentive to fish even when sea cucumber densities are extremely low;

It is well known that 'boom and bust' beche-de-mer trade is continued and exported illegally when the fisheries are closed. Anecdotal evidence suggest that illegal shipments continue to be made. For various reasons in combination with socioeconomic and market conditions, it is evident that closure of at least some fishery in PNG simply results in the trade going

underground, as communities and exporters seek to continue generating income and profits. This results in stocks being overfished, with all activities performed outside the law, beyond the control of PNG fisheries authorities.
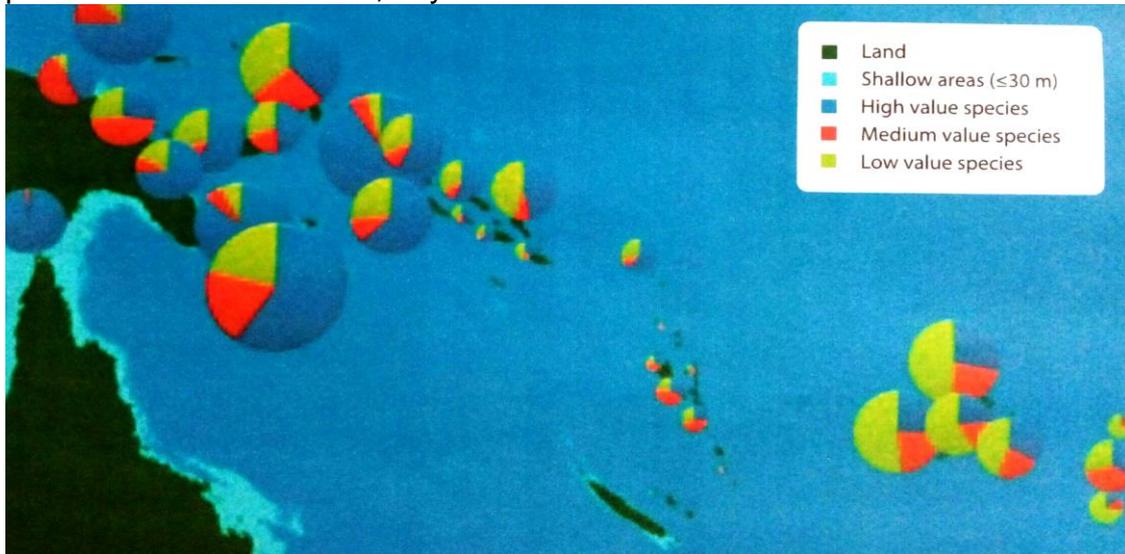
Figure 30: Fifteen-year average value of sea cucumber production by administrative area. Note: Milne Bay Province (the largest roundel) represents a value of USD 2.9 million (Source: Carleton et al. 2013)

Many of these local fishing threats are proportional to human population size . These coral reefs exist along a gradient of human population sizes from the heavily populated Bootless Bay to the remote Bismarck archipelago. Drew et al. 2015 evaluated the effects of development and human pressure on fish diversity across five different localities covering both mainland PNG and the Kimbe Bay and New Ireland in the Bismarck Archipelago. This study used the size of human population as a proxy for both environmental degradation and fishery pressure, given that the majority of fisheries within this region are local (<50km).They found that species diversity for both fished and non-fished groups decreases as the size of the local population increases, and this relationship is stronger in species that are targeted (fished).Together these findings show that the reef fish communities of PNG experience multiple anthropogenic stressors and that even at low human population levels targeted species experience population declines across both time and space.

3.3.2   Firewood

While firewood harvesting throughout rural PNG is not readily recognised as a direct driver of D&D and biodiversity loss, it does makes sense when wood is the only source of fuel for cooking and lighting available for many urban and rural communities in PNG. The scale of tree harvesting for firewood is likely to be large in the country, given only 18% of the population are estimated to have access to electricity in 2014 (World Bank 2016 b). Based on this proportion and the 2011 census of 7.1 million people there are around 5.8 million households in PNG who are dependent on firewood as their only source of fuel. At lower population densities and in remote areas of PNG the cutting of timber for fuel is likely to be sustainable , however in highly

populous areas of the highlands and around urban areas this cutting is likely to cause forest degradation and in some areas lead to complete deforestation.

Estimating the scale of the impact of timber for fuel on PNG's forest areas is challenging and poorly studied , with the exception of a detailed review by Jacka (2015) in the Porgera Valley in Enga Province, where increasing human populations and migration to the mine development site, coupled with local land tenure and resource management practices, colonial history and forest succession dynamics have resulted in a 'firewood crisis' and intensive cutting of forest areas along roads in the area. Associated indirect drivers of the use of firewood are likely to include population growth, migration, and infrastructure development.

Along the coastal villages of PNG, mangroves are the target for firewood. In the coastal villages of the Central Province, mangroves are targeted for firewood because they are better fuel for heating, cooking and smoking, and the species generally targeted is *Ceriops.*

Raga (2006) provides an insight into exploitation of mangroves across the entire Central Province. In most of the villages across the province, the preferred species is *Ceriops.* These trees are either cropped by direct felling, or are initially 'ring-barked' ,left to partially dry out before being felled and removed as billets. In most cases, trees are cropped while still 'green' as they are much easier to split into billets. Heavy cropping is common during traditional feasts and bride price food preparation (Raga,2006). Such practices have left large tracts of mangrove areas that are either completely devoid of mangroves or denuded areas are occupied regeneration species of *Bruguiera* or *Avicenna.* In extreme cases, such denuded areas are colonized by invasive species such as *Acrostichum* .   In contrast, in peri-urban villages particularly in Port Moresby, the targeted species is *Eucalyptus.*

3.3.3   Subsistence Hunting

Hunting is a major activity for many rural men in Papua New Guinea, and it is an important part of customary practice (Dwyer 1994).The cultural reasons that underpin hunting may be changing as the global cash economy makes in roads into PNG's largely rural communities. But the overall need for wild meat as part of the human diet and the overall impacts on game populations do not appear to be decreasing in many rural communities. A large segment of the PNG population lives at the fringe of the cash economy, with little access to cash, and lacks the option of obtaining protein from farmed domestic stock. Wild meat therefore is significant source of protein and nutrition for many rural PNG people. (Mack, 2005) estimated up to 1800kg of wildlife was consumed over a seven month study, yielding an estimated daily intake of roughly 23g of wildlife per person. Mack and West (2005) reported that most biomass came from mammals with birds second in importance. The most biomass (>80%) came from a handful of genera : *Sus ,Casuarius, Phalanger, Spilocuscus, Dendrolagus and Zaglossus.*The remaining biomass (20%) came from a variety of fauna (e.g. rodents, herpetofauna and fish).

There is a division in the consumption pattern. Majority of the kills (around 80%) are brought home to the villages and consumed and these included large mammal taxa as *Sus, Casuarius, Dendrolagus and Zaglossus.* A fair number of the kills are consumed in more distant bush camps. where most of the meat are smoked and brought to the village. Several hunting expeditions may be specifically organized for mortuary or bride price payment feasts and kills for such purposes are generally smoked in bush camps before being brought to the village.

Terrestrial mammals in PNG are experiencing an increasing collapse in their population sizes and ranges around the country, but many of the drivers , patterns and consequences of this decline remain poorly understood. Many of the decline in species populations in PNG are due to major coexisting threats that include deforestation, agricultural expansion, human encroachment.

The primary reason for hunting and trapping wild animals is to acquire meat for household consumption. The other reasons for hunting include ornamental use of body parts for cultural purposes. Wild meat hunting mostly for food appears to be the major driver for declining large and small mammal populations in PNG.

In PNG , population sizes of vertebrate species have been declining ,mainly due to the twin threats of direct exploitation and habitat destruction (Mack ,2005; Shearman et al. 2010). This local wild meat hunting crisis is a fundamentally distressing problem to address because it is intimately tied to human development challenges such as food insecurity, and land use changes (Filer, 2011). While acknowledging many rural communities in PNG have hunted wildlife over millennia, the unsustainability of this practice   has increased over the years in many regions across the country due to growing human populations, food security, and an increasing tendency for wild meat to be traded. The wild meat consumption trade is further exacerbated through the widespread use of illegal firearms, motorized transport that increase the efficiency of hunting. Mammals threatened by hunting consist predominately of large-sized marsupials (more than 10 kg), medium-sized mammals (1-10kg tree kangaroos) and bats and small-sized mammals (less than 1 kg-bandicoots, rodents) . As hunting is facilitated by access to land and the human footprint is increasing across the region, species and regions affected by severe hunting are often victims of habitat deterioration of many types including forest loss and fragmentation, expanding agricultural intensification, human settlement encroachment. Locally deforestation through logging and oil palm expansion predominately affects small mammals across the lowlands while direct exploitation through hunting affects a broad range of terrestrial vertebrates in the highlands .

Compared to the wildlife resources available in other tropical forests, there is very little available large game in PNG forests. Because of this, a disproportionate share of the dietary income of protein from wild game for any one community comes from a very limited number of species. This creates the risk of serious consequences should any of these few species become

significantly reduced in population or extirpated particularly species that are of high conservation values (e.g. tree kangaroos and echidnas).

The studies by Dwyer (1985), Flannery and Seri (1990), Mack (2005) and more recent by Kagl et al. (2015) suggest that a wide variety of taxa are hunted for wild meat . These taxa range from large marsupials, echinids and birds (cassowary) to small volant mammals, rodents and herpetofauna. The most biomass (>80%) came from a handful of genera ; *Sus, Casuarius, Phalanger, Spilocuscus, Dendrolagus* and *Zaglossus.* The remaining (20%) of biomass came from a variety of taxa. These studies strongly suggest that hunting patterns within PNG rural populations are largely unsustainable.

Hunting smaller mammals can also drive insidious alterations of ecosystems, as they can provide critical ecological functions including seed dispersal, consumption of vegetation and invertebrates, soil disturbance and prey items for other species. Of these functions, the role of smaller frugivorous mammals as seed dispersers, particularly marsupials and bats, has been widely documented. Removal of these seed dispersers can initiate widespread changes in forest regeneration, composition and structure (Stoner et al. 2007), and despite the overlap in their body size with birds and reptiles, studies show that the ecological role of mammals is not always replaceable by other taxa (Kurten, 2013). Likewise, some bat species serve as specialized pollinators and seed dispersers that are unlikely to be replaced. Yet bats are the largest group of mammals under 1 kg threatened by hunting (Middleburgh et al. 2009).

While acknowledging the conservation values of PNG's terrestrial vertebrates, other special considerations might need to include taxa that are targeted for cultural or socio-economic reasons independent of their abundance, such as Vulturine parrots (*Psittrichas fulgidus), (Mack & Wright,1998;Johnson et al. 2004) or Harpy Eagles (Harpyopsis novaeguineae) (Watson & Asoyama,2001),* which are killed for use and sale of feathers in traditional adornment. Special considerations need to be made of cultural uses, specialised hunting practices ,and the ecology of the species.

Most emphasis to date has been focused mainly on terrestrial wild meat, and while the concept of wild meat applied to aquatic wildlife was introduced some years ago (Alfaro and Van Waerebreek, 2001) ,it has yet to receive the attention it requires given the perceived scale of the issue. In fact, there is emerging evidence of a conservation problem on a scale similar to that documented for terrestrial wild meat now affecting aquatic wildlife species that includes cetaceans, sirenians, turtles, crocodiles and even seabirds (Georges et al. 2006). Increased demands for aquatic wild meat is considered to be a developing , significant and immediate threat to aquatic wildlife in many regions around the world. According to (Alfaro and Van Waerebreek, 2001) aquatic bushmeat is defined as products derived from aquatic megafauna (e.g. marine mammals, sea turtles and freshwater crocodiles and turtles etc.) that are used for food and non-food purposes including traditional uses. In Papua New Guinea, exploitation and unsustainable harvesting of aquatic wild meat is evident among the marine turtles, freshwater turtles and dugongs.

While the issues surrounding the sustainable use of aquatic wild meat has around for sometime, identifying the scale and impact of exploitation is difficult given that many cases of harvest take place in remote regions of the country. Species of aquatic wild meat that are being used as food in Papua New Guinea include these that are listed in CMS Appendix I and II. Appendix I listed species include green turtle (*Chelonia mydas)*,Hawksbill turtle (*Eretmochelys imbricata),* Leatherback turtle (*Dermochelys coriacea),* loggerhead turtle (*Caretta caretta), and* Olive Ridley turtle (*Lepidochelys olivacea).* The CMS Appendix II listed species include Dugong (*Dugong dugon),* Saltwater crocodile (*Crocodylus porosus).* Turtle harvesting has now extended beyond the traditional boundaries. This issue is more prevalent in the waters around the Central Province. Traditional harvesting was more pronounced along the East Hiri coast along the Papuan Barrier Reef system extending from Port Moresby eastwards to Hood Lagoon. Today most of the marine green turtle populations have been significantly depleted and local fishermen have now turned to 'poaching' in waters beyond East Hiri to Amazon Bay to the east and to Hall Sound near the waters off Yule Island to the west.

3.3.4   Non-wood Forest Products

Eaglewood (*Gyrinops ledermannii)* appears to be under significant threat at the population level from indiscriminate felling by villagers in their efforts to harvest *gaharu*, with suspected gaharu-bearing trees being cut regardless of infection. The real volume of trade is likely to exceed that being recorded at present (Zich and Compton, 2001). While there are numerous anecdotal reports of illegal trade across the border to Jayapura (Indonesia) from Vanimo (PNG) by land and sea, border officials noted that *gaharu* as one of the four main commodities in trade between Vanimo and Jayapura (6). Illegal trade of *gaharu* from PNG to Indonesia is most likely by small boats operated by locals. Logging ships are also likely agents for unregulated trade in *gaharu* across the border.

3.4 Eutrophication (Nitrogen & Phosphorus enrichment)

Since the industrial revolution, the global trend in the use of fossil fuels has been releasing nitrogen and sulphur into the atmosphere which are then deposited over the surface of the land and sea, in places far from its source. Following the similar trend, intensification of agricultural crop production has also led to widespread use of nitrogen and phosphorous fertilizers which get into the wider environment particularly through surface runoff. The result is a general increase in eutrophication over the land and at concentrated points in freshwater and marine ecosystems.   Millennium Ecosystem Assessment (2005) stated that nutrient loading (including nitrogen, phosphorous and sulphur) " *has immerged as one of the most important drivers of ecosystem change in terrestrial, freshwater, and coastal ecosystems, and this driver is projected to increase substantially in the future".* Sala et al. (2000) predicted that nitrogen deposition will have the greatest effect on nitrogen limited biomes. Other studies have predicted that this situation will be more profound in developing countries as agricultural   crop production intensify and

biodiversity hotspots will become under increasing pressure from nitrogen deposition. Millennium Ecosystem Assessment (2005) has also stated that nutrient loading will become an increasingly severe problem in developing countries.

As oil palm development in Papua New Guinea expands , agricultural intensification will no doubt become a driver of biodiversity loss in freshwater aquatic systems. Tilman et al (2001) predicted that agricultural expansion between 2001 and 2050 would result in significant increases in nitrogen and phosphorous fertilization, as well as pollution from increased use of pesticides, all of which will adversely affect biodiversity particularly in aquatic ecosystems. This is further supported by Dudgeon et al.(2006) who identified nitrogen enrichment as a major driver of biodiversity change in freshwater ecosystems and where excessive nitrogen loads enter marine environments from nearby rivers can result in the creation of 'dead zones' where marine biodiversity is severely affected.

According to Banabas (2007), the oil palm industry in Papua New Guinea uses over 12,000 tonnes of fertilizer annually to offset nitrogen deficiency which is the most limiting factor in oil palm production (Table 10). Oil palms strip out 160-200kgNha^{-1}yr^{-1} from the soil. Nitrogen fertilizer accounts for 60-70%of all variable production costs but 40-60% of applied fertilizer cannot be accounted for. This study states that losses are suspected to be high due to the combined effects of leaching, surface runoff and denitrification and could amount to over 50% of the amount of the N fertilizer applied annually; a loss that would be of significant economic and environmental concern.

Oil palm production in Papua New Guinea is into its third decade of development and expansion, and the industry's use of fertilizers and pesticides as drivers of biodiversity loss through eutrophication particularly in aquatic ecosystems in oil palm- growing provinces remains to be established.

Table 12: Tonnage of N fertilizer used by major oil palm plantations and smallholders in relation to other fertilizers used (1997 to 2005)

YEAR	PLANTATIONS								SMALLHOLDERS			
	NBPOL	%	HARGY	%	HIGATURU	%	POLIAMBA	%	HOSKINS	%	POPONDETTA	%
1997	ND		705 AMC	94	ND		ND		ND		ND	
			235 SOA									
1998	ND		1000 AMC	89	ND		ND		ND		ND	
19	ND		1200	8	ND		ND		ND		ND	

99			AMC	1								
			90 SOA									
2000	ND		1675 AMC	74	ND		1100 SOA	37	ND		ND	
			21 SOA									
2001	4978 AMC	77		88	ND		1250 SOA	34	1354 AMC	100	ND	
	2821 SOA											
2002	9521 AMN	79			ND		1050 AMN	29	1445 AMC	100	ND	
2003	8442 AMN	73	2193 AMC	72	ND		800 AMN	30	1615 AMC	100	ND	
2004	7122 AMN	64	4208 AMC	83	2494	60	215 AMN	35	2092 AMC	100	3000 SOA	100
			14 SOA		AMN		968 AMC					
2005	5282 AMN	54	2205 AMC	73	1311	38			2200 AMC	100	1848 SOA	100
			14 SOA		UREA							

SOURCE: Barnabas (2007):study of Nitrogen loss pathways in oil palm (Elaeis guineensis Jacq.) growing in agro-ecosystems volcanic ash soils in Papua New Guinea. PhD Thesis in Soil Science,Massey Univ.,NZ,349pp.

3.5 Ocean Acidification

About one quarter of the carbon dioxide emitted from human activities every year is absorbed by the oceans. As the extra carbon dioxide reacts with sea water it causes the ocean to become more acidic. The 'acid bath' impacts on the growth of corals and organisms that construct their skeleton from carbonate minerals. These species are critical to the balance of tropical reef

ecosystems. Data show that since the 18th century the level of ocean acidification has been slowly increasing in PNG water

Under the three emissions scenarios, the acidity level of sea waters in the PNG region will continue over the 21st century. With the greatest change under the high emissions scenario. The impact of increased acidification on the health of reef ecosystems is likely to be compounded by other stressors including coral bleaching, storm damage and fishing pressure.

Recently, researchers were able to study ocean acidification in Milne Bay waters in natural underwater habitat-coral reefs. In the recent Milne Bay study, two of the three natural CO_2 vents emitted pure CO_2.The scientists registered a pH gradient around the vents. The closer to vents, the lower the pH value. This trend showed that as pH fell, so did the number of coral species, until a zone where there was virtually no more coral growth. The study predicts that if the oceans become more acidic, the food available to plants and animals will be different, which is why the impact on the marine ecosystem could be even more severe (Kleine, 2011).

3.6 Invasive Species

Modern shipping and transport services have become much more efficient across the globe and such services in PNG have also followed the global trend. Movement across national, regional and global boundaries has become easier with increasing ease and rapidity and, in doing so , has introduced a large number of species to areas of the planet that they would not have naturally reached. With porosity of its national maritime borders, PNG currently faces challenges in containing invasive species particularly exotic weeds. As indicated in Section 3.1.1 , industrial logging in the country is one of the major drivers of biodiversity loss. Indirect effects of this industry also contributes to spread of invasive exotic weeds particularly *Piper and Mimosa*.

 Some of these introductions have be deliberate, but many more have been unintentional (e.g. those transported in ship's ballast). Many, if not most of these introductions are benign, but sometimes introduced species are able to exploit a novel ecological situation to the detriment of native species which have not evolved to cope with the new competition and, in such situations , they become problematic and can be a threat to local biodiversity.

Humans have been responsible for introducing animals and plants to new areas for thousands of yeas (Milberg & Tyrberg, 1993). With improvements in transportation and the globalization of trade, the introduction of non-native species to new habitats and ecosystems has greatly increased. The impacts of invasive vertebrate and plant species in Papua New Guinea is difficult to assess. However, where such plants or vertebrates exist, substantial declines in species richness and displacement of native flora and fauna have been observed (Hartemink,2010; Orapa, 2001; Allen,1991).

A recent review by Allison & Tallowin (2014) indicates among alien invasive species reported in PNG, among the vertebrates, there are no known reptiles introduced. The cane toad (*Rhinella marina*) is the only amphibian that has

established itself across the region. There are five species of birds; the rock pigeon (C*olumba livia)* , common myna (*Acridotheres tritis),* (an Asian species recently reported in Alotau),common starling (*Sturnella vulgaris),and* two species of sparrows (*Passer domesticus, P.montanus).* There are no known invasive mammal species, despite the domestic cats (Felis catus), dog (Canis lupus) feral pig (Sus scrofa) and the rusa deer (Cervus timorensis) being introduced into PNG.

By far the largest introduced alien species in Papua New Guinea are the freshwater fishes and exotic plants. According to Allen (1991) up to 22 species of freshwater exotic fishes were introduced to PNG since 1949. Most of these introduction were unsuccessful or were never released to the wild. Many of these early introductions were well meaning initiatives as food fish by fishery agencies. These include the common carp (*Cyprinus carpio*) introduced in 1959, now common in few isolated localities in Sepik-Ramu river systems. Rainbow trout (*Oncorhynchus mykiss*) introduced as food fish to the PNG central highlands around 1952, where its impact has been minimal possibly due to the high elevation. A successful aquaculture hatchery and farm based on this species is now based in the highlands. Brown trout also introduced to the central highlands at around the same time as the rainbow trout, but its present status is unknown (Allen, 1991).

A number of freshwater fishes were introduced into PNG several decades ago and include tilapia (*Oreochromis mossambicus*) to the highlands in 1954. Escaped stock from the highlands presently forms a well established fishery in the Sepik-Ramu systems accounting for up to 60% of the catch (Coates, 1987). Presently, tilapia is established throughout the lowlands of PNG ,often competing with native species. Another strain of tilapia (*Oreochromis rendalli*) has also been introduced to the highlands since . More recently in 1999, a genetically improved strain of tilapia (*O. niloticus*) as aquaculture candidate for aquaculture in the PNG highlands was imported from the Philippines. These were quarantined and released to the highland farms in 2002. in the growing farms in the highlands.

Another introduction to the Sepik river system was a South American freshwater native Pacu (*Piaractus brachypomus*). Pacu and several other exotic species were introduced to the Sepik and Ramu river basin as part of a fish stock enhancement project between 1995 and 1997. Such introductions threaten native biodiversity by extinction or displacement (Moyle & Leidy 1992). The ecological impacts of these introductions have yet to be determined but according to local sources, both introductions have significantly reduced populations of native freshwater fishes in the areas where they occur (Correa et al. 2014).

While the intentions are good, considering most of PNG's freshwater systems having very depauperate native fish fauna, the environmental impacts of such food fish introductions remain to be assessed .

Introduced around 1980's three South-East Asian fish species-Striped Snakehead (*Channa striata*), Walking Catfish (*Clarias batrachus*) and Climbing Perch (Anabas testudineus) have had significant impact on native fish species in the Western province of PNG. These three species have established wild populations in the Western Province after entering PNG from Indonesia. These fishes have already established themselves in the outer islands in the western province including Saibai and Boigu islands in the Torres Strait (Correa et al. 2014).

Other exotic fishes with established population in PNG include mosquitofish (*Gambusia affinis*),guppy (*Poecilia reticulata*), swordtail (*Xiphophorus helleri*), snakeskin gourami (*Trichogaster pectoralis*),threespot gourami (*Trichogaster teichopterus*), and giant gourami (*Osphronemus goramy*).

An overview of exotic plant species in Papua New Guinea has been provided by Orapa (2001) and Waterhouse (2003), following an earlier account by Henty and Prichard (1988). Presently, up to 83 species of exotic plant pests (weeds) were documented along the Kokoda Track (Allison and Tallowin, 2014). This recent study conducted along PNG's historical Kokoda Track, recorded the presence of six of the World's worst alien invasive species; *Mikanis micrantha, Spathodea campanulata, Lanatan camara, Clidema hirta and Oncorhynchus mykiss.* Also recorded were seven invasive plant species that are among the top 30 weeds reported in Wet Tropics of North Queensland;mikanis (*Mikanis micrantha),*african tulip(*Spathodea campanulata),*Snakeweed (*Stachytarpheta spp.),*Tobacco weed (*Elephantopus mollis),* bushmint (*Hyptis spp.),* Creeping ox-eye (*Sphagneticola trilobata)* and Mexican sunflower (*Tithonia diversifolia).*

Among the exotic plants recorded along the Kokoda Track , the ten most exotic plants in terms of abundance and invasive tendencies were sanchesia (*Sanchezia speciosa),* white angel's trumpet (*Brugmansia candida),* mikania (*Mikanis micrantha),* buffalo grass (*Paspalum conjugate),* Russell River grass (*Paspalum paniculatum),* tobacco weed (*Elephantopus mollis),* matico (*Piper aduncum),* clidemia (*Clidema hirta) ,*goatweed (*Ageratum conyzoides)* and Cinderella weed (*Synedrella nodiflora)(*Allison & Tallowin, 2014).

All the plant taxa (up to 90 species) documented from the Kokoda Track represent species have become established in Papua New Guinea, and are found commonly around villages in the lowlands, hill forests and lower montane rainforest zones throughout PNG (Allison & Tallowin, 2015).

The environmental and economic costs of eradication of alien invasive plant species have not been sufficiently given the attention it deserves , although experience from the costs involved in the control *Salvinia molesta* from the Sepik river during the 1980's is a reminder. Hartemink (2010) provided a review of the current knowledge of *Piper aduncum* , one of the alien invasive species in PNG. The paper reviews the presence of *P.aduncum* in Asia and Pacific, traces its spread across PNG (Figure 31) and its impact on the subsistence farming systems and rural livelihoods.

Figure 31: *Piper aduncum* invasion of hills along the Wau-Bulolo road. Photo by John Aruga (2010).

3.7 Roads

The impact of roads as a direct driver of D&D is largely associated with forest loss in most provinces throughout PNG. Roads directly cause deforestation and ultimately disturb and displace many forest-based biota through clearance of trees and other vegetation along the road's path. This is particularly the case where road construction is allowed to clear a wide surrounding strip of forest on either side (20m) of the road. Many roads in remote parts of PNG are constructed by logging companies as a means to access logs for export. Logging roads in many instances are responsible for displacement of many forest vertebrate biota due to poor snigging and hauling practices where large tracks of forests disturbed and young saplings destroyed.

As well as deforestation, roads also act as the source of forest degradation through the resulting migration and settlement by local landowning communities along them and subsequent clearing of patches of forest for gardening, including harvesting of timber for building, and firewood. In many cases, subsistence cultivation on the corridors of logging roads can extend beyond 1km on each side of the road.

3.8 Overexploitation (Fishing)

Overfishing as a result of direct exploitation has been highlighted in Section 3.3.1 and in almost all cases is industry-driven for such fisheries as tuna, prawn and shark fisheries. The marine invertebrate resources fishery (beche-de-mer, trochus etc.) is largely driven by local Asian interests. Thus, there is a distinction between direct exploitation of fisheries resources driven by the industry and over exploitation driven by local fishers under varying socio-economic conditions..

Currently ,the reefs in PNG are exploited almost exclusively by small-scale artisanal and subsistence fishers that use a range of techniques such as spear guns, hook and line, hand spears, gill nets, hand traps, derris roots, dynamite, weirs and bamboo traps to harvest reef and reef-associated fish. Despite the overall health of the PNG fishery, local overexploitation has been noted, particularly in fisheries with access to cash markets (Cinner and McClanahan, 2006) and fisheries in remote islands due high human population density (Drew et al. 2015)

In PNG ,government fisheries regulations such as size restrictions, gear restrictions and harvests bans exist, but are not thoroughly enforced (Huber 1994).Successful enforcement of fisheries regulations by the government is particularly complicated because (i) local fishers typically work on a small and dispersed scale, which makes monitoring and enforcement costly and complicated, (ii) highly decentralized customary marine tenure regimes make coordinated management of resources over large areas difficult, (iii) catches are multi-species which can make single-species management methods such as monitoring effort, growth and mortality expensive, and (iv) national and provincial governments often lack adequate personnel and funding resources to monitor catch or enforce regulations.

Study by Cinner and McClanahan (2006) covered several sites across PNG showed signs of overexploitation. Their data considered mean fish lengths and trophic levels of catches were strongly related to socioeconomic characteristics such as fishing pressure, distance to markets and size of fishing grounds. Despite the subsistence nature of fisheries in PNG, Cinner and McClanahan (2006) found that more than half of the caught fish were bartered or sold, which suggests susceptibility to market forces. This study concluded that resource use in PNG can be driven by factors such as subsistence and market demand, resource-use rights and the prestige associated with livelihood activities (Smith 2004). Cinner and McClanahan (2006) found that distance to markets was positively correlated to the mean trophic level of the fish caught, suggesting that communities in close proximity to markets had likely overfished the higher value and high trophic species.

3.9 Destructive Fishing practice

Destructive fishing practices in PNG involves a number of agents of destruction that cause excessive damage to marine habitats. These practices range from dynamite fishing, use of derris roots, gill netting, reef gleaning and by-catch.

Dynamite is generally sourced from WWII dump sites, illegally sourced from mining and road construction sites. Reports of high frequency illegal use of dynamite have been reported in Musau and Emirau in New Ireland , Manus, Central Province and Port Moresby (NCD). In the Central Province, dynamite fishing appears to be used extensively throughout the Papuan Barrier Reef system largely by peri-urban villages that have easy access to fresh-fish markets in Port Moresby city.

Derris roots are used throughout coastal PNG. The use of derris roots are usually controlled in many parts of the coastal areas and only used for fishing during traditional mortuary or bride price feasts. However, it is extensively used in the Western Province where derris roots are grown and harvested from traditional woodlots.

Gill nets and reef gleaning are also among the artisanal fishery practices that impact on marine habitats. The latter involves the use of metal rods or knives to extract bivalves or clams such as giant clam *Tridacna crocea.* The former impacts on reef habitats through entangled nets. However, increasing use of smaller mesh-sized nets (<than 1inch) has been responsible for declining harvests on many coastal villages in the region as recruitment of juvenile fish are impacted by use smaller mesh-sized gill nets.

Prawn trawling fishery is based along the Gulf of Papua and Orangerie Bay in Milne Bay in Papua New Guinea .While the fishery target is prawn , the environmental impact is more profound as far as benthic   habitats are concerned including the largely wasteful by-catch that also occasionally includes turtles. The by-catch in prawn fishery is usually dumped at sea and therefore unreported. In the Gulf of Papua prawn fishery the ratio of prawn to by-catch is about 1:9 and the by-catch is estimated at around 9,000 to 17,000 tonnes per year (NFA 2005).

While government fisheries regulations such as size restrictions, gear restrictions and harvests bans exist, these are not thoroughly enforced (Huber 1994).Successful enforcement of fisheries regulations by the government is particularly complicated because (i) local fishers typically work on a small and dispersed scale, which makes monitoring and enforcement costly and complicated, (ii) highly decentralized customary marine tenure regimes make coordinated management of resources over large areas difficult, (ii) catches are multi-species which can make single-species management methods such as monitoring effort, growth and mortality expensive, and (iv) national and provincial governments often lack adequate personnel and funding resources to monitor catch or enforce regulations.

3.10 Climate Change in a Marine Environment

Climate change is potentially a high threat to the marine species and their habitats in PNG through the potential disruption of ocean circulations, changes in the amount and distribution of fish populations, changes in the seas salinity, temperature and acidity, and other parameters. Current climate

change models include a wide range of potential future scenarios. A Study by CSIRO (2011) predicted that many of the reef systems would be impacted by coral bleaching in the Bismarck Sea and to a lesser extent in the Solomon Sea by 2062 (Figure 32).

Predicting Change in the Marine Environment from Climate Change
Current and projected Sea Surface Temperature (SST) averages show a steep gradient in temperature from higher to lower latitude. The cooler waters of the Coral Sea mix with the warmer waters of the west Pacific Warm Pool to form this gradient.
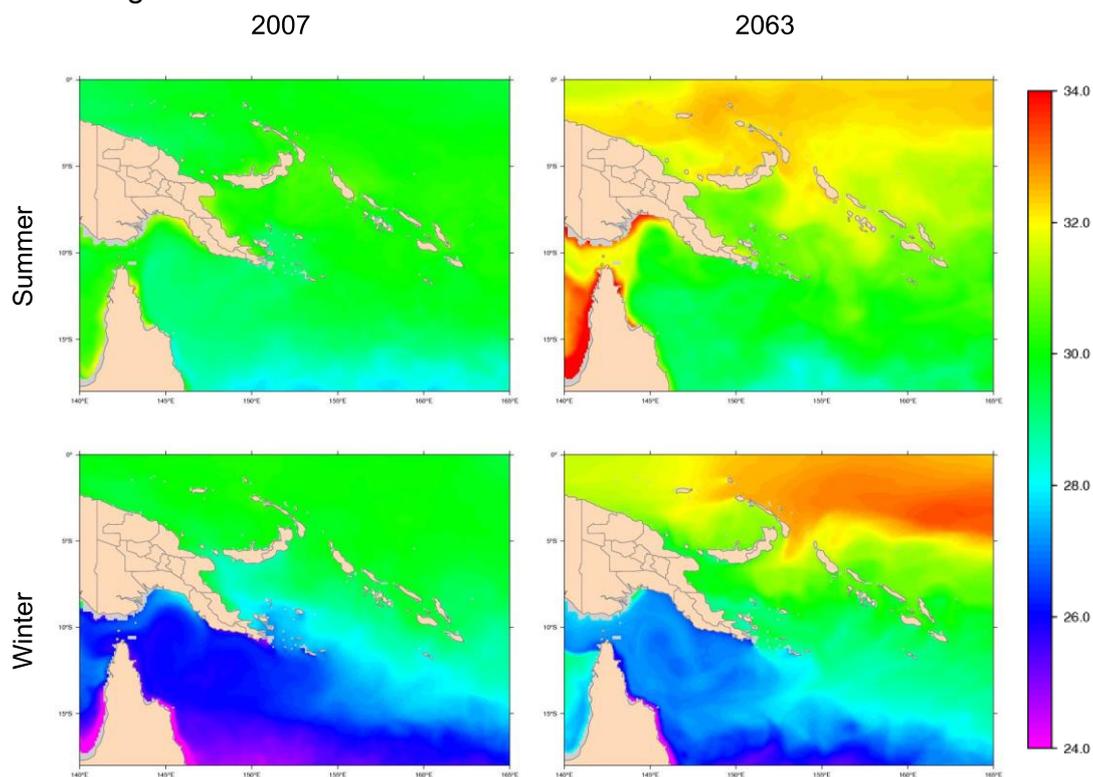
Figure 32. Three Month Average of Sea Surface Temperature (CSIRO Bluelink Modeled Ocean Climatology)

Coral reefs are vulnerable to increased SST due to temperature induced coral bleaching even to a depth of 20+ meters. The currently accepted threshold for bleaching is when sea surface temperatures are more than 1°C higher than normal summer maximum temperatures, though an absolute threshold of 32 degrees C has also been used. Degree-Heating Weeks (DHW), the sum number of degrees weekly water temperatures are above the bleaching threshold and 8 DHW has been a good indicator of bleaching risk (Figure 32).

The ability of reef corals to adapt or acclimatize to projected climate change is probably not great but this is not really known.

Figure 33. Projection of Degree Heating Weeks of Sea Surface Temperature

With the loss of corals the association of reef fish will change, probably flip to an algal association with more herbivorous fish.
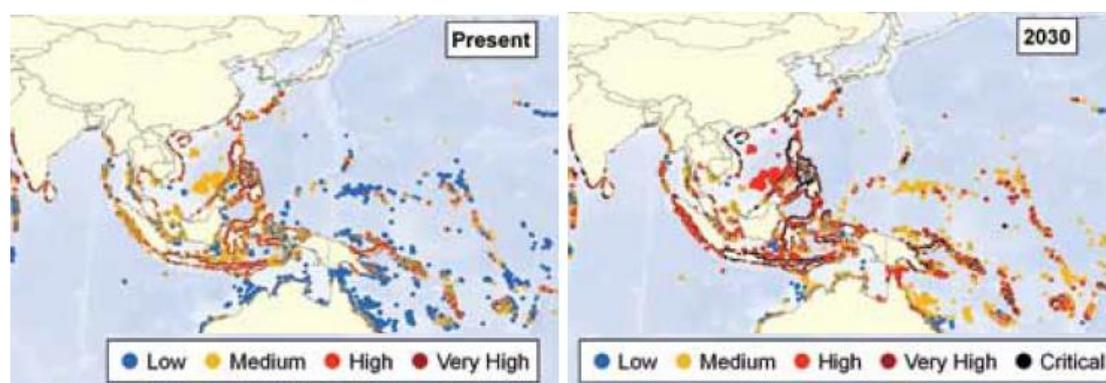
Figure 34 Reefs at risk, all factors.

Even on a shorter time line the risks to reefs is becoming greater from all sources (Figure 34).

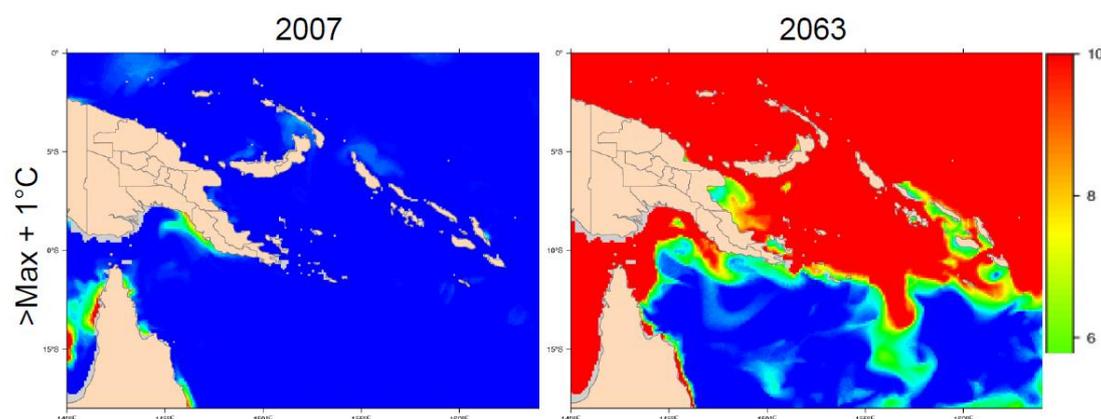Rising sea levels are altering the coast both through incremental change and through elevated storm surges, while the inundation of salt water into coastal aquifers will put pressure on water resources, especially within island ecosystems and communities.

3.11 Pollution

PNG's coastal waters are a major hub for shipping traffic ,including several major ports that service the domestic shipping activities. The international shipping routes includes several important sea lanes that facilitate for vessels transiting through PNG's water. These sea lanes include the recently IMO-approved Jomard Entrance including Vitiaz Strait, Saint Georges Channel and Rossel. All international traffic on north-south bound trips to Australia generally pass through the Jomard Entrance (Figure 27) . A number of threats arise from this intense shipping activity including oil spills, pollution from ports, ballast/bilge discharge, as well a garbage disposal. Impacts arising from

groundings and anchor-damage, leading to the direct destruction of coral reef formations.

Land-based pollution due to run-off from conversion of coastal forests and landscape into grasslands, agriculture and aquaculture diminishes the ability of coastal waters to retain soil and nutrients. Sediment run-off can have devastating effects on coastal ecosystems such as coral reefs and sea grasses. While coastal towns and cities, ports, and tourism development directly impact on coastal water quality and coastal ecosystem resilience, impacts arising from oil palm development along PNG's coastal provinces pose grave long-term implications for PNG's species rich coral reef ecosystems. All oil palm projects in PNG ; West New Britain, New Ireland, Milne Bay and Oro (Northern) Provinces are located along coastal waters and sediment run-off including fertilizer-laden sediments to coastal ecosystem is a grave environmental concern.

Pollution from large-scale mining activities are also a growing concern with numerous studies (Mudd and Roche 2014; Mudd 2012; Storey et al. 2009; Bolton 2008; Brewer et al. 2007;McKinnon, 2002; Swales et al.1998) directly attributing pollution of coastal ecosystems and changes in habitats and species composition due to discharges from mine waste streams.

3.12 Extractive Industries

The extractive industries' occupy a dominant position in the political and economic landscape of Papua New Guinea. PNG's extractive industry sector is currently based around five commodities-gold, copper, oil, gas and nickel/cobalt (see Figure 35) .
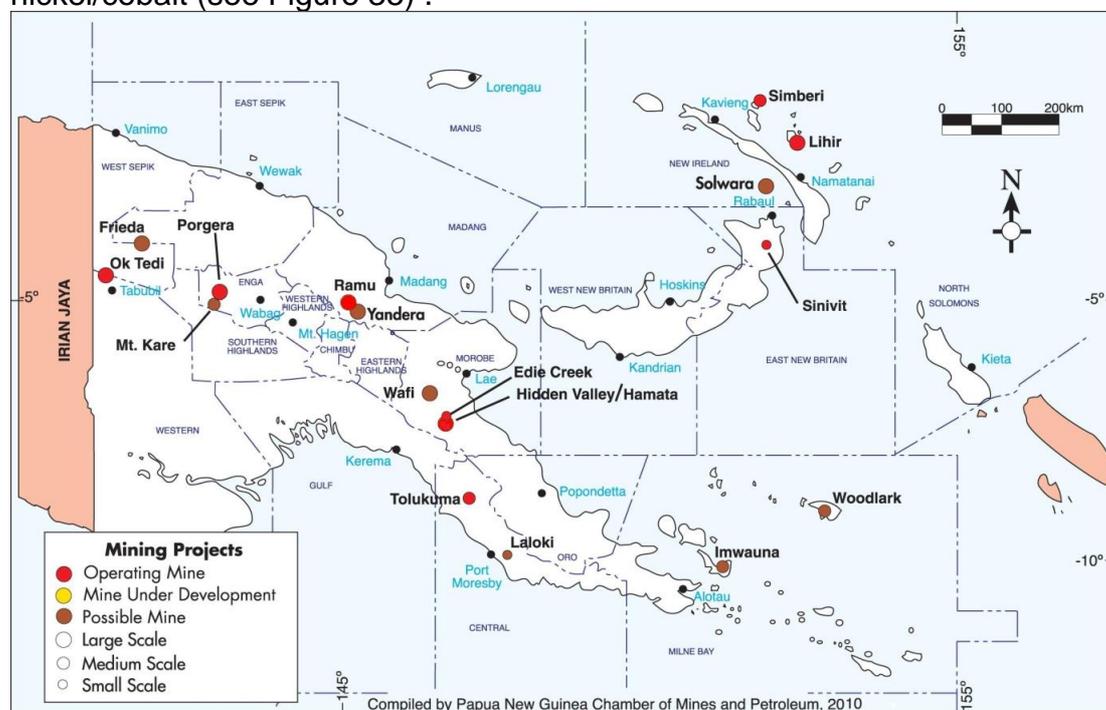

Figure 35: PNG's major mining projects

This has been further expanded with the recent commissioning of the US$20billion PNG LNG project. On the back of the LNG project, GDP growth for 2015 is projected to increase to more than 20% (ADB,2014). PNG stands

at an important juncture in its development. It has a unique opportunity to leverage significant sustainable and equitable improvements in levels of health, education ,income and other elements of broad-based development on the back of its current and projected economic growth rates.
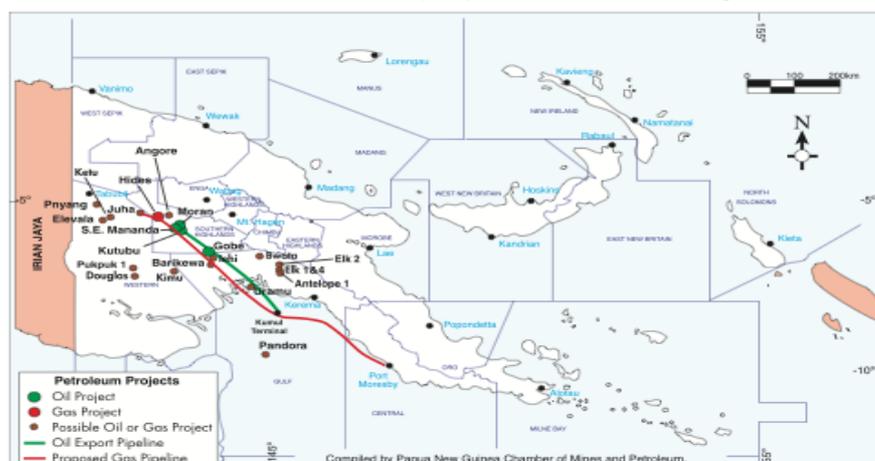

Figure 36: Exiting oil and gas projects in PNG

While the current resources boom have underpinned the nation's growth and development experience, there is widespread perception within the country that this extractive –based form of development has not been inclusive or reached as many Papua New Guineans as it could and should have(UNDP,2014). .

Papua New Guinea's natural environment provides levels and diversity of natural wealth that only a few countries in the world possess. PNG has been labelled one of the seventeen 'mega bio-diversity' countries (Mittermeier et al.1997). The country's biodiversity wealth has been highlighted elsewhere in this report.

The resource boom has also contributed to widespread environmental costs. The environmental aspects of extractive-led growth have in many ways the most damaging impact on the freshwater and coastal ecosystems and sustainable human development. Large scale mining (and to a lesser extent il and gas) and its operations involves the movement of hundreds of thousands of waste materials creating a variety of toxic waste streams. The huge infrastructure and production facilities associated with these operations also degrade and deforest land, forest, and watersheds ,permanently altering landscapes and habitats, and potentially detracting from the human development opportunities of people who reside in and beyond the footprint areas of operation sites.

The form of environmental impact from the extractive sector is both point-specific or 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.

Figure 37   : Hidden Valley mine, Papua New Guinea showing overland conveyor belt from the mine pit to the

central   processing plant and tailings dam. Photo: John Aruga (2010)

3.13 Development Access-Development Corridors

 In 1975, Papua New Guinea, Botswana and Malaysia were at a similar level of development as measured by their GDP per capita. These three developing countries were rich in natural resources. Three decades down the development path, Botswana and Malaysia have transformed their economy and escalated to a higher level of GDP in health and education indicators and have attained middle level income economies. By contrast, Papua New Guinea has fared badly and has underperformed due to various constraints, which if addressed effectively, can unlock untapped economic potential of the country's largely rural population. This is one of the key policy thrusts of the government through its Papua New Guinea Development Strategic Plan (PNGDSP 2010-2030). This development strategic plan is a roadmap that maps out a development path to transform PNG into a middle income country. It poses critical development questions of " where is PNG now ?", "where do we want the country to be in 2030?" and " how will PNG get there?".

Papua New Guinea is young developing country with a vibrant local economy based on rich mineral, petroleum, and gas resources, agriculture, forestry and fishery resources. A significant part of the sustained growth will have to be created in the natural resource sectors and related logistics and services. Unlike its Asian neighbours, Papua New Guinea's economic, transport, agriculture , energy, health and education sectors have also underperformed. The overall aim of the PNGDSP is to diversify the economy beyond mining and petroleum by laying the foundations for prosperity in each of these sectors.

The vision for 'development corridors' will not be achieved without major development and improvement of the existing transport sector. The PNGDSP target for the transport sector is to make sure that by 2030 all roads (national, provincial and district) are in good condition so that there is an effective and efficient service delivery to the rural majority. With an effective and efficient transport sector, all other targets set for land, energy, health and education can be achieved.

Agriculture ,including downstream processing is the most important sector as it relies on the factors readily available to the people-land and labour.

Facilitating economic clusters around important transport corridors that link to rural production networks-otherwise called 'development corridors' is one of the important means to strengthening the transport and agricultural sectors and creating jobs and enhancing service delivery to the rural communities.

Development corridors (see Figure 38) in Papua New Guinea's context is based on a vision that capitalizes on efficient transport network within a defined geography with the help of quality infrastructure, logistics, distribution networks that links production centres, urban and rural clusters and international gateways. Equally important for transport corridors into development corridors is an enabling policy framework that eases doing business and informal measures to facilitate trade and service delivery. The PNGDSP ambitious development corridors are a roadmap to promote growth by removing infrastructure bottlenecks, improving access to markets, stimulating trade and investment and boosting agricultural productivity and efficiency through associated network of road and transport infrastructure. Particularly important for PNG, the proposed 'development corridors' promote inclusive growth by expanding economic opportunities to its largely rural population by linking villages and towns with cities and international gateways.

Development corridors is one of the national government's development strategies to promote economic opportunities to its rural majority and one of the important sectors that ensures the target is achieved is transport. Like all development costs , environmental opportunity costs for 'development corridors' also need to be factored into the sustainable development plans.

The development and presence of transportation corridors results in three primary environmental impacts; reduced landscape permeability, habitat loss, and increased habitat fragmentation. These fundamental changes to landscape structure, which occurs during the construction and post-construction phases of road corridor development, all have profound cascading ecological impacts .

Landscape permeability

Landscape permeability is the degree to which wildlife individuals are able to move across a landscape (Bennett et al. 2011) . Natural landscapes are typically functionally connected , allowing wildlife to move unhindered between benign habitats (Kramer-Schadt et al. 2004). Transportation or road corridors represent barriers to movement (Bennett et al. 2011) . For example

, a road corridor acts as a barrier to certain individuals that overtly avoid crossing or coming near a corridor. Alternatively, wildlife are susceptible to mortality as a consequence of crossing a corridor. Road-related mortality is the most visible and direct effect of roads. It has the potential to significantly affect the dispersal rates of wildlife as individuals attempt to move across the landscape particularly for reptiles and amphibians (Bennett et al. 2011).

Habitat Loss

Road construction results in the direct and immediate loss of habitat (Bennett et al , 2011). It can also reduce the quality of the immediate surrounding habitat through habitat degradation (air and dust emissions, sediment mobilization, chemical runoff, and potentially impact on the quality of habitats further afield (e.g. downstream). Noise is another form of pollution generated by passing vehicles during and after construction(Forman & Alexander, 1998; Kuitunen et al. 1998).Many wildlife avoid activity patterns near road corridors owing to noise levels. For example, a number of echolocating bat species avoid foraging in suitable habitats near roads as the noise of traffic distracts their ability to echolocate effectively (Keuth and Melber,2009).Similarly, road-related noise has been reported as a contributing factor to a reduction in songbird density near roads (Tremblay et al.2008). Further, artificial lighting associated with road degrade habit by rendering it unsuitable for the nocturnal activities of many wildlife species. Conversely, there are also beneficial values of road corridors for some wildlife. For example, bats that forage on moth, butterflies and other insects, artificial lights generated by traffic act as attractants.

Habitat degradation is the primary agent for introduction and expansion of invasive plants and wildlife species. Logging equipment and vehicles   are the primary vectors for the movement of alien invasive plant species in Papua New Guinea .

Habitat fragmentation

Road construction corridors are a major contributor to habitat fragmentation (Kramer-Schadt et al. 2004).Direct effects of habitat fragmentation are an increase in habitat edge and thus edge effects, potential isolation of a habitat fragment from other similar habitat patches, and a decrease in average patch size across the landscape.

Development corridors should therefore consider the following in light of :
- Corridor has important national multi-modal transport (road, shipping, air) linkages between provinces and districts
- The existing development corridors are already under pressure from alien invasive plant species and these are expected to increase
- The corridor may be characterized by densely populated rural communities, economic infrastructure , a number of national or internationally recognized important sites of ecological, cultural and recreational importance.
- Availability of environmental data for corridor ,providing a good basis for EIA

- A multi-stakeholder analysis to design transport and land use within the corridor.
- Law and order issues
- Health issues (transmission of diseases across or within corridors)
- Encroachment into priority protected areas, wetlands, and conservation areas.

With porosity of its national maritime borders, PNG currently faces challenges in containing invasive species particularly exotic weeds and fishes. Logging machinery and vehicles appear to be the primary agents for spreading alien invasive plant species around the country (Figure 31). While development corridors offer immense socio-economic benefits, environmental costs are just as challenging.

Figure 38. Proposed Development Corridors for Papua New Guinea

3.14 Illegal Trade

International trade in wildlife is currently one of the greatest threat to biodiversity. Papua New Guinea is a signatory to the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) since 1975 and as such all international trade in protected or CITES-listed species are regulated under permits issued by CEPA. All exports of wildlife require permits to by issued by the Conservator of Fauna (currently the MD of CEPA) . Despite all non-CITES and CITES II-listed species being regulated by CEPA, there are still widespread illegal, unreported and unregulated trade in plants and other wildlife across PNG remote borders. CITES Appendix II listing is a powerful means of moving towards sustainable resource use for species that are vulnerable and receive little other management intervention.

Illegal trade in PNG occurs throughout the country though largely unreported covers both fauna and flora (e.g. various wildlife including sandlewood, eaglewood, ebony etc.). Much of PNG's illegal export in plants and wildlife is destined for East Asia where population growth and burgeoning affluence has

led to rising demand for exotic and luxury products ,including wildlife products (Traffic,2008).

One group, the freshwater turtles, has experienced far reaching population declines and extinction because the majority of the animals are sourced directly from the wild. PNG (including Papua Province in Indonesia) has the highest diversity of freshwater turtles (Chelidae) in the Australasian region and large numbers are harvested from the Indonesian province of Papua to supply the lucrative international pet trade (Rhodin and Genorupa, 2000). Trade in freshwater turtles, reptiles, birds and fishes at present appear to be restricted to the international exotic pet trade, and there appears to be significant illegal trade along the southern PNG-Indonesian border. Actual export numbers of all species are essentially several times greater than those reported by Indonesian authorities (Samedi and Iskandar,2000).

Illegal wildlife trade is by no means restricted to land-based species. Substantial volumes of marine wildlife are being illegally traded to supply regional and global demand, with extremely high profit margins for traders. Marine wildlife illegally traded from PNG include among others beche-de-mer, shark meat, shark fins, live reef fish (e.g. humphead wrasse), seahorses, marine turtles, giant clams etc. The consumption of shark fins is driven by wealth, social status and traditional beliefs (Halstead, 1992).

3.15   Other indirect drivers of Biodiversity Change

Many of Papua New Guinea's rural villages live in remote areas at the fringe of cash economy. Rapid population growth has placed immense pressure on food and particularly wild meat in terrestrial ecosystems and fish and marine invertebrates in coastal communities. Climate change has also exacerbated the problem across vulnerable areas in coastal regions. In remote islands, food security is a growing concern as salt water intrudes into freshwater reservoirs impacting on water resources and food production.

At the national level, migration is an indirect driver of population growth that results in further increase in biodiversity decline through habitat loss and disturbance , its major agents being deforestation and degradation. There is much synergies and interaction among indirect drivers. In a typical logging operations, construction of roads into previous inaccessible areas promotes migrations and subsequent increase in deforestation and degradation through clearance of forested land for resettlement and associated pressure of forest resources (clearance for gardens, timber for firewood and construction).

4   *Business as usual scenario*

Within Papua New Guinea there is a need to recognise our future pathway if the development paradigm moving forward is business-as-usual. We do not need to look far for indicators of where we currently are. In the 2013 Tracking Report of the Millennium Development Goals, Papua New Guinea is *Off track* not only for MDG 7 Environment (see Section 9.3) but every other MDG 1-6 is also *Off track* with some of the worst indicators for the Pacific.

The current Minister for National Planning and Monitoring the Hon Charles Abel in his forward to the *National Strategy for Responsible Sustainable Development for PNG 2014 The Strategy* said

> *If we continue doing as the current DSP suggests, we will have a population of 30 million by 2050, surviving on an economy heavily based on the extractive industries sector and an environment badly damaged by this, and forest and tuna stocks greatly depleted by unsustainable harvesting.*

*The Strateg*y *2014* outlines a future scenario based on the current *Vision 2050* and *Development Strategic Plan 2030* that currently define the development roadmap for the country. The downfall being that they advocate a growth strategy locking the country into a cycle of growth. An exponentially expanding population and need for services whilst negating the seriousness of the finite nature of non-renewable resources and irreversible damage to the environment and ecology. Papua New Guinea recognises the environmental and ecological dangers of pursuing the current model of growth that is largely dependent on the extraction of non-renewable resources and unsustainable use of natural assets.

Land Use, Land-Use Change and Forestry (LULUCF) makes up 95% of Papua New Guinea's current emissions and several sectors have been identified as the main drivers of deforestation and degradation: timber extraction, subsistence agriculture (expansion into forest and shortening of rotation cycle) and commercial agriculture (especially palm oil plantations). Under a Business as usual scenario, all of them will continue to represent the bulk of Papua New Guinea's GHG emissions by 2030.

The new paradigm proposed in the *National Strategy for Responsible Sustainable Development for PNG 2014* elevates and reasserts the ethic that responsible development means we don't undertake activities that compromise the World's biodiversity or puts our children's future at risk. That the natural ecosystems possess the right to exist, flourish, and evolve therefore continuing vital cycles, structures, functions and processes that sustain communities of PNG who in turn need to protect them.

But as indicated some 20 years ago in the *Report of the UN Joint Inter-Agency Mission to PNG on Sustainable Development 1992*, Agenda for

Action, a supportive and enabling system of governance is the cornerstone of a National Sustainable Development Strategy.

Part II   NBSAP Implementation and Mainstreaming of Biodiversity

5   *NBSAP Status*

Papua New Guinea has not reviewed the *NBSAP 2007* in part because the department responsible for the environment has been in preparatory transition to a Conservation Environment and Protection agency in recent years.

Within the 4th Report to CBD it was highlighted that the NBSAP of 2007 needed review. That it had essentially not been harmonized or followed effectively without adequate resources for implementation. Those aspects of the NBSAP that needed reviews were:

- Articulations and alignment of the national priorities with CBD requirements,
- Formation of an institutional arrangement to coordinate implementation of the NBSAP,
- Development of a national biodiversity conservation policy,
- Improve implementation and resource mobilization strategy for the NBSAP,
- Institute the Biosecurity Act and the Biosafety Policy Framework
- Institute a legal regime to protect intellectual property rights of organizations and individuals involved in biodiversity research and development
- Establishment of partnerships with NGOs, local communities and development partners (e.g. AUD Aid)
- Application of best management practices in Protected area – including the development of Management Plans for Protected Areas
- Limited resources within DEC to support implementation of the NBSAP
- Absence of a sustainable financing mechanism to support conservation work in PNG

Apart from the mainstreaming of biodiversity and ecosystem management and the emergence of a biodiversity offset , discussion for sustainable financing   remains a challenge. Despite the NBSAP not being formally reviewed many policies and plans have progressed the NBSAP through forward thinking.

6   Implementation of Convention

Under the Convention there is a hierarchy of policies and plans within Papua New Guinea with which to effect implementation. The higher order policies are longer term and were initiated at the beginning of this reporting period. The Sectoral policies that relate to the environment and biodiversity are quite recent and are yet to be implemented.

International Conventions	United Nations Convention on Biological Diversity !!
Higher Order Policies	National Constitution 1975 Vision 2050 PNG Development Strategic Plan 2010-2030 Medium Term Development Plan 2011-2015
Sectoral Policies & Plans	National Strategy for Responsible Sustainable Development 2014 (Dept of National Planning & Monitoring) National Climate Compatible Development Management Policy 2014 (Office of Climate Change and Development) National Sustainable Land use Policy 2014 (Dept of Lands & Physical Planning) Papua New Guinea Policy on Protected Areas 2014 (Dept of Environment andConservation)

The Department of Environment and Conservation has been in a state of transition towards a Conservation and Environment Protection Agency and passed the *Conservation and Environmental Protection Agency Act 2014*.
It maintains a core function to enable the conservation and protection of the environment and activities that help to achieve this. It has strengthened capability to impose and receive changes for its functions under the *Environment Act 2000*.

The CEPA will be overseen by a board led by the Managing Director with membership from the Departments of National Planning, Provincial & Local Level Government and of Treasury, and three from the business council including a lawyer and one is a registered public accountant. The composition of the CEPA board thus reflects a cross-sector agency thus reflecting its role as a regulator.

The environment is enshrined in the constitution and there are over 45 various legislations, regulations, and policies guiding environment issues, yet compliance, enforcement and adherence to standards remain a key challenge. Unsustainable logging operations, direct disposal of tailings, degradation and depletion of mangroves and unsustainable fishing practices continue to be pressing environmental concerns.

6.1 National Plans

6.1.1 PNG Vision 2050 (2010)

Papua New Guinea developed a *National Strategic Plan 2010-2050* known as *Vision 2050*.

Within this the 6th pillar is on Climate Change and Environmental Sustainability. To develop a Resilient Country using Sustainable Development Measures.

Under this pillar the objectives that relate directly to the environment and biodiversity are to:

- Conserve Biodiversity at the current 5-7% of the world's biodiversity
- Establish a total of 20 national reserves, wilderness areas and national parks
- Establish at least 1,000,000ha of Marine Protected Areas
- Conserve and Preserve Cultural Diversity
- Integrate environmental sustainability and climate change studies in primary, secondary and national high school curricula
- Establish a Sustainable Development Policy in all sectors; especially forestry, agriculture, mining, energy and oceans by 2015.

6.1.2. National Strategy for Responsible Sustainable Development for Papua New Guinea. The Strategy 2014 (Department of National Planning and Monitoring)

The ideas presented in this document are cited as a Development Revolution. It reviews the Development Strategic Plan *DSP 2010-2030* and subsequent *MTDP 2011-2015*.

Within the paradigm shift towards sustainable development outlined in Figure 39, is that Responsible Development means we don't undertake activities that compromise the world's biodiversity or puts our children's future at risk. It is recognised that PNGs current development pathway is eroding our environmental capital, in a planning cycle that is heading towards a massive population with an equal massive appetite that will lead to a severely depleted and damaged environment and a new sustainable development paradigm of greening the economy.
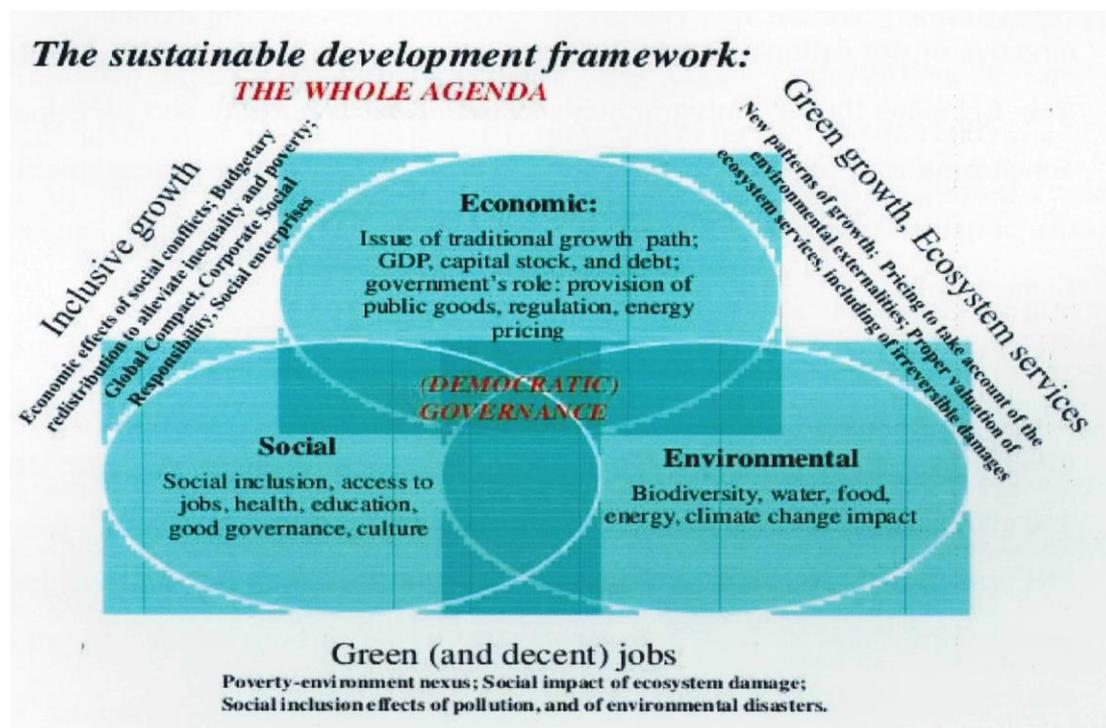
Figure 39 . Sustainable development Framework

This green growth will require mechanisms such as:
- A Strategic Environmental Assessment
- Certification of Sustainable Production and Trade.
- Green Accounting/Alternative Development Measures
- Payment for Ecosystem Services
- Environmental Fiscal Reforms
- Green Innovation

PNG's regulatory framework of legislations, institutions and enforcement will be needed to embed green growth and a sustainable development strategy going forward.

This is a document that aims to mainstream green/environmental principals across sectors in Papua New Guinea.

6.1.3 PNG Development Strategic Plan (DSP 2010-2030)

The *PNGDSP* also places emphasis on environmental sustainability and further articulates the Nation's 20 year plan to reach the Millennium Development Goals and targets for the environment. Within the plan the primary goal is to promote a sustainable environment but recent economic development initiatives have posed new challenges to this strategy.

6.1.4 Medium Term Development Plan (MTDP (2011-2015)

The first *MTDP 2011-2015* will focus on capacity building and improving legislative frameworks for the environment.

The main challenge faced in this sector is the unavailability of data in some areas and the available but outdated data in other areas.

***Biodiversity Data**.*
In 2013 the DEC in partnership with UNDP held two workshops in Biodiversity Survey and Data Capture, Data Analysis and Species Information Management Methods and Approaches for Application in Papua New Guinea. This was to determine the way forward from the existing SIMS (Species Inventory Management System) database. It was suggested that the Department maintain an internal Biodiversity database that is updated from existing data and from future surveys and Environmental Impact Assessments. This database should be linked with other specialized biodiversity databases in the country such as the PNG Forest Authority database and the Binatang Research Centre database through a user agreement. It was also recommended that the Biodiversity database be a part of a PNG Interface on the Australian, Atlas of Living Australia which had many biodiversity collections from PNG currently publically available within it. This data will be of importance to the new CEPA in the further development of a countrywide biodiversity plan, its evaluation of new Environmental Impact Assessments and in evaluating ongoing biodiversity monitoring of existing major development projects.

The Government will develop a Land Use Planning Scheme to guide the best use of land. This will ensure that the natural environment supporting the diverse culture is protected, that a particular economic activity is suitable for the designated parcel of land, and that there is sustainable economic development.

In the minerals resource sector to double mineral exports, while minimising the adverse impacts on the environment. The government has recognised a policy gap to address this and has in the MTDS stated that, the '*Government's environment policies and regulations will be reviewed to capture relocation, sea-bed mining and downstream processing matters.*' Proper stakeholder consultation will be critical to review existing environmental policies. This is to ensure all parties take ownership of proposed changes that capture current development issues. However, the underlying objective is to protect the environment from damages caused by the mining industry, for example from tailings disposal. The disposal of tailings through riverine systems was debated in 2014 in the review discussions of the Mining Act. Deep Sea tailings disposal and the impact to the deep sea environment from deep sea mining proposals are also openly debated in the public.

Within the MTDS it recognized that the increasing population is placing increased pressure on PNG's environment with its rich natural resources including forestry and fisheries. On small islands, population growth is placing increasing pressure on the environment, calling for better environmental management. Under the Sustainable Development Strategy this is recognized and family planning through the NGO Marie Steppes was initiated in 2014. There is a need to achieve a population growth rate that is sustainable for society, the economy and the environment.

6.2 Policies Adopted

The Government of PNG recently developed three key policies in relation to protected areas, sustainable land use and climate change. The development of these policies was initiated in consultation with stakeholders in 2008 ;Department of Land and Physical Planning (DOLPP), 2010 Office of Climate Change and Environment Sustainability (OCCES) and 2011 Department of Environment and Conservation (DEC) respectively. During 2011 however , a political turmoil in PNG, culminated in the general elections in mid 2012. With a new government in place these policies were again picked up and further developed with their final release in 2014.

These are key policies that will fill gaps that previously existed in environmental policy. Having been just released however they are statements of intent and guidelines for future action until such time as they are implemented.

6.2.1 Papua New Guinea Policy on Protected Areas 2014 (Department of Environment and Conservation)

Based on the CBD requirements and activities, the [draft] *PNG Policy on Protected Areas 2014* articulates the principles of **comprehensiveness, adequacy, representativeness** and **resilience (CARR)** as the basis for the development of a national protected area system.

The Government of PNG recognized that a policy was needed for Protected Areas (PAs) at the beginning of this reporting period. A discussion paper on a PAs policy was initially released for public discussion by DEC in December 2011. This was followed by four regional consultations. Following on from these consultations revisions were made by the DEC. This draft led to considerable inputs from a range of stakeholders from government, private sector, NGOs and civil society groups. – The National Elections in 2012 in Papua New Guinea further delayed the development of the Protected Areas Policy until 2013. A new consultative process in the four regions was again followed up in 2014 . A new draft of the Policy was drawn up and released for public comment in August 2014.

Figure 40: Framework for Papua New Guinea's National Protected Area Network (PNG PA policy)

6.2.2   The National Sustainable Land Use Policy 2014 (Department of Lands   and Physical Planning)

The National Sustainable Land Use Policy (NSLUP) is a systematic and evolving process that creates an enabling environment for sustainable development. It assesses the physical, socio-economic, institutional and legal potential and constraints with respect to an optimal and sustainable use of land resources and empowers people to make decisions about how to allocate those resources. The *NSLUP* is an over-arching policy framework that guides the planned allocation, management and best use of land in PNG. It comes under the legislative framework of the *Physical Planning Act 1989* and the *Environment Act 2000*.

Social and economic pressures have caused conflicting land use proposals. This policy proposes for a national land use planning system for the entire country. The policy provides an enabling environment for office of the Chief Physical Planner to dialogue with relevant agencies/ sectors to ensure relevant sector policies are taken into consideration at the planning stage.

Within this policy the allocation, management and best use of land lies within three broad land use zones in the country, supported by the existing legislative framework.

The three broad categories, land use zones, that the National Sustainable land Use Policy has identified are for:

- Development Promotion
- Sustainable Rural Development and
- Conservation

The *National Sustainable Land Use Policy* will be implemented through a *Strategic Land Use Plan (SLUP)* that will guide physical development throughout the country. To achieve the goals of sustainable land use practices and balancing rural-urban development, whilst optimizing the use of the countries finite land resources.

Within this policy there is a specific section on Environment and Conservation where conservation areas are identified under the three broad categories of land use. It recognised however, that the existing legislation on the protection of conservation areas needs to be strengthened.

It also recognised that there is environmental degradation and destruction of biological diversity from intensive land usage like resource extraction through logging, mining and commercial agriculture. And that there are a number of resource exploration and development leases which are given over Wildlife Management Areas (WMAs) often causing damage to WMAs through their activities. The rehabilitation, conservation and management of sensitive or critical ecosystems to preserve their integrity, to allow degraded resources to regenerate and to protect human population from environment hazards is critical.

The Department of Lands believes that the *Protected Area Polic*y should come under the over-arching policy framework for *National Sustainable Land Use*.

The *National Biodiversity Strategic Action Plan* for Papua New Guinea is seen as the instrument to protect rural areas from the impacts of developments on landscape quality, conservation and enhancement of wildlife species and biological diversity. Therefore there is a need for up-to-date information on the environment characteristics and potential impacts at the landscape level to ensure development is guided by principles of sustainability.

Under the current level of national development, current trends of forest harvest most economical forest will have been logged by 2040. Increasing numbers of rare fauna and flora will become endangered. Some species could become extinct if exploitation and land use practices continue at current unsustainable rates.

To develop a land use plan is a major challenge as 97% of the land is owned by customary land owners.

Priority Areas for Action

The land use plan should identify certain areas for specific development options, so that each development option such as timber production, climate

change and carbon trade, conservation areas and agriculture development activities can continue and be sustained. Achieved through integrated land use plans at the Provincial level.

This will need to be supported by strengthened Laws and compliance in the natural resource and extractive industries in relation to the environment.

6.2.3 *The National Climate Compatible Development Management Policy 2014 (Office of Climate Change and Development)*

Ecosystems, and forests face adaptive challenges to climate changes and preservation of these systems will required informed management approaches that support transition to a new climate in future.

The Development of a Climate Change Policy in PNG has gone through many iterations until its final release in August 2014. A *National Climate Change Policy Framework* was developed in 2009 followed by stakeholder consultations, which were held in the four regions of PNG in Goroka, Kokopo, Madang and Alotau. These then formed the first consultative draft of the policy put together by the then Office of Climate Change and Environmental Sustainability (OCCES) which produced a draft document for comment *Climate Change Compatible Development for PNG in 2010*. The office was restructured to the Office of Climate Change and Development in 2011 and *A Climate Compatible Development Policy 2013-2015 (draft)* was released in February 2013. This was further revised to what is the current policy document.

The policy recognises that climate change will modify natural systems and that in many cases, these modifications will be significant. For example, rising sea levels will alter the salinity of low lying coastal islands, drought will affect the habitat of many plant and animal species, and rising temperatures will extend the ranges of some species while contracting those of others. These changes will affect food supply, species diversity, timber harvest, and many other important components of the human relationship to the natural world.

As a mitigation of climate change, the majority of Papua New Guinea's emission are derived from land-used, with most of this a result of the forestry sector and clearance for extensive agriculture. This is due to large area over which logging operates in relation to its low population density. There are significant opportunities to reduce emissions from forestry, both by making the transition to sustainable forest management options and through re-afforestation.

The shift to sustainable forestry with processing into products in Papua New Guinea, and judicious use of international carbon credits to raise incomes and promote development, better forest practices should greatly increase the contribution of forestry to the national economy.

The Department of Environment and Conservation, the PNG Forest Authority, Department of Lands, Department of Agriculture, and Department of National Planning in collaboration with OCCD will support actions that preserve and manage natural assets, including agricultural and forestry lands and natural ecosystems, in such a way that the natural assets can be sustained despite climate change impacts and that the natural assets help reduce greenhouse gas emissions.

Within this policy there are several references to ecosystem level conservation. Through the protection of ecosystem function many aspects of this policy represent cross sectoral statements with climate change as a cross cutting concern to be addressed.

Provincial Cross-sector implementation priorities
Establish a Sustainable Development Policy in all sectors especially, Forestry, Agriculture, Mining, Energy and Oceans. From this to develop provincial priorities in adaptation and mitigation that are in alignment with the National and Provincial programs in these sectors as per the *Vision 2050* and the *MTDP*. These are outlined as follows:

Natural Asset Protection: Protect important natural assets within communities and regions to maintain their roles as "carbon sinks" and to enhance their long-term resilience to climate change impacts. Governments, businesses and institutions of higher learning should help communities identify and map these assets and sustainably manage them.

A Sustainable Land Use Policy is currently being developed that recognizes the threats of climate change to sustainable land use, environment and biodiversity in PNG and highlights the importance of incorporating climate and disaster risk concerns in the land using planning for risk reduction and sustainable development.

Environment: Promoting a sustainable society through the protection and preservation of the natural environment. The PCCIS is aimed at supporting the role of the Provincial Environment Sector in delivering tangible out puts in the provinces. This sector will be relied upon to play a very strong coordination role at the provincial level with the other supporting sectors. The Provincial Environment offices should be able to integrate some of the key issues being raised during the national consultation into their respective planning priorities.

Land and Physical Planning: Promoting Sustainable Land Use in Land Use-Land Use Change and forestry in response to climate change mitigation
The PCCIS intends to support this sector in promoting sustainable land use planning at the provincial level.

Agriculture: Promoting a sustainable and resilient society through food security and sustainable land use for agriculture. This sector will be increasingly impacted by changing weather patterns coupled with intense and

frequent weather patterns will greatly affect subsistence security, in terms of agricultural yield and output.

LULUCF Relevant Programs, Projects and Reforms: Support LULUCF emissions reductions by incentivizing initiatives that reduce and sequester GHG emissions, and by dis-incentivizing GHG emitting activities, emphasizing co-benefits from sustainable development, ecosystem conservation, biodiversity protection, community engagement, equitable distribution of benefit through the identification of appropriate carbon ownership rights. A 'no regrets' dual mitigation-adaptation approach will be implemented.

Forestry: Promoting a climate compatible society through forest conservation and sustainable timber harvesting options and to conserve biodiversity at the current 5-7% of the world' s biodiversity.

Establish a total of 20 national reserves, wilderness areas and national parks. The *Provincial Climate Change Implementation Strategy* is aimed at guiding the implementation of potential climate compatible forestry and REDD/+ pilot programs in provinces. It would also look at provincial government support of conservation efforts at the provincial level.

The PNG Forest Authority also complied a *Climate Change Compatible Plan 2010-2015* which contains relevant sections relating to the ecosystems and biodiversity. This will now have to be reviewed following on from the release of the OCCD Policy.

Fisheries: Promoting climate resilience through the protection of marine and fishing zones. The *Provincial Climate Change Implementation Strategy (PCCIS)* will guide the implementation of fisheries activities in the provinces.

6.2.4 National Policy on Traditional Medicine (2007 under review 2014) (Department of Health)

It is recognised within the National Policy on Traditional Medicine 2007 that appropriate measures will be taken to preserve medicine plants Through the identification and taking measures for the cultivation and conservation of Medicinal Plants (GovPNG 2007). This is currently under review in 2014 to take into consideration advances and changes in this important provisioning service from the localised species within ecosystems that provide health benefits to village based communities and primary health care.

6.3 Institutions

6.3.1 DEC Corporate Plan 2009-2012

In support to progress the Environmentally Sustainable Economic Growth (ESEG) agenda and the MTDS initiatives, both DEC developed the DEC Corporate Plan (DEC-CP) 2009 – 2012. This was not revised in 2013 in part

due to the process of transition of DEC to CEPA. The objectives within the DEC-CP 2009-12 were directed towards the establishment of a new effective department, improved administrative performance, effective implementation of GovPNG's ESEG agenda, improved environmental regulatory processes and demonstrated on-ground improvement in both environment and economic outcomes through implementing large scale pilot projects in partnership with other levels of government and external stakeholders

6.4   Programs/projects

There is considerable support and for biodiversity, environmental conservation and sustainable development through many program and projects. The following is a brief outline of many of these initiatives. Included are the *Aichi Targets* that they each in part contribute towards. Despite these efforts it will be seen that attaining these targets is still an ongoing process. There is a need to better coordinate these efforts and in inter-collaboration in their implementation and results.

6.4.1   Community-based Forest and Coastal Conservation and Resource   Management in Papua New Guinea UNDP (GEF-4) 2011-2018

This is a major investment in conservation development in Papua New Guinea under the initiative UNDP development program. Executed by the DEC (now CEPA), The overall objective of the project is to develop effective natural resource management and financing systems for community conservation areas in PNG. The key components of the project were to provide ; (a) enabling national environment for a community-based national system of Protected Areas (PAs) containing globally and nationally significant biodiversity, (b) identification and establishment of new PAs in the country, and (c) undertaking Conservation Area (CA) management planning, signing partnership agreements with communities and (d) providing capacity development and support for implementation of CA Management Plans.   . From 2011 to 2014 foundational work has been done on this project in part guided by the implementation of the *Kokoda Initiative,* which is a component that was already being implemented.

The Project Document (ProDoc) outlined a series of barriers to achieving effective sustainable natural resource management and conservation. Effectively articulating a program of work to implement aspects of the *PNG NBSAP* and *Aichi Target* commitments. These are being implemented in the Owen Stanley Ranges and the Island of New Britain but will inform strategy across PNG.

The barriers to effective sustainable natural resource management and conservation. are outlined here along with the primary strategies to overcome these and achieve positive results

1. Inadequate legal and policy structure and a lack of National biodiversity priorities to allow the planning establishment and funding of sustainable protected areas
   - Ineffective coordination amongst sectorial institutions for land use planning to incorporate protected areas
   - Ineffective and uncoordinated national protected areas policy
   - Lack of national conservation criteria
   - Inadequate policy and legislation to support payment for environmental service PES schemes
   - Inadequate institutional and staff capacity to implement national conservation strategies including protected areas management
   - Failure of national strategic planning policies to address population pressures on land degradation and conservation
2. Deficient biodiversity information and data analysis to facilitate conservation needs planning and develop baseline for environmental services
   - Inadequate data for accurate national conservation needs planning
   - Inadequate baseline information to quantify payment for ecosystem service schemes
3. Inadequate economic incentives and variable local capacities to support community conservation areas
   - Lack of economic incentives for community conservation
   - Low capacity for economic development and resource management at the local level
   - Variable types and capacity of local level organisations.

The primary strategies to overcome these identified barriers are to

- Establish a national enabling environment for a community-based sustainable national system of protected areas (PAs) containing globally and nationally significant biodiversity.

This component will focus on improved institutional coordination, consolidated policy and legislation, improved DEC/CEPA staff capacity and development of funding structures to underpin conservation planning.

- Identification and establishment of conservation areas through a structured science-based process.

This component aims to add 1 million hectares to the sustainable national system of PAs through the establishment of new Conservation Areas (CAs) and/or conversion of viable existing Wildlife Management Areas (WMAs) into CAs which can effectively remove current and future pressures for forest degradation and conversion.

Conservation Area management planning and partnership agreements with communities will ensure that CAs are effectively managed according to agreed criteria to maintain biodiversity values. In addition, this component will

create the service delivery, community development and economic development outcomes required to compensate community landholders for the opportunity costs of keeping their lands under protection. Integral to this will be the development of sustainable financing plans for each CA; to this end, communities in prospective project sites will be provided with the tools, resources and capacities to develop conservation-compatible livelihood opportunities in sectors such as PES, tourism, forest monitoring and sustainable agriculture.

Capacity development and support for implementation of CA Management Plans will deliver the training and capacity development tools needed for Provincial, District and Local Level Government officials to help community management groups to deliver improved services, income, planning and education opportunities for communities within and around CAs. This component will also help increase the capacity of landowners and communities to manage the CA and generate income from associated business activities. Finally, this component will also coordinate ongoing monitoring and evaluation of the project.

Although this project is in its initial stages it can be seen within the many recent policies developed, that these are proposing a more coordinated land use planning approach that has clear guidelines towards protected areas. Also how this is relevant to a new sustainable development paradigm that links human wellbeing to the health of the natural environment that is in a dynamic state due to anthropogenic influences.

6.4.2   *Kokoda Initiative (2008-2010-2015)*

This program has now entered a new phase through the *Second Joint Understanding 2010-2015*. Between Australia and Papua New Guinea this is a continuation of effort towards the progammes vision which is in part fulfilment of the *PNGSP (2010-2030)* and contributing to several of PNG's biodiversity and *Aichi* targets.

The vision of this program is the Sustainable development of the Owen Stanley Ranges, Brown River Catchment and Kokoda Track region and protection of its special natural cultural and historic values.

Within the Interim Protection Zone IPZ of this initiative it has become increasingly recognised that most areas are largely unexplored and many species remain undescribed with desktop studies revealing possibilities in working towards World Heritage Listing. Many of the work streams within the initiative are also regarded as a pilot in processes towards sustainable development and conservation.

The conservation of biodiversity and other values of the Kokoda track and IPZ has led to an integrated program through five main goals.

- The wise use and conservation of the catchment protection area, including the Kokoda Track and its natural and cultural resource and values.
- Biodiversity scoping in surveys, data and data management for surveys, in gaps such as Mt Victoria and in listing invasive species. Capacity development in spatial mapping in environmental management.
- A safe and well managed Kokoda Track, which honours its wartime historical significance and protects and promotes its special values.
- The ongoing development of the effective operation of the Kokoda Track Authority through organisational capacity, a track conservation program and capacity building of rangers and construction of a traditional prototype cane bridge a
- Enhanced quality of life for landowners and communities through improved delivery of basic services, income generation and community development activities.

These goals will be achieved through the development of several programs, which will also be a guide to process for other initiatives in the country through capacity building of PNG based agencies and strategic planning.

Social mapping to better understand communities and their relation to their environment, reviewing methodologies and developing future social monitoring processes.

Health and Education infrastructure improvement, training of health staff, outreach extension, education materials.

Building national and international tourism potential of the Owen Stanley Ranges and Kokoda Track Region, supported by future World Heritage nomination. Collaboration with the Tourism Promotion Authority in accreditation of accommodation and aligning sustainable tourism within provincial plans.

Working with communities, landowners and communities at all levels of government to ensure the activities established under the Kokoda Initiative are sustained into the future.

6.4.3   Multi-purpose National Forest Inventory EU 2013-

This program will contribute to the implementation of PNGs climate change policies and mitigation measures. The purpose of the new project is to support the PNG Forest Authority to implement a continuous and multi-purpose National Forest Inventory. Funds are provided from the Global Climate Change Alliance (GCCA) an initiative of the European Union to strengthen dialogue and cooperation with developing countries most vulnerable to climate change.

The PNG Forest Authority is taking the lead to carry out a multi-purpose forest inventory to improve planning and management of the forestry sector. Specific studies will be implemented in East Sepik and Milne Bay province. The national forest inventory (NFI) will be a key element to contribute to the REDD-plus initiative, implemented under the United Nations Framework Convention on Climate Change (UNFCCC) mechanism.

6.4.4   Enhancing Forest Law Enforcement in PNG ITTO 2011-

In the face of current environmental risks in PNG's forested areas which include:

- A net deforestation rate of approximately 0.5% per year, largely driven by informal clearing for subsistence agriculture,
- Forest fires exacerbated by a lack of forest management to prevent the build-up o fuel, and
- The risk of illegal logging activities by small-and-medium-scale operations

This project will develop and pilot a Chain-of-Custody (CoC) system based on international standard managed by the program for the endorsement of Forest Certification, customized for use by PNG timber processors. This customized standard will facilitate access to international markets for PNG timber processors. The program also has targets to achieve that work towards a framework of documents for a *PNG Timber Legality Standard, Industry Code of Conduct* to compliment the *Logging Code of Practice* 1996 and Stakeholder Monitoring Modules.

6.4.5   Lowering Emissions in Asia's Forests LEAF USAID 2011-2015

The USAID *Lowering Emissions in Asia's Forests (USAID LEAF)* Program is a 5-year regional project focused on achieving meaningful and sustainable reductions in greenhouse gas (GHG) emissions from the forest-land use sector across six target countries:Thailand, Laos, Vietnam, Cambodia, Malaysia and Papua New Guinea.
 The USAID Leaf program in PNG supports and build the capacity of its main provincial counterpart, the Madang Provincial Government , and at the national level the Papua new Guinea Forest Authority (PNGFA) ,Constitutional Law Review Committee (CLRC), and the Office of Climate Change and Development (OCCD) on forest and climate change planning and policy. USAID LEAF coordinates with other key development actors, including The Nature Conservancy (TNC),the Institute of National Affairs (INA), and UN-REDD at the national level for climate change policy formulation.

Within this program there are initiatives to build and institutionalize technical capacity for economic valuation of forest ecosystem services and monitoring

changes in forest carbon stocks and to demonstrate innovation in sustainable land management.

This program's regional approach works to connect national-level policy makers with regional platforms including the ASEAN regional Knowledge Network on Forestry and Climate change (ARKN-FCC) . Participating by PNG in such forums provides invaluable knowledge sharing among state and non-state actors in ASEAN on common critical issues related to climate change.

6.4.6   *Biodiversity Offset ExxonMobil – PNG 2013*

An objective of the ExxonMobil-PNG *Biodiversity Strategy* is that residual impacts on biodiversity values be appropriately accounted for through an offset program of conservation and rehabilitation measures, guided by good industry practices.

Biodiversity Offset was a requirement of the financiers of the PNG LNG project however Papua New Guinea had no system, formal or otherwise to guide the development of on offset plan. The biodiversity offset plan was therefore developed by the then Esso Highlands Limited, in consultation with stakeholders and institutions.

The *Biodiversity Offset Delivery Plan* was designed through a collaborative process with local stakeholders. It has been based on the criteria for offset, the legal and social framework for conservation and the identified protected areas in Papua New Guinea, along with identified constraints, opportunities and options. The *Biodiversity Offset Delivery Plan* and the biodiversity offset program consists of a series of separate but complimentary components (see Figure 41). Together, these components form a comprehensive program for biodiversity offset that encompasses conservation activities at the local scale through to strengthening existing protected areas and providing new protected area development where possible. These activities are supplementary to initiatives that support conservation and protected area planning at the landscape (regional) and national levels with the aim of enhancing conservation in Papua New Guinea.

Considering that the detailed design of each component is dependent on prevailing external circumstances at the time of implementation, change, and adaptation to change, are inherent features of the Biodiversity Offset Delivery Plan and the biodiversity offset program.

Figure 41. ExxonMobil PNG Biodiversity Offset Components

Each of these components are being progressively being implemented through ExxonMobil PNGs' support and collaboration with key local stakeholders.

The PNG Government has since made initial reference to apply the concept of biodiversity offset through the *Protected Area Policy 2014.* Stating that where existing industry proposals for resource extraction or development coincide with and conflict with Conservation Priority Areas, biodiversity offsets will be required in similar ecosystem or habitat types. In the case of new proposals, careful consideration would be required and only approved where no net harm can be ensured. How Biodiversity Offset can be formalized to facilitate conservation of biodiversity and ecosystems, is still under discussion and development within DEC.

Apart from biodiversity offset ExxonMobil PNG has an environment program that was set out during the construction phase, which included; biodiversity and baseline surveys, waste management, pollution prevention and abatement, invasive species control, tracking vegetation regeneration, water management and erosion/sediment control. A Biodiversity Strategy was developed in 2010 and is being implemented along with a Biodiversity Monitoring Program.

Green House Gas emission of the PNG LNG projects in country activities are also calculated on an annual basis.

6.4.7 Mangrove Rehabilitation for Sustainably Managed, Healthy Forests (MARSH) USAID 2013-

The MARSH project's main initiatives include the provision of training for community-based, sustainable mangrove forest management and mangrove reforestation and the strengthening of technical and scientific capacity of local

universities and public institutions to conduct forest carbon monitoring, reporting and verification.

In Papua New Guinea, the MARSH project will support the government in achieving the goals cited in the Papua New Guinea *Vision 2050* reducing greenhouse gas emissions by 90 percent, establishing a sustainable development strategy for forests by 2015, increasing resilience to natural disasters and environmental change and supporting the OCCD goal of planting one million mangrove trees by 2016.

6.4.8 Papua New Guinea Marine Program on Coral Reefs, Fisheries and   Food Security 2010-2015

This national program was closely tied to the Coral Triangle Initiative and has many initiatives outlined.

- Identification, demarcation, designation and sustainable management of priority seascapes.
- Effective application of an ecosystem approach to management of fisheries (EAFM) and other marine resources.

The approach will look at both food security of local artisanal fishers and well as sustainable commercial fisheries such as tuna. This will need the support of a strong legislative policy and regulatory framework.

- The establishment and effective management of a Marine Protected Areas (MPAs) system.

Networking is a key to achieving this and currently the CLMA network and Learning Training Network have been proactive in information sharing from practitioners across the LMMAs of the country.

- Implementation of climate change adaptation measures to management of the coastal and marine environment.

A current proactive program in PNG is the Coastal Community Adaptation Project C-CAP supported by USAID 2013-2015. Aspects of this are building local adaptive capacity, strengthening resilience, improved coastal zone and water resource management.

- Improved status of identified threatened species including sharks, sea turtles, sea birds, marine mammals, corals, sea grass and mangroves.

Of these species there is a proactive program on mangrove rehabilitation with support from the USAID Mangrove Rehabilitation for Sustainably-Managed Healthy Forests (MARSH) Project from 2013-2017. The MARSH project activities include training for community-based, sustainable mangrove forest management and mangrove reforestation and strengthening technical and scientific capacity of PNG universities and public institutions to conduct forest carbon monitoring, reporting and verification.

The *Fisheries Management Act 1998* also stipulates that each management plan is to include certain elements, including the objectives to be achieved in the management of the concerned fishery. The management objectives are a prominent feature of all current PNG management plans. As an example, the

National Shark Longline Management Plan gives the following management objectives:

> To apply a precautionary approach to the management of the shark fishery, ensuring the harvest of shark resources is sustainable and that shark fishing has minimal impact on the marine ecosystem.To ensure that there are benefits to Papua New Guinea from the sustainable use of its shark resource. To ensure that the utilization of the shark resource does not have negative impacts on coastal communities.

Many local NGOs are also proactive in dugong and turtle awareness. There are also some doing e turtle tagging and monitoring, supported through SPREP.

PNG is a party to the *Nauru agreement* in relation to the multispecies tuna fishery. In 2010 decisions were made to prohibit setting purse-seine nets around whale sharks, a ban on fishing near fish aggregation devices during the months of July through September. In December 2011, the PNA purse-seine free-school skipjack fishery was certified under the Marine Stewardship Council standards as being sustainable. Whilst in 2013 saw the establishment of a PNA Observer Agency to improve efficiency of national observer programmes in maintaining 100% independent observer coverage aboard purse-seine fishing vessels in PNA waters;

6.4.9   Coral Triangle Initiative and CTSP 2011-2014-

Coral Triangle Support Program
This initiative was to support Papua New Guinea's National CTI actions in integrated marine and coastal management in the Coral Triangle. It represented a collaborative effort between the implementing partners (World Wildlife Fund (WWF), The Nature Conservancy (TNC), Conservation International (CI), with various agencies of the government of PNG.

There are modest indications that social ecological conditions are improving in the LMMAs across the country from this initiative.

This was from the extension to communities of capacity in Local Marine Management Areas (LMMAs), Ecosystem Approach to Fisheries Management (EAFM), Climate Change Adaptation (CCA) planning and implementation are progressing, with the greatest tangible progress on LMMAs at the local level whilst EAFM and CCA concepts are diffusing among policy makers.

Manus Provincial government Environment Sustainable Development Plan (ESDP) 2010-2015 was developed and implemented in collaboration with stakeholders.
A feasibility study of Payments for Ecosystems Services (PES) focused on the Lorengau Watershed and catchment area in Manus province. The study is

guiding approaches to integrate PES into adaptation plans and programs at the local and provincial level.

PNG's Centre for Locally Managed Areas (PNG-CLMA) became the lead coordinating organization for marine learning and training activities in PNG which will be coordinated through hubs. This supported the *Manus Environment Conservation Communities Network (MECCN)* the first learning network established in PNG.

1. Ecosystem Approach to Management of Fisheries (EAFM) and Other Marine   Resources Fully Applied

The US CTI Support Program has:

- Improved the management of 15,000 hectares of marine protected areas.
- Improved the coastal, fisheries and natural resource management of over 250,000 hectares.

2. Marine Protected Areas (MPAs) Established and Effectively Managed

- The CTSP assisted in the development of the PNG and Coral Triangle Marine Protected Area System through integration of EAFM and CCA concepts into community management plans. The community of Pere with the *Pere Alalau Association* reviewed incorporated these into its updated LMMA management plans, launched in summer 2012. Several Manus communities are in the process of developing similar plans.

3. Climate Change Adaptation Measures Achieved

- Support in the building upon traditional knowledge in Papua New Guinea to improve scientific understanding of climate change and further incorporation into the design and development of climate-resilient LMMAs.

Kulungi, Lolobau and Tarobi LMMAs are priority development sites within the PNG region of the Coral Triangle.

The development of a broad range of well-designed educational materials and guidebooks also represents an opportunity for the next stages of US government and international NGO support for the CTI-CFF in partnership

Papua New Guinea ratified the Permanent Secretariat 2014

6.4.10   *Marine Turtle and Dugong Awareness Program for Western Province 2010-*

The government of PNG has bilateral responsibilities with the Australian government to manage marine turtle and dugong resources under the *Torres Strait Treaty 1984*. The Treaty allows for marine turtles and dugongs to be hunted in Torres Strait waters by Australian and PNG Torres Strait traditional inhabitants.

The emphasis under this program is to develop a *Marine Turtle and Dugong Management Plan* for the PNG's Torres Strait region under the Australian

Government funded PNG Engagement Project. The 'Guiding Framework' *is a* seven-point plan that addresses the impacts of unsustainable practices relating to marine turtle and dugong harvests in the PNG sector of the Torres Strait and provides a package of actions to address local, regional and national or international management needs.

6.4.11   Strategic Program on Climate Resilience ADB 2012-2017

The goal of the SPCR is to help PNG transform to a climate resilient development path, consistent with national poverty reduction and sustainable development goals. In its nature as a pilot program and supporting learning–by-doing, the SPCR implementation ultimately aims to result in an increased application of knowledge on integration of climate resilience into development. The overall outcome of SPCR for PNG will be the enhancement of PNG's resilience to climate change through improved access to resources , knowledge, and tools and climate resilience infrastructure at the national, sector, district, and community levels. These are the prerequisites for effective social development, food security, and overall poverty reduction. In PNG, the SPCR will support achievement of these key pillars for climate resilient development.

6.4.12   Coastal Community Adaptation Project C-CAP USAID 2013-

Aims to build the resilience of vulnerable coastal communities in the Pacific region including PNG to withstand more intense and frequent weather events and ecosystem degradation in the short term, and sea level rise in the long term.

Integrating climate resilient policies and practices into long-term land use plans. This involves community/risk mapping exercises to review risk to projected climate impacts and support land use planning exercises, scaling up plans to provincial and national government and to implement nature-based infrastructure activities when appropriate (mangrove reforestation, erosion control

6.4.13   Pacific American Climate Fund USAID 2014-

Is a fund to strengthen the resiliency of vulnerable communities in Pacific island countries including PNG to adapt to the negative impacts of climate change.

6.4.14   World Wide Fund for Nature WWF

Terrestrial Projects

Wildlife studies and land use planning/management in the Kikori River Basin and Upper Sepik, cross-border cooperation in the TransFly ecoregion,
The establishment of the Lake Kutubu WMA and RAMSAR site. Technical Support to DEC in 2012 in nomination draft for the Sepik Wetlands (2.44 million ha) RAMSAR site.

Marine Projects

Development of LMMAs on the northern coast of PNG through the CTI program.

6.4.15 The Nature Conservancy TNC

Terrestrial Projects

Development of a Conservation Area within the lower montane forest of the Adelbert Mountains of the Madang Province in collaboration with the Adelberts Conservation Cooperative Society. First Fair trade-certified cocoa in the country. Technical support for the Madang Sustainable Development: Ridges to Reefs Gap and Priority Analysis 2013.

Marine Projects

LMMA establishment in Kimbe Bay West New Britain province and Manus Province through the CTI and CTSP programs. Development of PNG PoWPA 2009 and further refinement. Assistance in the development of PNG Marine PoWPA 2013.

6.4.16 Conservation International CI

Terrestrial

Reviewed the ExxonMobil PNG Biodiversity Offset program 2011, reviewed the EIA of Woodlark Mine 2013 and did the second P'nyang Biodiversity Rapid assessment in 2013.

Marine

Awareness in marine ecology, with the development of marine management plans, preliminary LMMAs in island communities (Nuakata, Iabam-Pahilele, Wialoki and Ware) of Milne Bay. Monitoring of management results through the CTSP program.

6.4.17   Wildlife Conservation Society WCS

Terrestrial

REDD+ pilot survey in Manus. Biodiversity assessment of the Hindenberg Wall in 2013.

Marine

Awareness in marine ecology, with the development of marine management plans, preliminary LMMAs in Manus and New Ireland communities.

6.4.18   Partners With Melanesians

Development of the *Managalas Conservation Area Project (MCAP)* 300,000 hectares of diverse vegetation located, between the Owen Stanley and the Sibium Range which contains the upland population of the Endangered Queen Alexandra Birdwing Butterfly. This CA was advertised for public review or acceptance and is responding to critical comment.

6.4.19   The Centre for Environmental Law and Community Rights CELCOR Inc

CELCOR offers affordable legal assistance and advocacy for Papua New Guinean customary land owners in Environmental concerns. The vision, mission and main objectives of the organisation have remained relatively consistent.

6.4.20   Centre for Locally Managed Areas CLMA Inc

CLMA developed collaboration between PNG LMMAs with capacity building and the development of a learning training network.

6.4.21   PNG Ecoforestry Forum EFF

The umbrella PNG Ecoforestry Forum has been proactive in REDD+, timber certification support and in education, empowerment and advocacy. It is developing a database information hub in 2013 of its 15 members activities.

6.4.22   Binatang Research Institute

This institution based in Madang looks at plant insect interactions building up ecological knowledge. This includes the capacity building of local university graduates in collaboration with overseas researchers but also equally important the collaboration with local para-ecologists from within communities.

6.4.23 Institute of Biological Research

IBR was founded in 2008 by a group of local scientific colleagues dedicated to conserving Papua New Guinea's flora, fauna and ecosystems to ensure a biologically sustainable future. They conduct research, train PNG biologists

and conservationists, ensure information is shared with policy makers, landowners and PNG citizens, and integrate traditional knowledge & customs with modern concepts of conservation

6.4.24   Tree Kangaroo Conservation Program

In 2013 TKCP established TKCP-PNG, the local implementing NGO to manage the YUS Conservation Area. This program envisions a sustainable, healthy, and resilient Huon Peninsula landscape which supports the area's unique biodiversity, human communities, and culture. Whilst the TKCP at Woodland Park Zoo is the international conservation program, focused on conserving the endangered Matschie's tree kangaroo and its habitat. Due to their biological and cultural importance, tree kangaroos remain the program's flagship species but conservation also includes habitat for a wide range of threatened species. Conservation is supported by a Trust fund for management and through landscape planning and local livelihood initiatives.

7   Outcomes Achieved

7.1   Mainstreaming Biodiversity

Marine PoWPA Conservation Planning

Following the Terrestrial PoWPA reported in the PNG's 4th Report to CBD the CEPA is currently undertaking a national marine gap analysis to contribute towards their commitment under the Convention on Biological Diversity. The design criteria for identifying and addressing PNG's Protected Areas (PAs) was based on the **Comprehensiveness, Adequecy, Representativenes, and Resilience (CARR) principle** to establish a "comprehensive, effectively managed and ecologically-representative national system of protected areas."

With assistance from the Australian Government, The Nature Conservancy, CSIRO and the University of Queensland, CEPA has completed a national marine gap analysis aimed at identifying and addressing ecological gaps in their marine protected area (MPA) system, and identifying areas of conservation interest for protected area planning, environmental impact assessment and other management and conservation activities.

Initially a regionalisation of PNG's marine areas was developed to classify the large and diverse marine environment into different regions so that CARR principles could be applied to the gap analysis. The ecoregions and bioregions defined in Figure 42 were used as stratification units to apply these CARR principles in the PNG National Gap Analysis, where these principles will be applied to:
- Deep water habitats based on ecoregions; and
- Shallow water habitats based on bioregions.

This is because the delineation of shallow water habitats was based primarily on characteristics of shallow water ecosystems (particularly coral reefs), so they are not applicable to deep water habitats.
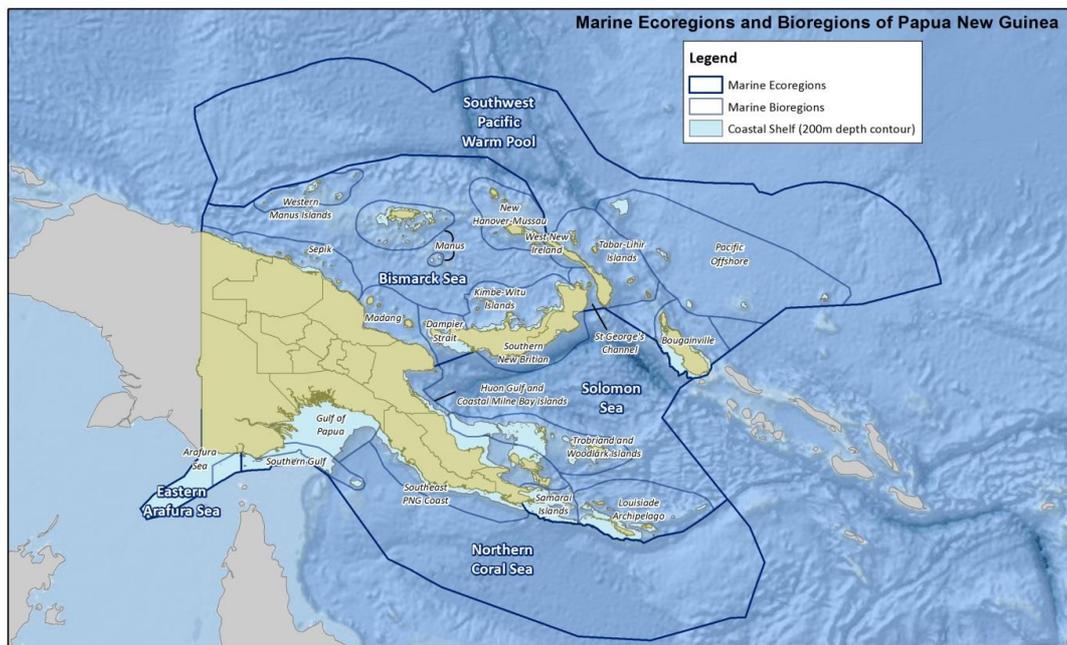

Figure 42. Papua New Guinea EEZ, ecoregions and bioregions

Following on from regionalisation of marine protected areas, a series of targets were chosen for analysis through the Marxan software planning tool. Several repeated runs of the software resulted in the production of the map shown in Figure 42. The resulting targets were that Local Marine Managed areas at various base scenarios ranging from 10 to 20% could be produced with the capacity to overlay other significant environmental impacts within the target area (e.g. mining) as indicted in Figure 43.
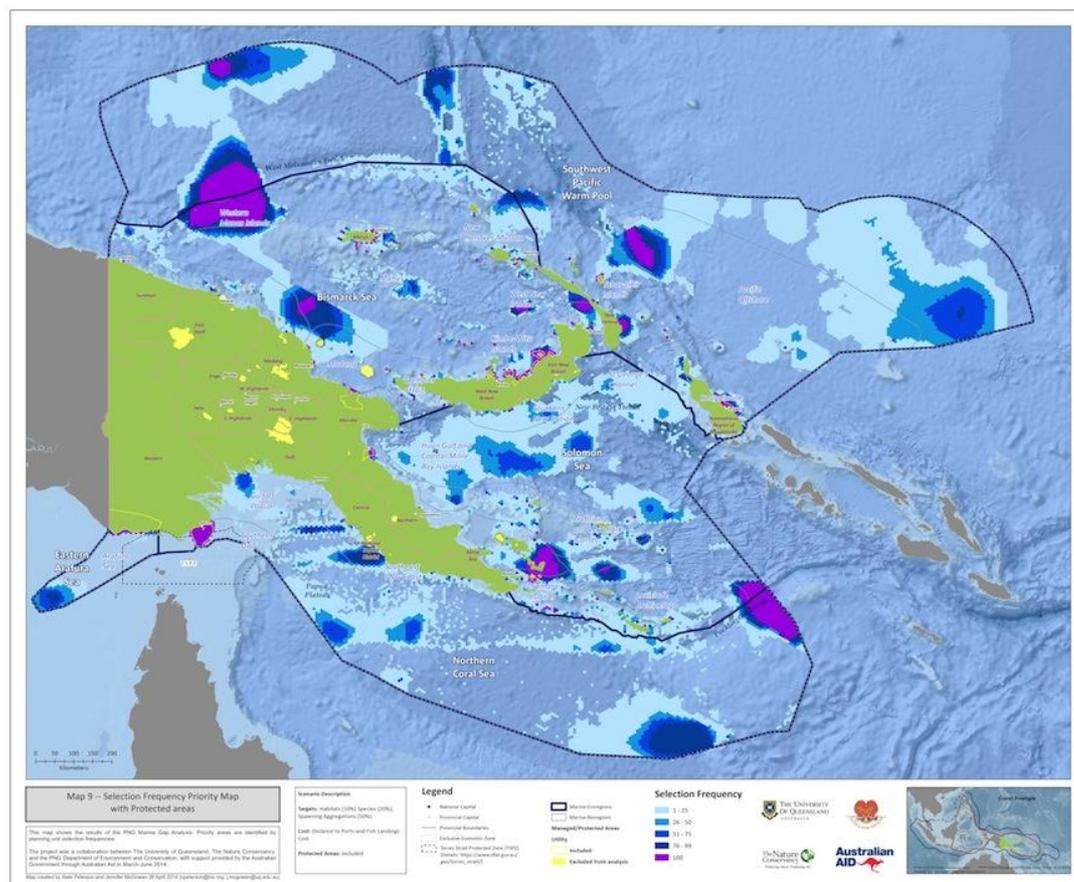
Figure 43. PNG Marine PoWPA Selection Frequency Priority Map, showing Terrestrial Protected Areas, Local Marine Managed Areas Habitats 10% Species 20% Spawning Aggregation Sites 50% and costs of distance to port and Fish Landings Cost. Selected for representativeness for each Bioregion stratification.

The preliminary Marine PoWPA process and verification process with products of this and other maps was done in mid 2014 with stakeholders and was in fulfillment of the *CBD Program of Work on Protected Areas (PoWPA) Action 1.1.5: complete protected area gap analyses at national and regional levels based on the requirements for representative systems of protected areas that adequately conserve terrestrial, marine and inland water biodiversity and ecosystems.*

The PoWPA process of planning towards an affective protected areas system is also in fulfillment of the first goal of the PNG Marine Program. DEC is also working towards a combined terrestrial and marine PoWPA so that a holistic ridge-to-reef-to-deep-sea, conservation and natural resource management plan is articulated for the first time.

7.2   *Biodiversity Integration into Planning Processes*

The Conservation and Environment Protection Authority has strengthened its capacity and independent evaluation of Environmental Impact Assessments as required under the *Conservation Act 2000*. Major developments such as mines broadscale agriculture and development corridors require EIA/SIAs which also have a Social Impact Assessment. Apart from the developer

submitting an EIA for consideration it also pays for an Independent review of this through DEC to a qualified consultancy. DEC needs to further develop its database and technical capacity so that it can make informed comments on EIA in the process towards the issuance of an Environmental Permit. This will be a core function of the CEPA.

The National Lands Department, Minerals Resources Authority and Forest Authority have spatial capacity and the current Protected Areas have been recognised in their maps. Protected areas are therefore referenced in Land Use planning and zoning, the issuance of Exploration Licences, Forest Management Areas and Logging Plans respectively. This is a recent development of the integration of environmental plans in the development agencies. With a PNG biodiversity plan informed by PoWPA mapping it is anticipated that priority areas for conservation currently not under protection will also be considered in any development planning. This is currently lacking for PNG.

8   NBSAP Implementation

The following tables are the main sections and objectives within the Current *PNG NBSAP 2007*. As mentioned it was recognised early within its implementation that this needed revision to reflect the changes within country but this has not yet been done. In part due to the line Department of Environment and Conservation being in a state of eminent transition to a CEPA during this reporting period.

Tables Colour Code
In this and in following tables the colour code can be interpreted as
red   (not achieved/off target),
orange (variable achievement/mixed) and
green   (on target).

Table 13. Achievement of PNG NBSAP to date

1. Policy, Legislation and Administration		
Establish the NCC, expand mandate beyond advisory role and establish a NBSAP Coordination Sub-committee	red	NCC & Environment Council set out within CEPA Act
Review the functions of PINBio immediately to strengthen biodiversity conservation programs	red	PINBio no longer is an active body.
An effective legal framework for the implementation of the CBD and related Conventions	orange	CEPA Act 2014 now in place. Environment Laws to be reviewed following establishment of CEPA
Develop innovative policy and law that protect the intellectual property rights of organizations and individuals engaged in biodiversity research and development	orange	IPR WS discussions held and still being developed
Improved effectiveness of existing legal mechanisms by creating greater awareness of conservation regulations and enhancing the capacity of law enforcement agencies (including the police, customs, airlines and NAQIA).	red	Surveillance remains a core activity of these line agencies who collaborate with DEC

2. Financial and Technical Resource		
To develop the human capacity to ensure the short- and long-term financing and sustainability of NBSAP	red	Capacity building within DEC
To design and implement a spectrum of sustainable	orange	Within CEPA Act and plan

financing mechanisms for NBSAP implementation	🟧	
Obtain necessary financial support for biodiversity initiatives	🟧	CTI, GEF4, GEF5 ProDoc
Encourage local investment in biodiversity conservation as a complementing measure to foreign donor support	🟧	Industry funding Government co-financing
Expenditure reduction through reduction of duplication of effort, streamlining activities, and strategic actions to ensure maximum mileage from minimum investment by the Biodiversity Projects Coordinator.	🟥	No specific actions on this

3. Human Resources and Institutional Capacity Building		
Enhance the administration, planning and mobilizing funding and technical resources for the implementation of NBSAP	🟧	Is a part of the DEC work-plan
Better coordination of the required policy, legal, scientific and economics work	🟧	Within Policy section of DEC & through *ad hoc* Technical Working Groups
Enhance capacity as implementer, coordinator, delegator, mobiliser and motivator of stakeholders (i.e. helping them to help implement NBSAP)	🟧	Primary recurrent function of DEC and the C of CEPA.
Strengthening human capacity in Biodiversity Conservation and Management	🟩	UPNG program development but is an ongoing process also other tertiary institutions
Strengthen existing partnerships that promote biodiversity conservation and sustainable use of biological resources	🟩	Continuing biodiversity surveys with overseas institutions
Identify new partnerships to encourage biodiversity conservation and sustainable use of biological resources.	🟩	Bilateral, NGO & Industry partnerships well developed
Devise programs that promote greater collaboration	🟩	*Ad hoc* Technical Working Groups
Introduce better mechanisms for stronger coordination	🟩	As above
Source funds to strengthen partnership collaboration	🟩	CTI, GEF4, GEF5
Develop stronger partnerships with provincial and local-level governments	🟧	The structures and linkages of National DEC and Provincial Administration remains *ad hoc*
Develop programs to build stronger partnerships with local communities	🟧	Specific projects are built upon this as a standard practice

4. Benefit sharing		
To upgrade national legislation to enable the protection of intellectual property on biodiversity and to promote the use of prior informed consent in the granting and obtaining of access to biodiversity and knowledge of biodiversity.	🟥	Cultural Properties Act 1991 still under review. IPR in relation to traditional environmental knowledge poor
Ensure benefits arising out of genetic and ecosystems resources use promote sustainable rural development	🟥	Genetic No. Payment for Ecosystem services REDD+ still being discussed
Genetic and ecosystems to be harnessed for the development of agricultural products to ensure food security	🟧	NARI has genetic material collections as part of farm systems research. Needs greater support.
Genetic and ecosystems to be harnessed for the development of pharmaceuticals products that support human health.	🟥	Bio-prospecting not currently actively developed.

5. Research and Information on Biodiversity		
To ensure timely availability and access by all to biodiversity information	🟧	SIMS database exists but National Biodiversity Information System database yet to be fully developed and populated
Establish national needs and priorities for biodiversity inventory and research	🟧	WS on biodiversity data 2013 DEC follow-up 2014
Develop sub-projects for the prioritized national needs of biodiversity research	⬜	
Secure funding and research bodies to implement sub-projects	⬜	
Strengthen capacities of locally based institutions and Papua New Guineans in biological research and development.	🟧	Ongoing government commitment
Vulnerability due to climate variability and climate change	🟩	Climate Change Vulnerability

	🟩	Map NARI
Adaptation strategies for biodiversity.	🟩	OCCD within Policy 2014.
Sustainable land-use strategies	🟩	National Sustainable Land Use Policy DOLPP Sep 2014
Prevention and control of desertification.	🟧	Mangrove and some forest rehabilitation
To develop the capacity to use genetic technologies to characterise PNG biodiversity and aid monitoring of illegal trade	🟥	Beyond current capability

6. *In situ* and *ex situ* Biodiversity Conservation		
Review the current national protected areas system in PNG	🟧	NBSAP done, full review will be done under CEPA
Empower local communities and promote the full and active participation of landowners in biodiversity conservation programs	🟩	Localized projects NGO led
Increase the number of protected areas to ten percent by 2010	🟥	PAs area remained static pending CEPA and PA Policy 2014 implementation
Rehabilitate and encourage better management of existing protected areas	🟥	As above
Develop a national conservation/ protected areas policy	🟩	Completed September 2014
Design and utilize methodologies and indicators for monitoring and evaluating impacts Strengthen ex-situ programmes and their contribution to biodiversity conservation	🟧	Interrelationships between overseas Zoos and *in situ* conservation initiatives especially for tree kangaroos
To document all *ex situ* conservation activities currently being pursued	🟥	Not documented
To develop a cohesive national network involving agencies engaged in *ex situ* conservation	🟥	Above action is a precursor to this activity
Select priorities in the light of PNG's specific cultural and social context.	🟥	Undeveloped concept
Develop demonstration projects to test selected priorities	🟩	Both Terrestrial and Marine Projects experiences have been shared, some within Learning Training Networks (marine)
Develop regional (watershed/provincial) conservation programmes to integrate conservation activities and protected area management with regional (watershed/provincial) land use planning.	🟧	Catchments for Port Moresby are developing this. Some provinces only.
Enhance the capacity of local communities and NGOs to conserve, manage, and sustainably use biodiversity.	🟩	All conservation work this is a foundational component but not all communities are reached
Ensure that protected areas and adjacent buffer zones are treated as a single planning unit. Of particular importance in this regard, is to support implementation of an integrated coastal zone management (ICZM) plan for the entire coast of PNG	🟥	Not implemented as outlined. ICZM still a concept
Protect native species and habitats	🟧	Ongoing priority activity
Linking development activities and EIA (application of EIA for resource management)	🟩	The EIA process has been strengthened through both DEC and Independent Evaluation process

The results of the current NBSAP have been mixed. The development of Policy and Sustainable Development Strategy being well supported late in this reporting period. Capacity Building at different levels and the building of partnerships has also been done well. However this has not been sufficient to maintain or improve the status of biodiversity overall across the country.

Part III   Progress towards the 2020 Aichi Biodiversity Targets and contributions to the relevant 2015 targets of the Millennium Development Goals

9   *Progress Outlines*

9.1 Progress of PNG towards the implementation of the Strategic Plan for Biodiversity 2011-2020 and its Aichi Biodiversity Targets

The following Table 14 outlines which of the environmental actions within the PNG Development Strategic Plan relate to Aichi Targets and the level of current implementation of these. This is the existing plan that guides the development of the government. It is also a guide to the level of integration of environmental concerns across stakeholders.

Table 14. Achievement of DSP to date and links to Aichi Targets

DSP 2010-2030	Impl. score	Aichi Target
Develop and implement the ESEG policy	(orange)	!
Develop environment and natural resource development plan for Economic Corridors	(red)	4 9
Comprehensive range of natural resource management guidelines that addresses drivers of deforestation	(orange)	5 7
Waste management policies and guidelines for mining and petroleum projects operations and closure	(orange)	8
Enhance management of land degraded by commercial extraction	(orange)	8 9 14
Enhance the coastal zone conservation management plan	(red)	6 10
Review of the Environmental Act 2000 and new legislation to create EPA	(orange)	
Ensure more comprehensive waste management practices are employed	(red)	8
Streamline EPA monitoring and compliance and build capacity	(orange)	
Standards and code of practices for projects category 1 and 2	(red)	
Streamline permit procedures and processes	(orange)	
Implement Multilateral Environmental Agreements (MEAs) like the UNCCD, UNCBD and UNFCCC	(orange)	17
National Capacity Self Assessment (NCSA) of the global environmental conventions	(green)	
Endangered species and habitats conservation and management plan for marine and terrestrial protected areas	(red)	11
Develop Terrestrial Protected Area Policy	(green)	11
Develop Marine Protected Area Policy	(green)	11
Strengthen customary practices for enhancing and preserving the environment and educate landowners on the importance of conserving the environment	(orange)	18
REDD + and payment for ecosystems services (PES)	(orange)	1 14 15 16
Increase water catchment and water and sanitation programs	(orange)	8
Maintained inventory of all licensed national water usage	(red)	7
Develop Sustainable Land Management Policy	(green)	7 11
Develop water resource management policy	(red)	6
Introduce land zoning systems to increase agricultural production	(orange)	7
Minimise land degraded by commercial extractive purposes	(orange)	5
Build information database for natural resources and environment management	(orange)	19
Establish a database for environmental risk and hazard accounting	(orange)	19

Aichi Target: 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20

9.2 Progress towards the Aichi Targets an overview

The next table outlines each *Aichi Target* in full and a statement of progress towards its achievement. PNG does not have any explicit internal targets apart from the NBSAP that are recognised by the CBD and therefore the *Aichi Targets* are a primary target to report against.

Table 15. Achievement of Aichi Targets to date

Aichi Targets		comments
Strategic Goal B		
Target 10	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.	Under the CTI/CTSP a series of LMMAs have been established across PNG. These are far short of the marine conservation target.
Strategic Goal E		
Target 16	By **2015,** the Nagoya Protocol on Access to Genetic Resources and the Fair and Equitable Sharing of Benefits Arising from their Utilization is in force and operational, consistent with national legislation.	Not developed in PNG
Target 17	By **2015** each Party has developed, adopted as a policy instrument, and has commenced implementing an effective, participatory and updated national biodiversity strategy and action plan.	The NBSAP of 2007 has not been revised. It will be revised under the new CEPA 2015/16. Policies that will assist in implementation are all dated 2014 and yet to start being implemented.
Strategic Goal A Address the underlying causes of Biodiversity loss by mainstreaming biodiversity across government and society		
Target 1	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.	Communities do not properly know values of biodiversity. Is known intrinsically but not empirically.
Target 2	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.	Biodiversity and Ecosystem Values are not currently part of National Accounting. This could change if National Sustainable development strategy is implemented

Target 3	By 2020, at the latest, incentives, including subsidies, harmful to biodiversity are eliminated, phased out or reformed in order to minimize or avoid negative impacts, and positive incentives for the conservation and sustainable use of biodiversity are developed and applied, consistent and in harmony with the Convention and other relevant international obligations, taking into account national socio economic conditions.	
Target 4	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.	With increasing population the subsistence sector can not be sustained. Current rates of logging can not be sustained. Tuna is at TAC and will need regulation to be sustained. Mining continues to cause environmental damage.

Strategic Goal B   Reduce the direct pressure on biodiversity and promote sustainable use

Target 5	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.	Logging and subsistence agriculture continue to cause degradation of rainforest
Target 6	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.	Currently Tuna are near TAC BDM total ban in place in current reporting period to allow stocks to regenerate
Target 7	By 2020 areas under agriculture, aquaculture and forestry are managed sustainably, ensuring conservation of biodiversity.	Subsistence Agriculture is currently sustainable but becoming less sustainable in some areas Forests have a determined sustainable rate of cut that is being exceeded
Target 8	By 2020, pollution, including from excess nutrients, has been brought to levels that are not detrimental to ecosystem function and biodiversity.	Mine tailings causing major environmental damage. Runoff from urban areas poorly contained. No proper disposal of toxic or e waste. Runoff from agroindustry monitored only
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.	NAQIA has an ongoing invasive species capacity building of staff. Priority Species are controlled in development projects e.g. mines but not other areas

Strategic Goal C Improve the status of biodiversity by safeguarding ecosystems species and genetic diversity		
Target 11	By 2020, at least 17 per cent of terrestrial and inland water, and 10 per cent 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.	Current rates of areas conserved is not on track to reach these targets
Target 12	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.	Some species have improved status whilst others have become more threatened
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.	Agricultural diversity is passively maintained by the 80% of the population who are reliant on subsistence agriculture. Not catalogued. Wild varieties passively maintained in their habitat but not formally conserved. NARI maintains some genetic material at research facilities.
Strategic Goal D Enhance the benefits to all from biodiversity and ecosystem services		
Target 14	By 2020, ecosystems that provide essential services, including services related to water, and contribute to health, livelihoods and well-being, are restored and safeguarded, taking into account the needs of women, indigenous and local communities, and the poor and vulnerable.	Provisioning ecosystems are not safeguarded. Minority groups environmental links and need are not well documented.
Target 15	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 per cent of degraded ecosystems, thereby contributing to climate change mitigation and adaptation and to combating desertification.	PNGFA is currently defining 2 carbon REDD+ projects in Forest Management Areas. Some mangrove areas being initially rehabilitated.
Strategic Goal E: Enhance implementation through participatory planning, knowledge management and capacity building		

Target 18	By 2020, the traditional knowledge, innovations and practices of indigenous and local communities relevant for the conservation and sustainable use of biodiversity, and their customary use of biological resources, are respected, subject to national legislation and relevant international obligations, and fully integrated and reflected in the implementation of the Convention with the full and effective participation of indigenous and local communities, at all relevant levels.	Traditional Environmental Knowledge is being maintained to some degree by clans and communities. It is however being eroded over time through a lack of formal recognition of its worth. Many developments do not properly gain consensus and over rule traditional use of natural resources.
Target 19	By 2020, knowledge, the science base and technologies relating to biodiversity, its values functioning, status and trends, and the consequences of its loss, are improved, widely shared and transferred, and applied.	This is currently not being proactively done. Ongoing monitoring by developments if interpreted may give some information relating to biodiversity and trends.
Target 20	By 2020, at the latest, the mobilization of financial resources for effectively implementing the Strategic Plan 2011-2020 from all sources and in accordance with the consolidated and agreed process in the Strategy for Resource Mobilization should increase substantially from the current levels. This target will be subject to changes contingent to resources needs assessments to be developed and reported by Parties.	Government funding allocation currently inadequate. Many funds are being accessed through bilateral aid and by NGO partners. Industry is also funding biodiversity initiatives. This has to be better understood and coordinated.

9.3   Progress Towards the Millennium Development Goal 7

MDG   GOAL 7 : *Ensure environmental sustainability The environment provides goods and services that sustain human development so we must ensure that development sustains the environment. Better natural resource management increases the income and nutrition of poor people.*

	Baseline	Mid-point	Latest

MDG **7**	7.1	Proportion of land area covered by forest (%)	69.6(1990)	66.5(2000)	63.4(2010)
	7.2a	CO_2 emissions, total ('000 metric tons)	2142.0(1990)	2688.0(2000)	3480.0(2009)
	7.2b	CO_2 emissions, per capita (metric tons)	0.5(1990)	0.5(2000)	0.5(2009)
	7.2c	CO_2 emissions, per $1 GDP (PPP) (kg)	0.2(1990)	0.3(2000)	0.1(2009)
	7.3	Use of ODS (ODP metric tons)	28.5(1991)	52.0(2000)	3.3(2010)
	7.4	Fish stocks within safe biological limits (%)	…	…	…
	7.5	Total water resources used (%)	…	0.0(2000)	…
	7.6	Protected terrestrial and marine areas (%)	0.9(1990)	1.4(2000)	1.4(2010)
	7.7	Species threatened with extinction (%)	…	…	…
	7.8	Using an improved drinking water source (%)	33.0(1990)	35.0(2000)	40.0(2011)
	7.9	Using an improved sanitation facility (%)	20.0(1990)	19.0(2000)	19.0(2011)
	7.10	Urban population living in slums (%)	…	…	…

Figure 44. MDG 7 Statistics from MDG 2013 Report

Table 16. MDG 7 Status 2013

OFF TRACK MDG 7		
	● TARGET 7.A ● TARGET 7.B	Rigorous regulatory regime in place but lack of compliance and enforcement major issues. Funding for maintaining PNG's wealth of biodiversity has declined substantially. Activities in the mining sector have adversely affected the environment, in some cases quite detrimentally. PNG's environmental track record is largely poor.
	● TARGET 7.C	Very large numbers do not have access to safe water. Majority of rural households use traditional pit toilets, while a significant number does not have any toilet facilities at all.
	● TARGET 7.D	Squatter settlements increased in and around urban centres due to rural to urban drift. Squatter areas house most of the unemployed and under-employed, especially youths.

OFF TRACK   MIXED   ON TRACK   INSUFFICIENT INFORMATION   NOT APPLICABLE

The Reporting of the Millennium Development Goal 7 further reinforces the findings of this report. Target 7.A is clearly linked to biodiversity and highlights the need for funding support, regulation and compliance. The transition to the CEPA is one initiative in achieving this but sectors that impact the environment must also ensure that regulations safeguard the environment and that these are followed up with compliance mechanisms.

10 Lessons learnt from the implementation of the Convention in Papua New Guinea

Papua New Guinea ratified the Convention in 1993 and has since made significant progress in implementing the Convention as highlighted in previous sections. Despite significant progress being made a number of factors continue to influence the rate at which the convention-activities are carried out at the national level. The customary land tenure system in PNG continues to play an balancing role in the implementation of particularly the Protected Area System in the country. Despite the continuous challenge imposed by the land tenure system, significant progress has been made in the following areas:

- Strengthening and refining policy and legislation
- Strengthening the knowledge base for biodiversity conservation and management , including inventories, mapping and classifying ecosystems, Red listing, and spatial biodiversity planning
- Strengthening biodiversity information sharing and management across sectors
- Mainstreaming biodiversity conservation and management the issuance of environment permits to a range of resource development

sectors, including but not limited to agriculture, land-use planning, mining, fishery, forestry and agriculture

- Increasing and expansion of biodiversity protected area systems through engagement with traditional landowners
- Identify priority conservation areas through environment awareness and education programmes
- Strengthening international and regional co-operation to build capacity and skills in the biodiversity conservation and management sector

The need for synchronization of policies of the natural resource sector agencies such as CEPA, NFA and PNGFA is paramount for addressing challenges of biodiversity management and conservation.

Just as CEPA is mandated to be responsible for environment management and protection, PNGFA while under close scrutiny of many international and regional conservation NGOs plays a vital role in complementing CEPA's role in biodiversity conservation. There is an urgent need to synchronize forest development planning with biodiversity conservation particularly in terms of 'conservation set-asides' or protected areas within timber concession areas.

PNG's coastal region is very dependent on the coastal and marine resources which support important commercial fisheries such as tuna and prawn fisheries. The livelihood of many coastal communities also depend on artisanal fisheries and, if the challenges of biodiversity conservation including sea level rise and climate change are not appropriately addressed, the lives and livelihood of many coastal communities will be at risk.

- Influencing the cross-sectoral policy environment requires flexibility and responsiveness
- Mainstreaming biodiversity into sectoral policy

Many state-run institutions interested in PNG's terrestrial biodiversity organized over 100 expeditions to areas throughout the country leading up to late 1990's (Frodin and Gressit 1982;Allison 1991). These areas were generally chosen on the basis of their biological interest. Frodin and Gressit 1982 presented an excellent history of the terrestrial biological exploration of Papua New Guinea. Starting In the late 1950's, local scientific institutions began to carry out research and collections throughout the country. Various government departments particularly agriculture, fisheries, forestry, public health, national parks and wildlife, and UPNG and Unitech developed their own research programs and scientific collections. Such research programs culminated into the current Lae Herbarium, a world-class centre for botanical studies, and Wau Ecology Institute established by the Bishop Museum and recently the PNG Forest Research Institute. This highlights the problem of collections that are held in institutions scattered across the country. There is therefore the need for a major mainstreaming of biological data. For example, most insect collections are held at NARI, plant collections at Lae Herbarium, and major biological collection data being held at the Bishop Museum. Efforts were made to mainstream all biological data to DEC back in 2000 but remains ineffective.

- Effective mainstreaming of biodiversity knowledge and spatial assessment

Papua New Guinea has a long history of biological collections that have contributed to the current knowledge of the biodiversity (Figure 10). Collaborative partnerships with international museums and institutions have enabled PNG to keep abreast with the ever evolving biodiversity knowledge. A recent series of RAP publications by CI (Richards,2007a, Richards & Gamui 2011) and WCS (Whitmore, 2015; Richards & Whitmore, 2015) have immensely filled the gaps in our knowledge about richness of our biodiversity. Such field surveys, including the identification and establishment of biodiversity priority areas at the landscape and ecosystem level based on science-based inventories, provides a strategic starting point for protected area establishment, expansion and management of ecosystems , as well as engagement with local communities for long-term sustainable management of protected area systems.

- Creating partnerships with key stakeholders

The conservation and management of biodiversity in PNG has a long history of collaborative partnerships with various stakeholders. CEPA being the lead agency in implementing the CBD Strategic-Goals and Aichi Targets has long established relations with stakeholders including government agencies, NGO's, civil society and the private sector. This has played a significant role in implementing the management and conservation of biodiversity at ecosystem level, as discussed at greater length in *Papua New Guinea Conservation Needs Assessment , (Beehler et al. 1993).* Establishment of inter-agency biodiversity -working groups, building long-term partnerships with international and regional NGO's , collaboration with the private sector in biodiversity conservation and management programmes is essential for successful achievement of biodiversity goals. committees,

- Realigning national biodiversity strategies to CBD Strategic –Goals and Aichi Targets

Given PNG's land tenure system, implementing the Aichi targets may require a review of the biodiversity-related mandates of some of the institutions of government, and require broader mandates within biodiversity mandated institutions. While the importance of biodiversity conservation is widely accepted within state institutions, the actual implementation of strategies may be constrained by lack of resources and project funding. Realigning national biodiversity strategies at all levels of government is urgently needed to fulfil CBD Strategic-Goals and Aichi Targets

10.1   Areas where achievements have been made

The major achievements in this reporting period is the development of an overarching *Responsible Sustainable Development Strategy 2014* that recognises that a new development paradigm is needed for Papua New Guinea. It recognises that the current development pathway that PNG is on is eroding our environmental assets, that we are caught in a cycle of demand from a growing population, of profits and growth policies which are undermining a sustainable future.

Nested within this new direction a series of Policies have been developed that directly relate to sustainable land use, protected area development and climate change. Each of these policies outline processes and mechanisms to harmonise for their implementation.

For the planning of biodiversity conservation as a country the PNG Government needs to now combine the Terrestrial PoWPA and Marine PoWPA analysis based on currently known biodiversity. This would be a ridge-to-reef-to-deep-sea analysis that takes into account sound environmental, evolutionary and ecological principles, opportunities and threats, within the socio-economic context of PNG. This would then be a guide for strategic cost effective actions towards conservation initiatives.

There are biodiversity conservation projects across PNG that have made a positive impact on species, their habitat and the management of the environment through land owner interventions (e.g.Tree Kangaroo Conservation Program and YUS Conservation Area) .

Getting back on track

In this way PNG and its government agencies are now better placed to move forward and get our targets on biodiversity within the *Aichi Targets* and *MDG 7* back on track in a coordinated effort.   A matrix of all conservation initiatives across PNG by all stakeholders that indicates which Aichi targets they contribute to, is a possible starting point. Determining what are the extra efforts required to achieve these targets by 2020 needs to be then clearly defined.

10.2 Areas where progress is lacking and where challenges are encountered

The lack of progress towards the Millenium Development Goals within PNG is stark.

The challenge is to have all enabling requirements in place. These include; a vision, political will, law/compliance, policy, strategy, financial commitment and support, an effective implementing agency and mechanism, with stakeholder support.

10.3   Suggested Actions to get back on track.

NBSAP revision linked to sustainable development paradigm

The first action is to revise the *PNG NBSAP 2007* taking into account the changes in policy and the current state of implementation, ensuring that all are considered and linked to the Aichi and future MDG targets and the countries' new direction under the *Sustainable Development Strategy 2014*. The newly developed national policies to be assessed for all relevant sections that relate to biodiversity that can guide the NBSAP revision

The revised *NBSAP*, the *Policy on Protected Areas 2014* to then be implemented by the CEPA and harmonised with other line departments and government agencies for inclusion in their work plans.

Governance

Laws that relate to biodiversity and the environment to be reviewed and harmonised wherever possible such that they reinforce and compliment each other.

Data

The SIMS database to be upgraded to a database that has sections that are publically available and user friendly and others which are secure for internal use only. This database to be linked to others within the country and to databases outside the country that contain information on PNG biodiversity wherever possible.

A Spatial Conservation Planning Blueprint

The Terrestrial and Marine PoWPA evaluations to be combined into a single Papua New Guinea Conservation Priorities Map with supporting data layers, outline of the process followed and defined logic of decisions made, which includes the *Aichi* area targets. This process to be refined by DEC on a regular basis with new information and broadened to include the customary and social values of biodiversity.

Ecosystem Services Development

An assessment of ecosystem services across the country and their value/replacement value. These ecosystem services to then be linked to human wellbeing and or poverty reduction. An example being the provisioning services of fresh water and its relative importance to domestic water use or hydropower that can be determined in a multivariate analysis. Another example is the provisioning, regulating and cultural services of the rainforest. Currently the carbon value in relation to REDD+ is being developed in pilots in selected areas of PNG and this is foundational in an potential future carbon offset mechanism.

Valuing Environmental/Ecosystem Services in Local and National Accounting

The value of environmental/ecosystem services needs to be incorporated into National Accounting. In this way the costs of changes in the environment can be. considered and inform development plans and any associated permits or

offset requirements. In this way the costs of development that impact upon the environment can be recognised and recompensed.. Also there is a policy gap on the payment for ecosystem services that needs to be addressed. This would also determine legislative requirements and the outline of a mechanism to achieve PES.

Biodiversity Offset

The concept of Biodiversity Offset is an emerging strategy for development projects to link their conservation efforts into the PNG NBSAP. Payment for Ecosystem Services along with Equitable Benefit Sharing as a new paradigm in development projects is also a way forward. Determination of the value of these services is required.

Mainstreaming Conservation

Reaching all areas of the country with environmental initiatives has been shown to be complex. The strategy of reaching all communities through Mainstreaming Nature Conservation was the theme of the Action Strategy for Nature Conservation in the Pacific Region, 2003-2007 which contained 30 year goals. However this has not been referred back to in applying this concept.

The foremost and most effective action conservationists can take now to mitigate the coming crisis is to prepare the national conservation communities so they are more capable to deal with the unknowns ahead.

Investing income from resource extraction in responsible development

The PNG LNG project is a game changer for the country and the economic growth that it drives along with other current and future resource extraction projects must also fund activities to implement the new responsible development strategy that lead to sustainable ecological and biodiversity management. This will require political will, a clear implementation plan and a fully resourced and capable agency to lead a collaborative effort of implementation in partnership with all stakeholders.

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Figures

Tables

Appendix I Acronyms

ADB	Asian Development Bank
AMSA	Australian Maritime Safety Authority
C-CAP	[USAID] Coastal Community Adaptation Project
CA	Conservation Area
CARR	[principals of] Comprehensiveness, Adequacy, Representativeness and Resilience
CBD	[United Nation] Convention on Biological Diversity
CBO	Community Based Organisation
CCA	Climate Change Adaptation
CEPA	Conservation and Environmental Protection Agency
CELCOR	The Centre for Environmental Law and Community Rights [Incorporated]
CI	Conservation International
CLMA	[Papua New Guinea] Centre for Locally Managed Areas [Incorporated]
CMS	Convention for Migratory Species of Wild Animals
CNA	Conservation Needs Assessment
CR	[IUCN Red list] Critical
CSIRO	Commonwealth Scientific and Industrial Research Organisation
CTI	Coral Triangle Initiative
CTI-CFF	Coral Triangle Initiative on Coral Reefs, Fisheries and Food Security
CTSP	Coral Triangle Support Program
DEC	Department of Environment and Conservation
DEC-CP	Department of Environment-Corporate Plan
DHW	Degree Heating Week
D& D	Deforestation & Degradation
DSP	Development Strategic Plan
DOLPP	Department of Lands and Physical Planning
EAFM	Ecosystem Approach to Management of Fisheries
EFF	[Papua New Guinea] Eco-forestry Forum
EU	European Union
EIA	Environmental Impact Assessment
EN	[IUCN Red list] Endangered
EEZ	Exclusive Economic Zone
ENSO	El Niño/Southern Oscillation
ESEG	Environmentally Sustainable Economic Growth
FAO	Food and Agriculture Organization of the UN
GCCA	Global Climate Change Alliance
GDP	Gross Domestic Product
GEF	Global Environment Facility
GHG	Green House Gas
GIZ	Deutsche Gesellschaft für Internationale Zusammenarbeit
GovPNG	[National] Government of Papua New Guinea
ha	Hectare
ICZM	Integrated Coastal Management
IFTA	Insect Farming and Trading Agency
IMO	International Maritime Organization
IPCC	Intergovernmental Panel on Climate Change
IPZ	Interim Protection Zone
ITTO	International Tropical Timber Organisation
IUCN	International Union for Conservation of Nature

km^2	Square Kilometer
LEAF	Lowering Emissions in Asia's Forests
LMMA	Local Marine Management Area
LULUCF	Land Use, Land Use Change and Forestry
MARSH	Mangrove Rehabilitation for Sustainably-Managed Healthy Forests
MDG	Millennium Development Goal(s)
MECCN	Manus Environment Conservation Communities Network
MSC	Marine Stewardship Council
MTDP	Medium Term Development Plan
MTDS	Medium Term Development Strategy
Mt CO$_2$e	Megatonnes Carbon Dioxide Equivalent
MW	Mega Watts
NAQIA	National Agriculture and Inspection Authority
NARI	National Agricultural Research Institute
NBPOL	New Britain Palm Oil Limited
NBSAP	National Biodiversity Strategic Action Plan
NCC	National Conservation Committee
NCD	National Capital District
NFA	National Fisheries Authority
NFI	National Forest Inventory
NGO	Non Government Organisation
NMSA	National Maritime Safety Authority
OCCES	Office of Climate Change and Environmental Sustainability
OCCD	Office of Climate Change and Development
p.a.	per annum
PA	Protected Area
PACAM	[USAID] Pan-American Climate Fund
PES	Payment for Ecosystem Services
PINBio	Papua New Guinea Institute of Biodiversity
PIP	Public Investment Plan
PNA	Policy Needs Assessment
PNG	Papua New Guinea
PNGFA	Papua New Guinea Forest Authority
PNG LNG	Papua New Guinea Liquid Natural Gas [Project]
PoWPA	Plan of Work Protected Areas
ProDoc	Project Document
PSSA	Particularly Sensitive Sea Area
RAP	Rapid Assessment Program
RAPPAM	Rapid Assessment and Prioritisation of Protected Area Management
REDD+	Reduced Emissions from Deforestation and Forest Degradation and the role of conservation, sustainable management of forests and enhancement of forest carbon stocks.
RTD	Riverine Tailings Disposal
SABL	Special Agricultural Business Lease
SIMS	Species Information Management System
SLUP	Sustainable Land-use Plan
SPC	Secretariat of the Pacific Community
SPREP	South Pacific Regional Environment Programme
SST	Sea Surface Temperature
STD	Submarine Tailings Disposal
TAC	Total Allowable Catch
TCA	Tenkile Conservation Alliance
TKCP	Tree Kangaroo Conservation Program
TMR	Torricelli Mountain Ranges
TNC	The Nature Conservancy

UNFCC	United Nations Framework Convention on Climate Change
UPNG	University of Papua New Guinea
USAID	United States Agency for International Development
UN	United Nations
UNDP	United Nations Development Program
UNESCO	United Nations Education, Science and Cultural Organisation
VTS	Vehicle Traffic Service
VU	[IUCN Red list] Vulnerable
WCS	Wildlife Conservation Society
WMA	Wildlife Management Area
WWF	World Wide Fund for Nature
YUS	Yopno, Uruwa and SOM

Appendix II Contact Information

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Appendix III Outline of Process in the Compilation of this Report

This 5th Report came out of discussions with key leadership within the Department of Conservation and the principal author on the outline requirements as per the CBD.

Staff within the Department contributed information relevant to their section in relation to the required information required within the report.

Staff within key Government Department and Agencies, NGOs, research Institutions, business were contacted and information relevant to biodiversity was requested for inclusion in the report.

The principal author made a desk top study of available documents and combined these with all additional information from stakeholders.

This was the basis of an initial draft report which was sent out to stakeholders for comment either through e mail or through attendance of a verification workshop held at the offices of the Department of Conservation in Waigani. Comments from this workshop were incorporated into the final draft.

All references used during desk top study and those from which information was gained are outlined in the reference section of the document.

The Department of Conservation moved office locations within this reporting period and much of the hardcopy information has been put into unorganised storage and is therefore retrieval was not possible. Similarly the Office of Climate Change and Development which comes under the same National Ministry as Environment has also changed location and has faced similar constraints.

This draft was then presented to the Managing Director of Conservation and Environment Protection Authority (CEPA) for his consideration.

Annex 1 : Terrestrial Protected Areas in Papua New Guinea