



Palau Ridge to Reef Island Diagnostic Analysis Technical Report



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Produced and Prepared by GEF Pacific International Waters Ridge to Reef Regional Project,
Pacific Community (SPC), Suva, Fiji



Suva, Fiji, 2021

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ABBREVIATIONS

EQPB	Environment Quality Protection Board
IDA	Island Diagnostic Analysis
MEA	Multilateral Environmental Agreement
NDRMF	National Disaster Risk Management Framework
NEMO	National Emergency Management Office
NGO	Non-government organisation
PAN	Protected Areas Network
PCS	Palau Conservation Society
R2R	Ridge to Reef
SAP	Strategic Action Programme
SIDS	Small Island Developing State

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EXECUTIVE SUMMARY

Environmental problems that affect Pacific Island countries affect the livelihood, socio-economic and general well-being of local communities. Many of these problems are cross sectoral in nature, and influence the entire system, from ridge to reef. The rising onslaught of climate change and the issues relating to unsustainable and irresponsible management of natural resources, further compounds the problem. This report is a diagnostic analysis of priority environmental problems identified through extensive literature review and desk-based research of current and previously identified environmental issues in Palau, followed by wider national stakeholder consultations.

The following six priority issues were common during stakeholder discussions and are documented in the Asian Development Bank (ADB) Initial Environmental Examination Report (2012), the Republic of Palau National Report (2013) and the Palau State of the Environment Report (2017). These are issues that affect the ridge to reef system and have both direct and indirect socio-economic and environmental impacts. These identified priority issues of concern are:

1. Marine Resource Depletion
2. Illegal fishing practices
3. Biodiversity Loss
4. Solid and Liquid Waste Management
5. Deterioration of water quality
6. Ecosystem Degradation – near shore, terrestrial and surface water, inland flora and fauna, lagoon flora and fauna and wetlands.

Simple analyses were then conducted to identify the root causes of these problems, along with observed and documented practices and environmental threats. The main causes of the environmental problems in many areas of Palau relate to poor marine and land resource management practices. These practices would form the basis of potential leverage points where options for reform and intervention may be introduced. The thirteen (13) principles of ridge to reef would provide guidance and a planning framework to address the challenges and to implement commitments that will ensure ecosystem integrity, conservation and sustainable use of the goods and ecosystem services in Palau.

INTRODUCTION

The close inter-connections between the 'Ridge to Reef' ecological systems in Small Island Developing States (SIDS) covers a significant part of the countries' land, water, and coastal/ marine systems. The integration of freshwater watershed management with coastal/ marine area management is considered essential to foster effective cross-sectoral coordination in the planning and management of these resources. Inherent in the approach is the philosophy of cross-sectoral coordination in the planning and management of freshwater use, sanitation, wastewater treatment and pollution control, sustainable land use and forestry practices, balancing coastal livelihoods and biodiversity conservation, hazard risk reduction, and climate variability and change.

Proper and thoughtful diagnosis is necessary to effectively mitigate and address issues and challenges that affect the 'ridge to reef' ecosystems. Focussed dialogue and consultations with the relevant stakeholders, using appropriate gender and socially inclusive approaches, provide the participatory opportunity to identify priority issues affecting environmental and socio-economic landscapes of SIDS. Sex disaggregated data is an important dataset to inform gender related policy interventions in R2R interventions and planning.

The Island Diagnostic Analysis (IDA) was designed as a tool and a collaborative stepwise process to identify, quantify, and set priorities for environmental problems that are cross-sectoral (or from ridge to reef) in nature. It was also intended to help identify potential leverage points and options for reform and intervention. An IDA aims to provide the factual basis for the formulation of a Strategic Action Framework (SAF) and/or Strategic Action Plan (SAP) for ridge to reef interventions. In addition to this, however, the IDA is part of a process of engagement with stakeholders through the initial IDA development steps and the subsequent development of alternative solutions through the development of the SAP.

All activities aimed to be gender inclusive, using participatory approaches to encourage the meaningful participation of men, women, youths and other marginalised sectors of the community. For Palau, a largely matriach society, the engagement of men, especially young men in communities, is the focus. Palau is a matrilineal society in which women have traditionally held positions of power and respect in a spirit of equality with men. In contemporary society, Palauan women enjoy higher levels of education and better health than men. In public service, women dominate the judiciary and are well represented on public sector boards and commissions.

National stakeholders were engaged at the outset to form part of the IDA Development Team and perform the bulk of the analysis. National consultants were engaged to develop specific aspects of the IDA reports, particularly the economic and social evaluations of options for reform.

1. METHODOLOGY

1.1 Background

The approach taken for the Ridge to Reef Programme Island Diagnostic Analysis (IDA) has been derived from the Global International Waters Assessment (GIWA), the GEF Transboundary Diagnostic Analysis, and Pacific IWRM Diagnostic Analysis methodologies. The substance of these methodologies has been adapted to suit the broader ecosystem approach of the Ridge to Reef Programme and include terrestrial and marine ecosystems as well as water. The resulting approach is a highly collaborative process to be used as a major strategic planning tool for integrated coastal management nationally.

The participatory process of community and stakeholders' workshops or consultations is central to rolling out an IDA. Stakeholders from the various sectors and disciplines participated in the IDA consultations and included representatives from government, the private sector, civil society organisations and leaders of the local communities. Both genders were represented at the workshop.

1.2 Steps and Processes

Identifying and prioritising environmental problems:

- i. With the aid of a facilitator and the predefined list (of common environmental problems) provided in **Annex 1**, the IDA Development Team used the list as basis to brainstorm a complete list of the environmental problems in country. The facilitator recorded all the discussions that occurred.
- ii. Having the list was refined, the participants deliberated on the realistic and practical environmental problems noting the distinct difference between underlying root causes of a problem and the impacts.
- iii. Participants were asked to prioritise the problems based on a prelisted criteria in printed score sheets as set out in Annex 1. The ranking of priorities showed differences in what men and women considered important priority issues. Each team member was requested to score and rank the environmental problems.

Island Environmental Problem Prioritisation Criteria:

- iv. Based on the set of defined criteria, a score was assigned to each transboundary problem between 0 (no importance), 1 (low importance), 2 (moderate importance) and 3 (high importance) to determine the relevance of the problem.

Determining environmental and socio-economic impacts:

- v. Facilitator briefly explained the process of determining impacts followed by small breakout groups discussion. The IDA Development Team members were divided into groups between 3 and 8, and each group was given a topic categorised by discipline, environmental problem or mixed.
- vi. The groups need to have fair representation of men, women, and youths. The lead facilitator defined the groups prior to the workshop. At the end of the group work, each working group reported back in plenary.

- vii. Each group nominated their own facilitator/chair, a rapporteur and ensuring familiarisation and comfort amongst group members.
- viii. The group will identify one priority cross-sectoral problem and start assessing it in accordance with the following categorisations:
 - The environmental impacts
 - The direct and indirect socio-economic impacts
 - Make linkages between impacts and other island environmental problems
 - Identify geographical location(s) of impacts/consequences
- ix. A set time was allowed for each island environmental problem, e.g., 20 minutes

Developing causal chains:

- x. Facilitator briefly explained the process of developing causal chains followed by small breakout groups. The IDA Development Team members are divided into groups between 3 and 8 each taking responsibility for an island environmental problem.
- xi. Project Manager/lead facilitator needs to define the groups prior to the workshop.
- xii. Mixed discipline groups worked well in ensuring that the group members were working on this process covering all areas of expertise. For instance, natural scientists, social, legal, political, and economic experts will also be required.
- xiii. A facilitator/chair and a rapporteur were selected by each group. At the end of the group work, each working group should report back in plenary.
- xiv. The priority problems were reviewed and their associated environmental and socio-economic impacts.
- xv. For each problem, the Participants identified and listed the following:
 - The key sectors (e.g., industry, agriculture, fisheries etc)
 - The immediate causes
 - The underlying resource uses and practices that contribute to each immediate cause
 - The underlying social, economic, legal, and political causes of each immediate cause
 - Link the resource uses and practices, and social, economic, legal, and political causes
 - Determine the root causes
- xvi. The groups also needed to make linkages between problems on butcher paper/flip charts. The causal chain was developed, and each group presented their results and discussion points.

Report back and discussion:

- xvii. Each group presented their group outcomes to the workshop and seeking feedback. Each group was given a specific time span to present (e.g., 10 minutes) within a set time. Discussion followed and outcomes recorded by a rapporteur.
- xviii. The flip charts and main discussion points were collected by the facilitator and the discussion points, transferred onto Microsoft word.



Palau (Belau)



Sonsorol

Pulo Anna

Merir

Tobi Helen Reef

0 Kilometres 100



0 Kilometres 20

Source: SPC Pacific Community

2. DESCRIPTION OF PALAU

2.1 Physical and Geographical Characteristics

The Republic of Palau is a chain of islands located in the western Pacific between 5° 53' and 8° 12' north and 134° 07' and 134° 39' east. The 650 km archipelago is perched on the Kyushu-Palau Ridge and lies in the southwest corner of [Micronesia](#), with [Guam](#) 830 miles (1330 km) to the northeast, Papua [New Guinea](#) 400 miles (650 km) to the south, and the [Philippines](#) 550 miles (890 km) to the west. There are about 340 coral and volcanic islands that vary in size from small islets to Babelthup, which is one of the largest islands in the western Pacific Ocean. Only nine of the islands are inhabited with [Babelthup](#) (Babeldaob), [Koror](#), Malakal, Arakabesan and Peleliu being the most populated (Abbott 2016). Most of the archipelago is surrounded by an enormous [barrier reef](#) system, continuous on the west and broken on the east - see Figure 1.



Figure 1 Map of Palau

Soils and Topography

The soils of Palau are mostly ancient and of volcanic origin. They have been heavily leached by the high rainfall over a long period and are generally deficient in phosphorous, nitrogen and calcium. Potassium, manganese, iron, and aluminium levels are mostly high. Most soils in Palau are well drained upland latosols of silty clay loams. Based on the survey, Military Geology of Palau Islands (US Army Corps of Engineers 1956), the major soil types in Palau are classified as:

- i. Palau Association (over hard volcanic rock);
- ii. Ngardok Association (over soft volcanic rock);
- iii. Ngatpang silty clay loam (over bedded clay);
- iv. Babeldaob Association (containing bauxite); and
- v. Tabecheding Association (over bedded clays).

The more important soil types where pastures could be grown for cattle production are the Palau Association. This is where most of the extensive upland grasslands occur and the smaller patches of alluvial soils that are usually found around existing settlements.

Generally, soils on upper slopes and ridges are heavily leached and covered with concretions of aluminum and iron oxides. Soils in these habitats support poorer vegetation with shrubs, ferns, and sedges. At the base of slopes, the soils are richer and more moist (occasionally swampy) supporting dense stands of palatable grasses. The acid nature of the soil (mostly below pH 5), which results in low phosphorus availability, suggests that the application of coral sand is beneficial to plant growth (Mayer 1982).

Arekabesan and Malakal islands are of volcanic origin while Babelthuap and Koror are partly elevated limestone and partly volcanic. Auluptagel, Ngargol, Urukthapel, Peleliu and Angaura are of raised coral limestone. Of the Palau islands group, Peleliu alone is flat (www.fao.org).



Climate

Palau has a steady warm climate with an annual mean temperature of 30°C. Under the Köppen-Geiger climate classification system, Palau is listed under the group Af (tropical rainforest climate). There is a great deal of rainfall in Palau varying from 120 inches to 160 inches per year, even in the driest month. The average annual temperature is 27.5°C and precipitation averages 3638 mm – see details in Figure 2 (<https://en.climate-data.org>).

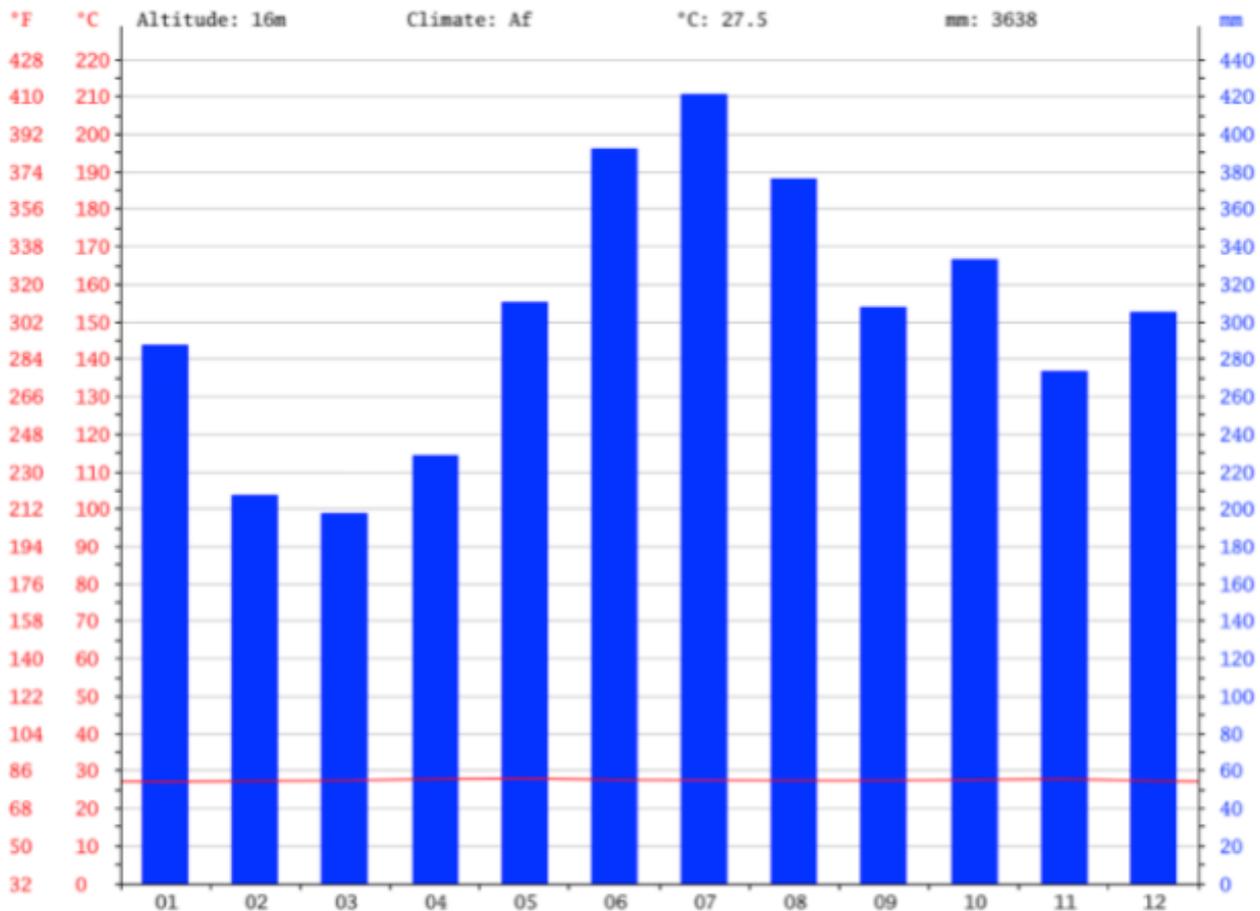


Figure 2 Palau Climograph

Natural disasters

Palau faces a relatively moderate degree of risk to natural disasters, with tropical storms, drought and tidal surges being the main hazards. As with other Pacific Island countries, Palau is particularly vulnerable to climate change impacts, including severe weather events and rising sea levels. Palau was hit by Tropical Cyclone Bopha in December 2012 and, although there was no loss of life, the coastal houses and infrastructure were extensively damaged. In November 2013, less than 12 months later, Super Typhoon Haiyan struck Palau, devastating homes, and infrastructure in the northern states of Kayangel, Ngerchelung and Ngaraard. In both emergencies, UNOCHA (the United Nations Office for the Coordination of Humanitarian Affairs) provided government and humanitarian partners with coordination and resource mobilisation support.

In addition to natural disaster risk, the island nation has also been affected by human-induced disasters. In September 1996, the Koror-Babeldaob Bridge, spanning Palau’s two main islands, collapsed suddenly, and in 2002 a report found that Palau’s public water supply had been contaminated due to a violation of public water standards (<http://www.unocha.org>).

Vegetation

Palau's forests cover 75% of the land; however, during World War II, under the Japanese administration, significant swathes of land were cleared for mining and pineapple and sugar plantations. While recovery has been slow, the forest extent on Babeldaob has been slowly increasing and expanding. However, in outer islands, the forest extent is decreasing. Forest surveys have shown signs of damage and degradation, especially from invasive vine species. Also of great concern is the rate of burning, which has increased dramatically over the years. Despite the investment in a fire station on the island, there is very little legal authority over fires and risks are generally unmitigated. The management of land and forests falls to the States with some assistance from the Protected Areas Network (PAN) and non-profit organisations.

A total of 75 vascular plant species and 12 endemic varieties are listed as endemic to Palau's volcanic islands. While the majority of these are expected to be found only in Babeldaob, some have ranges that extend to Koror State. There are also four endemic fern species and 68 endemic angiosperm species also recorded. Fires and invasive species threaten many of these recorded species. An example is the *Gulubia palauensis*, an endemic palm which is threatened by the introduction of a cockatoo species that escaped from Oreor (NEPC 2017).

Hydrogeology

The rains are plentiful, with over 3600 mm (140 inches) per year; the rainiest months are those of summer (June, July, and August). The driest time of the year is in March; and the wettest is in July. The temperature is stable throughout the year. The following table illustrates the average precipitation in the Airai airport.

Table 1: Average Precipitation - Airai

Airai	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
Prec. (mm)	280	200	190	220	310	395	425	380	315	335	270	300	3620
Prec.(in)	11	7.9	7.5	8.7	12.2	15.6	16.7	15	12.4	13.2	10.6	11.8	142.5
Days	20	17	17	16	17	18	19	19	17	19	18	20	217

2.2 Socio-economic Situation

Demographic processes

Table 2 below outlines Palau's key population data based on 2016 figures. The population is dominated by those in the age category of 0 to 54 years, of < 20% of the population live longer. Close to 90% of the population reside in urban areas suggesting the high level of urbanisation, and possibly large of area of in rural areas possibly uninhabited and naturally conserved.

Table 2: Palau demographics summary (source, http://www.indexmundi.com/palau/demographics_profile.html)

Population	21,347 (July 2016 est.)
Age structure	0-14 years: 19.93% (male 2,196/female 2,059) 15-24 years: 17.02% (male 1,814/female 1,819) 25-54 years: 46.03% (male 5,997/female 3,829) 55-64 years: 9.35% (male 697/female 1,299) 65 years and over: 7.67% (male 429/female 1,208) (2016 est.)

Population	21,347 (July 2016 est.)
Median age	total: 33.3 years male: 32.7 years female: 34.7 years (2016 est.)
Population growth rate	0.39% (2016 est.)
Birth rate	11.2 births/1,000 population (2016 est.)
Death rate	8 deaths/1,000 population (2016 est.)
Net migration rate	0.7 migrant(s)/1,000 population (2016 est.)
Urbanization	urban population: 87.1% of total population (2015) rate of urbanization: 1.66% annual rate of change (2010-15 est.)
Major cities - population	MELEKEOK (capital) 299 (2012)
Sex ratio	at birth: 1.06 male(s)/female 0-14 years: 1.07 male(s)/female 15-24 years: 1 male(s)/female 25-54 years: 1.57 male(s)/female 55-64 years: 0.54 male(s)/female 65 years and over: 0.37 male(s)/female total population: 1.09 male(s)/female (2016 est.)
Infant mortality rate	total: 10.9 deaths/1,000 live births male: 12.4 deaths/1,000 live births female: 9.3 deaths/1,000 live births (2016 est.)
Life expectancy at birth	total population: 73.1 years male: 69.9 years female: 76.5 years (2016 est.)
Total fertility rate	1.71 children born/woman (2016 est.)
HIV/AIDS - adult prevalence rate	NA
HIV/AIDS - people living with HIV/AIDS	NA
HIV/AIDS - deaths	NA
Drinking water source	improved: urban: 97% of population rural: 86% of population total: 95.3% of population unimproved: urban: 3% of population rural: 14% of population total: 4.7% of population (2011 est.)
Sanitation facility access	improved: urban: 100% of population rural: 100% of population total: 100% of population unimproved: urban: 0% of population rural: 0% of population total: 0% of population (2015 est.)

Population	21,347 (July 2016 est.)
Nationality	noun: Palauan(s) adjective: Palauan
Ethnic groups	Palauan (Micronesian with Malayan and Melanesian admixtures) 73%, Carolinian 2%, Asian 21.7%, caucasian 1.2%, other 2.1% (2015 est.)
Religions	Roman Catholic 45.3%, Protestant 34.9% (includes Evangelical 26.4%, Seventh Day Adventist 6.9%, Assembly of God .9%, Baptist .7%), Modekngei 5.7% (indigenous to Palau), Muslim 3%, Mormon 1.5%, other 9.7% (2015 est.)
Languages	Palauan (official on most islands) 65.2%, other Micronesian 1.9%, English (official) 19.1%, Filipino 9.9%, Chinese 1.2%, other 2.8% note: Sonsoralese is official in Sonsoral; Tobian is official in Tobi; Angaur and Japanese are official in Angaur (2015 est.)
Literacy	definition: age 15 and over can read and write total population: 99.5% male: 99.5% female: 99.6% (2015 est.)
School life expectancy (primary to tertiary education)	total: 17 years male: 16 years female: 18 years (2013)
Health expenditures	9% of GDP (2014)
Physicians density	1.42 physicians/1,000 population (2010)
Hospital bed density	4.8 beds/1,000 population (2010)
Obesity - adult prevalence rate	47.1% (2014)

In the 2013/2014 Palau Household Income and Expenditure Survey (HIES) almost all – 92% – of the women who could potentially work for pay or profit had attained either secondary or post-secondary level education. Palauan people working in professional occupations are most likely to be women, who comprise 66% of professional occupations, which include health and education related occupations: teachers, nurses, and business administrators.¹

Migration Processes

In 1947 Palau became part of the United States administered Trust Territory of the Pacific Islands. In 1986 the Trust arrangement was declared no longer effective, and the USA and Palau entered negotiations on the conclusion of the trusteeship. Substantial emigration was anticipated, and provision was made in the Compact of Free Association that would allow Micronesians free access to the US to live and work there indefinitely.

By 1953, with their own Palau Association, there were 100 Palauans on Guam “in quest of education, high wages and bright lights” (Hezel and Levin 1987), and since intermediate school was at that time the highest level available in Palau, others had already begun to move out to extend their educational pursuits and occupy the handful of government jobs available in other Trust Territory districts. 1970 was a period that was something of a turning point in the development of the islands,

¹ Palau 2013/2014 HIES Gender profile

with emigration from Palau continuing unabated. This movement was triggered by the education explosion. As new pressures and the educational avenues to escape them began to appear, the extent of emigration subsequently showed a tremendous increase. Graduates throughout the 1970s were faced with either the choice of returning to their family and friends or strike out to the town in search of a job. Much of the internal migration within the islands and the increasing urbanisation were responsible for these circumstances. The young people who could not find employment left Palau altogether (Hezel and Levin 1987).

In 2017, Palau’s population count stood at 17,808 (<http://www.worldometers.info/world-population/palau-population/>). In 1999, persons not Palau-born accounted for nearly 30% of the total population. Most were born in the Philippines, China, and Bangladesh; there were also significant numbers from the Federated States of Micronesia, the United States and Japan. Most were workers, with foreigners making up 46% of the workforce. A vast majority of these foreigners were located on Koror. About one-fifth of all Palauans live abroad, many in Guam. In 2016, Palau had a net migration rate of 0.7 migrant(s)/1,000 population (https://www.indexmundi.com/palau/net_migration_rate.html).

State of Economy

According to the Asian Development Outlook 2017 Update, the government projected a fiscal surplus equal to 4.0% of Gross Domestic Product (GDP) in FY2017, down from the 4.7% surplus realised in FY2016 largely because of declining tourism receipts. However, the fiscal surplus was expected to hit 5.0% of GDP in FY2018 with an expected recovery in visitor arrivals and a planned increase in the departure tax to be implemented in 2018 (<https://www.adb.org/countries/palau/economy>).

The current account deficit is expected to widen marginally in FY2017, partly because of lower tourism receipts, with a smaller increase in imports of project construction materials and stable fuel imports. The continued implementation of these projects in the near term is expected to widen the deficit further in FY2018.

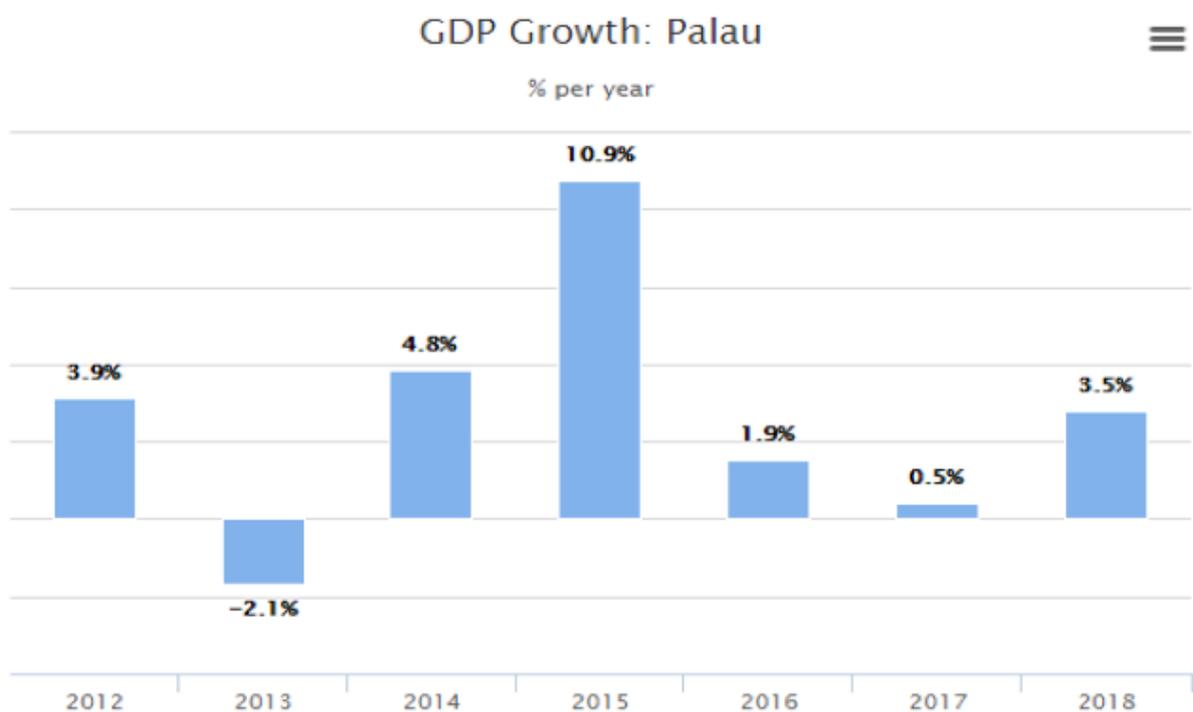


Figure 3 GDP growth rate forecasts for 2017 and 2018

GDP growth rate forecasts for 2017 and 2018 Tourism and other services, such as trade, subsistence agriculture and fishing, make up the economy. As a result of limited natural resources and few skilled personnel, the economy has a narrow production base. The services sector is largely composed of government administration and trade. There are large gaps between government revenues and expenditures between imports and exports. These gaps are largely financed by the United States grant assistance. A major problem is unemployment. In the fiscal year 2014, business and leisure tourist arrivals totalled over 125,000, a 13.4% increase over the previous year. The expansion of air travel in the Pacific, the increasing prosperity of industrial East Asia, and the willingness of foreigners to finance the development of infrastructure have bolstered long-term prospects for tourism. The proximity to Guam, the region's major destination for tourists from East Asia, and a regionally competitive tourist infrastructure, enhance Palau's advantage as a destination. https://theodora.com/wfbcurrent/palau/palau_economy.html / SOURCE: 2017 CIA WORLD FACTBOOK AND OTHER SOURCES

In 1994, after being part of a United Nations trust territory administered for 47 years by the USA, Palau became independent. It relies on financial aid from the USA, under the Compact of Free Association which gives the US responsibility for the defense of Palau and the right to maintain military bases there. Direct aid was set to end in 2009, but in January 2010, the USA agreed to an additional \$250 million package (BBC News 2018). <http://www.bbc.com/news/world-middle-east-15446659>

Industry

The government is Palau's largest employer. Palau's economy is mainly dependent on tourism. The Palau government aims to promote and encourage the development of Palau's tourism industry as one of the two leading sectors while maintaining pristine land and marine environments and ecosystems, to promote economic growth. Many visitors come from Taiwan with whom Palau has diplomatic ties. Taiwanese assistance boosts the economy. The service sector is the largest in the economy, contributing to 80% of GDP and employing 75% of the workforce.

Manufacturing plays a limited role in the economy. A copra- processing plant is located in Malakal. Concrete blocks are manufactured, utilising imported cement, and there is a small-scale sawmill industry. Other industries include the manufacturing of craft items (from shell, wood, pearls), construction, and garment making.

Agriculture

Agriculture is one of the key economic activities in the country, along with tourism and fishing. However, in 2014 it contributed only 1.4% to GDP, a major decrease from the previous years (SPC 2015).

The major constraint to increasing agricultural production in Palau is the lack of appropriate technologies to improve the quality of soil for crop production. Palau's soils are highly weathered, acidic, and clayey and there is a limited amount of land area that is suitable for agricultural productions without substantial inputs and soil amendments (McGregor & Bishop, 2011).

Approximately 2.5% of household income is derived from agriculture and forestry activities (2006), and 7.8% of the national labour force is involved in activities in this sector (2005). Of the total land area, 10.9% is considered arable (2012) and 87.6% of land area is currently forested (2015).

The matrilineal succession of land rights gave women a position of great importance and influence in traditional society. According to custom, every Palauan has land rights inherited from his or her

mother. *Women in Palau therefore own taro patches while men go fishing.* This is a first step in the *right* direction to ensure gender equality is addressed, where men and young men in many cases may be the disadvantaged and need recognition in a largely matrilineal society (SPC 2016).

Crops

The main staple foods in Palau are taro (*Colocasia esculenta*), giant swamp taro (*Cyrtosperma chamisionis*), cassava (*Manihot esculenta*) and sweet potato (*Ipomea batatas*). In addition, bananas and coconut comprise an important component of the Palauan diet. The root crops are vital to the food security of the people in Palau as well as for customary purposes. Production of these root crops is principally at the subsistence level which is now gradually shifting to the semi-commercial nature. Excess production after family consumption and custom use, is brought to the market for income generation (SPC 2015).

Livestock

Crops and livestock generated only about 2% of GDP in 1998. Since Palau cannot incorporate any economies of scale in agricultural production, the likelihood of significant increases in the sector are slim. Livestock activities primarily involve poultry (for eggs and meat), dairy cows and pork. Aquaculture is also practiced.

In the past buffalo, cattle (beef) and goats have been the major ruminants in Palau livestock agriculture, but numbers now are very limited. There is little statistical data on present livestock production in Palau (Bureau of Agriculture, 2003) .

Social development and living conditions

Traditionally, and continuing in large measure today, kinship has served as the foundation of social relations in Palau. Based on kinship, every Palauan has a defined role, status, and behavioural pattern. Ten clans make up a village, which serves as a social and political unit. The chief is not a sole ruler and must rely on diplomacy and persuasion to gain support from constituents. Mechanisms are in place to replace a ruling chief who proves unsatisfactory. In Palau, chiefly titles are inherited or attained through maternal lineages. Moreover, women have the power to bestow and rescind chiefly titles. Women also define cultural practices and act as educators, thereby cultivating and preserving cultural practices. Most women own the taro patches and are free to participate in public discussions. This combination of democratic and traditional principles allows decision makers to draw upon centuries of traditional knowledge and values that historically enabled the Palauan people to prosper, balancing environment and growth (Crombie et al. 1999).

This traditional system of governance still wields considerable power today, with both the constitution and the legal code recognising customary law as equally authoritative alongside codified law. Respect, sharing and cooperation, participation in community activities, work, responsibility and self-reliance, spirituality, and humility are all values that Palauans hold dear today. The population enjoys a per capita income, roughly double that of the Philippines and much of Micronesia (Otto 1998).

Health and Hygiene

Palau's health services are supported in varying degrees, by grants from the Federal government of the United States and have access to United States technical agencies. These funding services influence management and organisation of health services and the training and registration requirements for health professionals. In addition, there is assistance from the World Health Organization. <http://www.who.int/en/>.

The national government, through the Solid Waste Management Office of the Bureau of Public Works, is responsible for waste disposal. Koror's landfill, known as the "M-dock," is the country's largest waste disposal facility, however, the landfill reached its full capacity in 2012. As a temporary measure, a new dike was constructed to expand the existing capacity of the landfill. A 2010 solid waste survey estimated that around 1369 metric tons of solid waste are generated annually by households in Koror. In Palau, waste collection is a state responsibility. Recently, the Koror state government has started implementing a new system for collecting wastes from segregation stations.

Palau successfully recycles aluminium cans, composts organic wastes, crushes glass for reuse, and compacts cardboard. In 2011, with the enactment of the Beverage Container Recycling Regulation, Palau launched its container deposit fee programme, where a \$0.10 deposit fee is charged on each imported plastic, glass, or metal container. Consumers can redeem \$0.05 (Woodruff 2014).

According to the OEC database, the top imports of Palau refined Petroleum (\$25.1M), Surveying Equipment (\$8.06M), Cars (\$5.74M), Beer (\$3.25M) and Recreational Boats (\$3.14M) (<https://atlas.media.mit.edu/en/profile/country/plw/>).

2.3 Ecological Status

Assessment of legislation /policy that defines National Protected areas

Palau's road to achieving environment sustainability has been met with challenges in the form of rapid development, climate change and sea level rise, the introduction of invasive species, over-harvesting, and pollution (Ministry of Resources and Development 2013). However, national efforts to achieve this goal and overcome the opposing challenges is evident in the legislations enacted. Key legislations for environment protection in Palau are listed in Table 3. The Republic of Palau may assign National Protected Areas based on important historical, cultural, and natural aspects of Palauan heritage, and maintain, wherever possible, an environment that supports diversity and variety of individual choice, as provided for in the Environment Quality Protection Act (1981) and the Protected Areas Network Act (2008).

Table 3: Environmental legislations with formal status

1981	Environment Quality Protection Act
2014	Biosecurity Act
2008	Protected Areas Network Act
1989	Trust Territory Land Planning Act
1999	Declaration on Environment and Development
2013	Dugong Protection
2015	Endangered Species Act
2014	Marine Protection Act

Identification of hotspots

Biodiversity hotspots are areas that support intact natural ecosystems and native or endemic species that are associated with those ecosystems. The area must have 1500 species of vascular plants and have lost 70% of its original habitat to qualify as a biodiversity hotspot (Marchese 2015). Biodiversity hot spots are also characterised by a high diversity of endemism. Hot spots help prioritise funding for management of areas of biological and ecological importance.

Palau is known for having high species density per square kilometre (OERC 2014). Palau’s location in the “Coral Triangle” is credited as one of the main reasons for this marine life hotspot. The countries that make up the area have the world’s highest diversity and density of shallow-water marine species (Colin 2004). Papua New Guinea, Indonesia, the Philippines, and Malaysia are among the countries in this region.

Species of note

Palau has over 5000 known insects and 156 native and migratory bird species of which 12 species and 10 subspecies are endemic. The population of endemic species declined between 1991 and 2005 and lately there has been a steady increase in the number of birds on the IUCN Red List of Threatened Species (NEPC 2007). Over 40 species of freshwater fish of which 4 are endemic, 46 species of terrestrial reptiles and amphibians, 3 species of bat of which 1 species and 1 subspecies are endemic, and at least 69 endemic species of land snails have also been recorded (Palau Conservation Society 2016). The above does not include marine species. Under the Palau Conservation Society, marine and terrestrial species are given special consideration according to their conservation status and endemism to the area. The sea cow or dugong can be found in waters around Palau and other notable species including the Micronesian imperial pigeon and the endemic Palau fruit bat.

Table 4: List of Important terrestrial and marine species of Palau

Status	English Name	Scientific Name
Critically endangered	Hawksbill turtle	<i>Eretmochelys imbricata</i>
Endangered	Palau megapode	<i>Megapodius laperouse senex</i>
Endangered	Green turtle	<i>Chelonia mydas</i>
Endangered	Napolean wrasse	<i>Chelinus undulatus</i>
Vulnerable	Squairetail coral grouper	<i>Plectropomus areolatus</i>
Vulnerable	Blacksaddled coral grouper	<i>Plectropomus laevis</i>
Vulnerable	Dugong	<i>Dugong</i>
Near threatened	Micronesian imperial pigeon	<i>Ducula oceanica</i>
Near threatened	Nicobar pigeon	<i>Caloenas nicobarica</i>
Near threatened	Leopard coral grouper	<i>Plectropomus leopardus</i>
Near threatened	Brown marbled grouper	<i>Epinephelus fuscoguttatus</i>

To protect the endangered species, the Palau Conservation Society in conjunction with the government has set in place programmes that address this problem and sees to the survival of the species. The programmes revolve around conservation, setting up of protected areas, policy and planning, communication and outreach and administration and development.

Major threats and concerns

One of the issues impeding efforts to preserve the country's biodiversity is poor land management and planning. Since the construction of the Compact Road, there have been ample opportunities for development to creep into what was once untouched Palau native forests (SPC 2003). Roads help provide a pathway for invasive species to establish themselves in native forests. Invasive species are considered as possibly the greatest threat to the biodiversity of the Pacific Islands. For example, predation of bird eggs and nestlings by monkeys are decimating native bird populations; and introduced parrots and cockatoos eat the hearts of native palm trees, killing them. Other detrimental anthropological activities include hunting, dynamite fishing and mangrove cutting. Climate change is also a major concern to both terrestrial and marine organisms. During the 1997/1998 El Nino/La Nina, at least a third of Palau's corals died because of climate change-related weather events with coral mortality as high as 90% in some areas (Bruno et al. 2001).

Review of Rapid Coastal Assessment

Climate change is seen as the greatest threat to Palau's long term sustainability plans. The number of hot days in Koror has increased from an average of 46 days per year in the first records (1952–1961) to 100 days per year in the last decade (2009–2018). Surface air temperatures is expected to increase, which will result in a rise in the number of hot days and warm nights and a decrease in cooler weather (NOAA, 2020). Due to the increasing warmer climate, there is a scientific consensus that tropical cyclone intensity is likely to increase as well. Given Palau's status as a marine life hotspot, the impact of climate change on coastal and marine life is concerning. The changes in sea surface and sub-surface water temperature can dramatically alter marine ecosystems and affect the circulation pattern in the ocean (Colin 2018). For Palau, 30°C is considered the threshold for initiation of coral bleaching. Palau has one of the most comprehensive temperature monitoring networks on any single coral reef area in the world (NOAA 2020), there is a very high chance that water temperature will continue to increase, and that widespread bleaching is projected to occur annually by 2040 (van Hooijdonk et al. 2016).

Mangroves in Palau are in a healthy and resilient state (Gupta 2019). Mangrove forests serve as a transition zone between terrestrial and marine ecosystems and play an integral part in stabilising coastal areas. Mangroves are also known to serve as a nursery for fish and other economically important invertebrates like the mud crab. Mangroves also protect Micronesia's only saltwater crocodile population (Bauman et al. 2010).

Palau has numerous marine lakes (large bodies of sea water surrounded by land) with close to 70 identified. Along the edges of the lakes, there are extensive invertebrate and algal communities. The mix of species in any given lake often produces unusual communities (Colin 2004). Jellyfish lakes are a small group of lakes containing millions of jellyfish, which photosynthesise to produce food. In terms of the geological makeup of the areas, more research is needed to fully comprehend the ecology and evolution of these special biomes.

3. RIDGE TO REEF MANAGEMENT IN PALAU

3.1 Natural Resources

Freshwater

In Palau, water is sourced mainly from surface water run-off (ADB 2008). On the island of Babeldaob, there are 5 major watersheds and 11 minor ones (SOPAC 2007). The Ngerikiil River in Airai supplies about three quarters of Palau’s population between Airai and Koror. The other islands source water from rainfall and aquifers. Almost every home located in Koror, which is the most populous of the islands, uses various tanks to catch rainwater (SOPAC 2007).

Since the 1990’s, it has been apparent that water yields are much lower than the demand. The current yield of Ngerikiil and Ngerimal water sources, is about 1 million gallons per day during a drought period (that would normally occur once in a 25-year period). This yield is far below the required yield of about 4 million gallons per day. Through the years 1983 to 2003, Palau was affected by at least 3 severe droughts, raising concerns with the government as impending climate change will see more frequent water supply issues (ADB 2008). In some cases, the government has had to use the remaining water at the bottom of Ngerimel dam, to cart water to heavily populated areas of Koror and Airai (Ewart 2016).

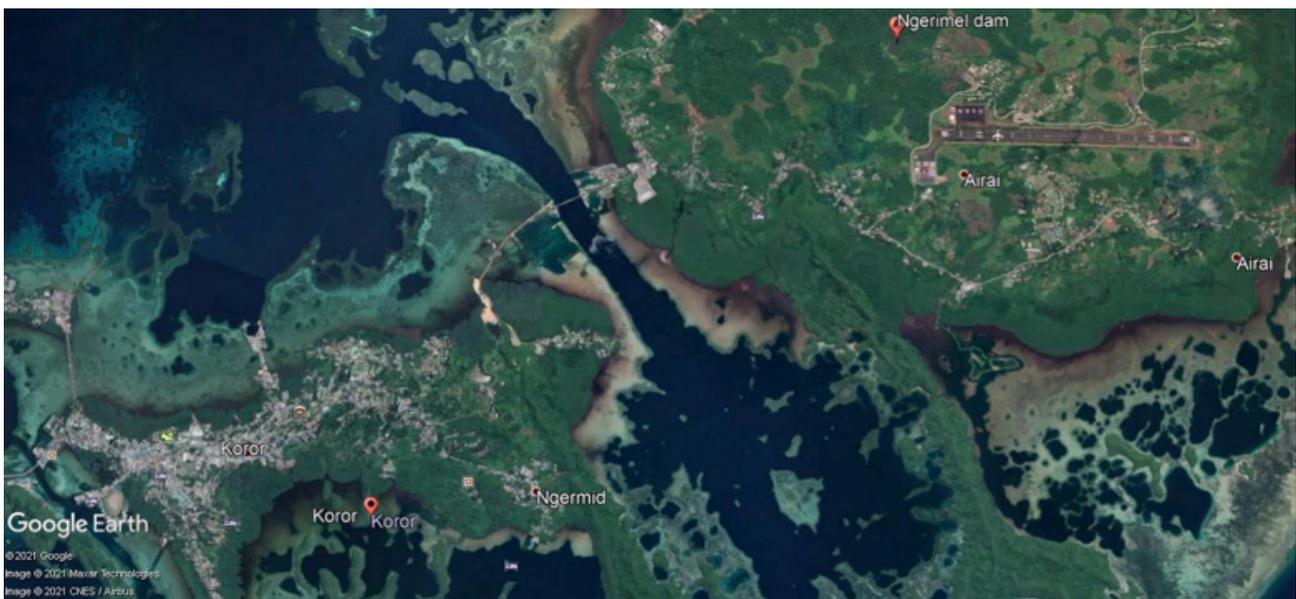


Figure 4 Ngerimel Reservoir supplying water to Koror

There are concerns as well with the contamination of some of these water sources. Poor erosion controls and land-use practices have given way to sedimentation, and poorly maintained sewerage systems, seepage from landfills and saltwater intrusion are some of the other pollutants, including for groundwater sources. On-site sewerage systems are the most common in Palau, except for Koror and Melekeok sewerage treatment plants (ADB 2008). These sewerage systems as well as the public water systems are at the mercy of adverse weather conditions. Recent human-induced contamination, by way of road constructions and deforestation, has led to turbid water conditions. Poor maintenance, planning and management are also part of the problem (Williams 2008). With the help of SPC’s project ZOOM, smaller peripheral islands of Palau have improved water quality and security with repairs of large cisterns mainly on Sonsorol and general water pipe maintenance for Peleliu (SPC 2017).



Figure 5 Pipes being fixed on an outlying Palau island

Coastal

Palau's coastal zone is a dominant sector serving its population both for subsistence and commercial use. It is also a major attraction for the tourism industry, which is Palau's largest revenue earner worth about 47% of the country's GDP (UNDP 2017). Most tourism-based initiatives include white sandy beaches and pristine coral reef ecosystems. However, coastal erosion, coastal flooding and coral reef degradation are frequent causes for concern (SOPAC 2008).

The underlying factor cause of these concerns was mostly attributed to poorly planned infrastructure developments on the coast, most of which are tourism-related businesses (ADB, 2008). Apart from this, the realities of climate change threaten even more adverse weather conditions, including that of, but not limited to rising sea levels and temperature, flooding, prolonged drought, etc. The State of Melekeok, located on the central-eastern coast of Babeldaob, is an example of infrastructure development that has caused reef and shoreline damage. Dredging has deepened channels across reefs and sandy beaches have an eroded appearance. Anthropogenic influenced modifications have altered 'flow patterns on the reef flat', 'interrupted alongshore sediment transport', 'abrupt wave energy reflection', and made coastal plain sediments vulnerable to attack because of the mangrove fringe removal (SOPAC 2008). Table 5 highlights generic environmental features and issues that affect them.

Table 5: Goods and Services from Coastal ecosystems

(Refer to table in **Annex 3** for ‘General Environmental impacts of infrastructure’)

Element	Goods & Services	Threats
Coral reefs	Dissipation of wave action and storm surges, coastal/beach protection from wave damage and shoreline erosion, replenishment of sand, food production and food source, wildlife habitat, nutrient accumulation, supports highest species diversity of any marine ecosystem (role in global bio-diversity), source of medicinal and drug products	Sedimentation (from human and natural activities), polluted or contaminated run-off, eutrophication (from agricultural effluent and sewage), destructive fishing practices and/or over-fishing, dredge and fill operations (port and tourism development activities), unsustainable tourism activities, fuel and oil spills
Coastal wetlands	Provide protective habitat, act as buffer between land and sea and protect shoreline from storms and erosion, nursery areas for spawning and juvenile marine fauna	Reclaimed and converted to land-uses (farming, forestry, fish-farming), damaged by industrial and agricultural development (roads, dams and irrigation systems), dredging and filling activities, accidental spills, polluted run-off, use as solid waste dumps and landfills, over-use as fuel-wood
Mangroves	Marketed; poles, charcoal, wood chips, mangrove crabs, fish or shell fish in adjacent waters Non-marketed; medicinal uses, domestic fuel wood, food, nursery for juvenile fish, feeding ground for estuarine fish and shrimp, nutrient flows to estuaries, buffer to storm damage, coastal stabilization, pollutant traps, protection against erosion, cultural importance, wildlife habitat, filter and purify water	Reclaimed and converted to land-uses (farming, forestry, fish-farming), damaged by industrial and agricultural development (roads, dams and irrigation systems), dredging and filling activities, accidental spills, polluted run-off, use as solid waste dumps and landfills, over-use as fuel-wood
Seagrass beds	Produce food for dugongs, manatees, turtles and birds, function as nurseries for some commercially exploited fish, protect coastlines from erosion by slowing wave movements, stabilisation of bottom sediments and reduces turbidity	Any physical or chemical changes in coastal water characteristics from; increased siltation and silt loads, effluents, run-off, thermal pollution, removal through reclamation
Rocky coasts	Perform important biological functions, provide attachment for marine algae and filter-feeding invertebrates, habitat for finfish and shellfish for subsistence or commercial purposes, support food-webs, feeding and breeding sites for seals, seabirds and other fauna not found in other ecosystems, help dissipate wave energy, protect sediments and soils from erosion	Mining and quarrying, pollution and polluted/contaminated run-off and effluent and spills can damage habitat values and functions, construction projects can increase turbidity and water temperature, aesthetic value undermined by unsightly development

Source: Adopted from World Bank- Environmental Assessment Sourcebook Update No. 7 (March 1994).

For the Palauan people, coral reef ecosystems have always been an important part of life. As previously stated, there are two types of dependence on this diverse natural ecosystem: subsistence and commercial. People staying outside of Koror and Airai are more dependent on the reef resources for subsistence living. Apart from the threat of climate change, infrastructure development projects seem to be the greatest contributor to pollution. Impacts (such as increased sedimentation) from construction related projects, especially in the tourism industry and civil sector, are witnessed across sensitive coastal areas and marine ecosystems (ADB 2008). This has the potential to affect both the physical and biological processes of marine ecosystems.

A massive coral bleaching event hit Palau in 1998, wiping out about 560 km² of patch reef, barrier reef, outer reef, or about a third of the island's corals (Golbuu 2007). The coral reefs have yet to fully recover from this devastating event, and are slowly deteriorating due to large-scale fishing, reef dredging and sedimentation from land activities. Climate change is also expected to have a negative impact on the agricultural sector and production. Farms and agroforests are already exposed to impacts from flooding, soil erosion, droughts, winds, disease, pests and clearing for developments. Climate change will aggravate these impacts for some crops and locations for example, low-lying taro fields are at increasing risk of saltwater intrusions (Del Rosario et al. 2015).

Vulnerability & Adaptation (V & A) Assessments

The entire country is being focused on adaptation, resiliency, and mitigation. Palau's climate-change policy is centred on adaptation, disaster preparedness and building resiliency. It is a single integrated government policy established at the highest political level, with mechanisms in place to allow the government to establish the institutional frameworks and infrastructure required to ensure that adaptation and resiliency are incorporated into all government planning and programmes. It guides national budgeting and government spending on climate change, both as a standalone issue and as a part of broader economic development.

Palau has also committed to halving its carbon emissions by 2025, largely through the use of renewables, and has declared 80% of its exclusive economic zone a no-take zone, meaning that commercial fishing will be prohibited in a 500,000 km² area. President Remengesau told delegates at the COP21 climate conference in Paris that such a large marine protected area—or carbon sink—allows marine diversity to recover and fish stocks to rebound, with spillover benefits for our oceans and the rest of the world.

Palau is one of 43 countries that make up the Climate Vulnerable Forum, and it has been a vocal advocate for keeping global warming to 1.5° Celsius. The Paris Climate Agreement aims to keep global warming below 2° Celsius (Palau, n.d.).

Land

Palau has exceptional biological diversity for such a small nation. The country has the largest amount of undeveloped forestland in Micronesia. Palau has nine different types of forest, including upland native forest, low coastal island forest, raised limestone island forest, and mangrove forest. The forest spans 77,248 acres, while the agroforest covers 2,700 acres and is dominated by coconut groves. Palau's forests are highly valued as watershed areas, as well as sources of firewood, medicines, building materials, and foraging and hunting grounds (Office of Environmental Response and Coordination, 2007). Community engagement and the participation of women and youths in land development and management is important. Awareness and capacity building will enable communities to be aware of the benefits and incentives to long-term planning, resource management, and sustainable land management. Landowners will also be more receptive to and

utilise sustainable land management practices when they are more aware of the benefits. Through the identification of incentives communities and landowners will be better able to maximise the socio-economic potential of land (UNDP 2008).

Solid Waste

Solid waste is categorised as any sort of rubbish that is dumped in landfills. This would be inclusive of, but not limited to, things like harmful hospital chemicals, batteries, fertilisers, garbage etc. A solid waste survey conducted in 2010 estimated that around 1369 metric tonnes of solid waste is generated annually by households in Koror. According to the survey, more than half of municipal solid waste consist of biodegradable kitchen waste (Rechelulk et al. 2012). Over the years the numbers have likely increased with the increasing population.

Liquid Waste

This is referring to domestic wastewater as well as septic waste. As mentioned in the first part of this section, sewerage systems are in place for residences in Koror (least populated bigger island) and Airai (smaller island, heavily populated), though most residences have on-site sewage systems or septic tanks. Other homes outside the busy urban areas use pits and water-seal toilets, with untreated wastewater being washed into streams.

In 2014, Palau received a \$28.8 million loan from the Asia Development Bank to improve its sewage system. This was to serve 80% of people living in Koror and Airai with the inclusion of visitors to the Island. The project sought to deal with uncontrolled sewage flows and offer resident within the Koror and Airai corridor improved water and sanitation. All of this is done to ensure that sewage treatment and disposal meet environmental health standards in the long run. This is critical because, as the demand for development increases these systems must be able to keep up (ADB 2014).

Land rehabilitation

Palau is heading toward a more modern and developed infrastructure society. There are a variety of developments and constructions for tourism businesses as well as public and civil infrastructure. Williams (2008) found that tourism related businesses and overall public infrastructure contributed heavily to the surrounding environment, such as land degradation. These impacts have already been listed and they include impacts along the coast to the reefs. In the wake of Palau's pursuit of becoming a more developed country, it should be considered that legislation and environmental/land management are a top priority to ensure sustainable practices.

Forest

The forests in Palau are in good condition with high diversity. While the secondary vegetation is extending, the recent land cover and loss of primary forests is unknown. However, trends indicate that the extent of damaged and degraded land and forests and the amount of damage trees is increasing. This has led to the rapid increase of endangered species on land. In 2014, approximately 30% of Palau's total land was disturbed. These disturbances include fire, wind, tree disease, invasive species, and vegetation suppression (Gupta 2019).

Despite these disturbances, the Forest Inventory Analysis (FIA) survey by the United States Department of Agriculture (USDA) reveals that there is good baseline information on forest diversity in the Ngardok Nature Reserve. The survey showed that a hectare in the reserve contained 62 species of native woody plants, 29 of which are endemic to Micronesia and 21 endemic to Palau (Forest Service 2014). Palau's forests are relatively dense and have a higher species density. The survey recorded 126 tree species with 32 species making up 75% of the forest structure.

Minerals

Palau's mineral resources have not been widely researched. Although some papers have documented sightings of all kinds of minerals, there is still a need for extensive research. However, a journal article by Gilbert Corwin (1954) documented the following. Minerals on the Islands of Palau can be classified into four groups:

- i. Volcanic rock-forming minerals
- ii. Zeolites and other cavity minerals
- iii. Vein and ore minerals
- iv. Minerals of limestone islands.

Basalts, andesites, plagioclase feldspars, augite, hypersthene, hornblende, magnetite and in some specimens, olivine or quartz are among the minerals found. Some of these minerals are isolated in tuffs and exposed primarily along coastlines and in volcanic island streams. Minerals such as augite, hypersthene and hornblende can be in the tuffs on Babeldaob's western coast. A wide variety of zeolites can be in the vesicles, cavities, and veinlets of volcanic and pyroclastic rocks. Gold and deep-seabed minerals can also be found in certain parts of the Islands (Corwin 1954).

In 1990, the United States of America conducted a Deep-Sea Minerals (DSM) Geological Survey within Palau's EEZ. It was found that there were occurrences of both cobalt and phosphate with seafloor-massive sulphide and, with the aid of SOPAC, a DSM workshop was held in 2012. This workshop outlined policy proposals and proposed DSM mining guidelines for mineral resource development stakeholders.

3.2 Nature Reserves and Protected Areas

The people of Palau have relied on their reefs and forests for survival for over 2000 years but increasing pressures on these resources have put both nature and people at risk. For the past 25 years, The Nature Conservancy has collaborated with Palau’s community leaders and government agencies. During that time, they have aided in bridging the gap between traditional and modern conservation approaches. The Nature Conservancy assisted in the formation of the Palau Conservation Society; a local environmental organisation dedicated to the preservation of Palau’s natural heritage ([UNDP 2017](#)).

Table 6 List of Nature Reserves or Protected Areas in Palau

National Preserves	<ul style="list-style-type: none"> • Ngerukuid Islands
Nature Reserves	<ul style="list-style-type: none"> • Lake Ngardok
Reserves	<ul style="list-style-type: none"> • Helen Reef • Ngeruangel
Sanctuaries	<ul style="list-style-type: none"> • Ngemelis Conservation Area • Ngkisaol Sardine • Trochus Sanctuaries (2 located nationwide)
State Conservation Area	<ul style="list-style-type: none"> • Mesekelat • Ngelukes • Rock Islands
Conservation Areas	<ul style="list-style-type: none"> • Airai • Ebiil • Ngederrak Reef • Ngemai • Ngerameduu • Ngemasech • Ngerumekoal Spawning Area • Tululeu
Other Protected Area	<ul style="list-style-type: none"> • Ngardmau Waterfall • Ngerchelchuus • Ngarchelong and Kayanga Reef Channels

Overexploitation of fisheries, tourism, non-sustainable forest practises and increasing development, combined with the impacts of events such as the 1998 El Niño-related coral bleaching, led Palauans to realise that action must be taken to protect their environment for themselves and future generations.

Protected Areas Network

The Palau Protected Areas Network (PAN) was established by national law in 2003, establishing a framework for a national system of protected areas. State, community, and private protected areas may apply for membership, which enables access to technical resources, participation in a national monitoring system, and eligibility for national funding. To access PAN funds, PAN member sites must have a management plan that meets strict requirements. In return, states and communities owning PAN member sites agree to effectively conserve the natural resources in the protected areas (<https://pipap.sprep.org>).

The PAN sites, which total more than 40 conservation areas, provide a mix of watersheds and coastal/marine areas. A Palauan site must be part of the PAN in order to count towards the [Micronesia Challenge](#). The [Palau Conservation Society](#) is responsible for the work of the PAN and partners with national and state governments and communities to strengthen and implement the PAN.

Micronesia Challenge

The Micronesia Challenge was launched in 2005 by President Tommy E. Remengesau, Jr., who pledged to effectively conserve at least 30% of Palau's near-shore marine resources and 20% of its terrestrial resources by 2020. This commitment raised the bar for coral reef and island discussions, prompting four other Micronesian governments to make the same audacious commitment to strike a critical balance between the need to use natural resources now and the need to sustain those resources in the future (UNDP 2017).

In 2015, the Palau Government declared over one million square miles of the ocean (which is an area bigger than Texas and Alaska combined) over the course of that year, as a protected area. This makes the Palau marine reserve the sixth largest marine protected area in the world. This marine reserve is part of the 22 protected areas in the Palau islands (Figure 6).

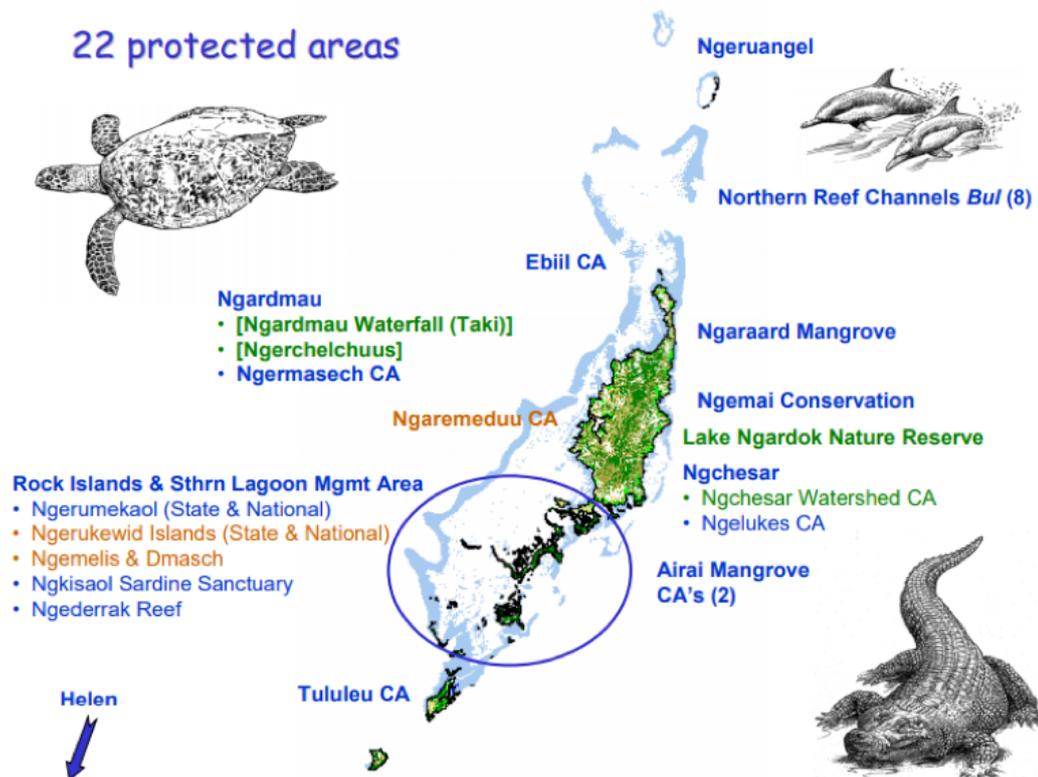


Figure 6 Protected areas network in Palau (Source: Min. of Resources & Development, 2012)

Shark Sanctuary

Palauans have a deep respect for the ocean and its inhabitants, including sharks. Sharks are critical to a resilient system because they are the top predators and help maintain the health of the populations of smaller fish. Without sharks, the delicate balance of fish and sea life changes, with negative impacts on the livelihoods of Palauans.

International fishing vessels continued to be caught and fined for illegally fishing for sharks amid a nationwide ban on shark finning in 2003. So, in 2009, Palau created the World’s first shark sanctuary stretching over 230,000 square miles of ocean, an area the size of France (www.nature.org).

In addition to protecting sharks, Palau’s sanctuary acted as a model for the region. Guam, the Northern Mariana Islands, and the Marshall Islands all established shark sanctuaries after Palau, and the Federated States of Micronesia recently passed legislation to establish its own. The combined Micronesia Challenge shark sanctuary will cover more than 3 million square miles — an area larger than the United States landmass (www.nature.org).

3.3 Island Vulnerability

Palau Island

Like other Pacific Island countries, Palau is particularly vulnerable to the effects of disasters, including the impacts of climate change e.g., severe weather events and rising sea levels. It is susceptible to several human-induced disasters as was seen in September 1996 when the Koror-Babeldaob Bridge, spanning Palau’s two main islands, collapsed suddenly, and in 2002 a report found that Palau’s public water supply was contaminated due to a violation of public water standards which potentially have a large impact on the economy and population (UNOCHA n.d).

Although most disasters have been caused by natural events in the past, human-induced or technological disasters are predicted to become more common in the future, if national development is not adequately monitored or mitigated.

Table 7 shows the natural and man-made hazards and risks that have been identified through stakeholder consultation as being those most likely to affect the Republic of Palau. They were given a high, medium or low risk ranking based on their risk potential (<http://palaugov.pw/wp-content/uploads/2017/05/2016-Amended-Palau-Risk-Management-Framework.pdf>).

Table 7 Rate of man-made and natural hazards and risks

Natural Hazards	Level of Risk
Storm Surge	High
Drought	High
Typhoon	High
Sea level rise (sea water intrusion/soil Saline/coastal inundation & erosion	High
Tsunami	Low
Earthquake	Low

Human-induced Hazards	Level of Risk
Oil spill	High
Water contamination including sewerage	High
Solid waste disposal	High
Wildlife affecting aircraft movement	High
Increased sedimentation of watershed/ coastal waters	High
Fire (industrial areas)	High
Fire (residential)	Medium
Invasive species	Medium
Hazardous substances spill	Medium
Emerging/infectious disease	High
Terrorism/Civil Unrest/UXO	Low
Structural collapse:	Low
• Bridges/causeways	Low
• Water dams	Low
Power	Low
Communication	Low
Landslides	Low
Airport/port incidents	Low
Civil uprising	Low
Political instability	Low

<http://palaugov.pw/wp-content/uploads/2017/05/2016-Amended-Palau-Risk-Management-Framework.pdf>

Figure 7 below shows approximately 3% of the government’s budget toward NEMO and the ministries associated with Disaster Risk Management.

	Risk reduction / prevention (%)	Relief and reconstruction (%)
National budget	0.3	
Decentralised / sub-national budget		
USD allocated to hazard proofing sectoral development investments (e.g transport, agriculture, infrastructure)		

Figure 7 Disaster Risk Management, relief, and construction

Extent of disaster impacts on water/coastal management

Inundation of water resources

Increasing atmospheric temperatures and saltwater inundation because of climate change may threaten Palau's freshwater supplies, despite the island's abundant rainfall. Historically, Palau has had distinct wet and dry seasons, but these have become less distinct as storms have hit during traditionally drier months, and dry periods can occur when rain is expected. Typhoons and other severe storms have wreaked havoc on local infrastructure and fisheries, and an increase in storm frequency associated with climate change could pose a significant threat to Palau in the future ([UNDP 2017](#)).

Saltwater Intrusion

The cultivation of taro is essential for both socio-economic development and cultural obligations. Food security, customs, and cultural identity are all influenced by it. Taro is usually cultivated very close to the sea and thus, faces the threat of saltwater inundation and wave overtopping. Taro patches are vulnerable to climate change, which is resulting in sea-level rise, droughts, and floods. Sea-level rise and increase of seawater temperature have led to accelerated loss of taro production areas and eventual decrease in taro production and supply.

The Pacific Adaptation to Climate Change project has attempted to address the lowland taro production vulnerability in Palau. In collaboration with the Secretariat of the Pacific Community (SPC) and farmers in Ngatpang state, the project sought to identify and test taro varieties that can grow in higher salt environments to improve lowland taro production. The project team built on traditional knowledge to construct dikes that reduce saltwater intrusion into the taro farms (OERC, 2008). The project has four areas of activity: lowland taro production, upland agroforestry, aquaculture, and food processing.

Water quality impacts from pollution

Sedimentation is the primary source of pollution, and it degrades the quality of surface water. Poor erosion controls, the loss of riparian buffers, and poor land-use practices all contribute to sedimentation. Poorly maintained septic tanks, leaching from nearby landfills and saltwater intrusion pollutes the groundwater sources. Land-based pollution, as well as gasoline and oil from outboard motors and ships, have an impact on coastal water quality. According to the Pacific Water Community, the water quality in Palau may also face challenges such as sewage, chemical pollution, and oil spills from future development on the larger islands ([Liu 2017](#)).

Wetlands

Lake Ngardok Nature Reserve, Palau's first designated Ramsar wetland site of importance, is home to at least 11 indigenous bird species including the national bird, the Palau fruit dove or biib (*Ptilinopus pelewensis*). The lake and marshes surrounding the lake are home to the endangered crocodile (*Crocodylus porosus*) and serves as an important breeding area for the species. Palau is currently looking for financial aid to help look after the reserve (OERC, 2008).

Droughts

In March 2016, Palau became another Pacific Island nation to declare a state of emergency. Rainfall in the capital Koror had been at its lowest in 65 years over the previous four months (Feb–May), and the city’s only dam had dried up.

Those states with groundwater sources were particularly vulnerable because they relied on rain to recharge their groundwater sources and water lenses. It was deemed most probable that these water sources would experience increased water salinity. In addition, severely low levels at water sources can increase water turbidity in the water and affect water systems. 80% of the areas in Palau experienced a decrease in the water supply. Farming and crops were and would be damaged, and health issues such as bacteria in the water and food, a lack of food and dehydration were likely to increase. The risk of wildfire was amplified. Due to the water shortage, many water bottling companies in Palau have stopped producing bottled water (NEC 2016).

3.4 Climate Change Issues

Rising Sea Levels

The expansion of ocean water as it warms causes the sea level to rise. It is also aided by the melting of glaciers and ice sheets. Sea level rise is measured using satellite-mounted instruments and tide gauges. According to satellite data, the sea level in Palau has risen by about 0.35 inches (9 mm) per year since 1993. This is larger than the global average of 0.11 inches – 0.14 inches (2.8 mm–3.6 mm) per year. This higher rate of increase may be partly related to natural fluctuations that take place year to year or decade to decade caused by phenomena such as the El Niño-Southern Oscillation.

Sea level is expected to continue to rise in Palau. This rise in sea level is projected to be in the range of 3.1 inches–7.1 inches (8 cm–18 cm) by 2030 under a very high emission scenario. Storm surges and coastal flooding will be exacerbated by sea-level rise combined with natural year-to-year variations. As there is still much to learn about sea level, particularly how large ice sheets such as Antarctica and Greenland contribute to sea-level rise, scientists warn a higher increase than currently predicted could be possible (Republic of Palau National Report 2013).

Table 8 Sea-level rise projections for Palau. Values represent 90% of the range of the model results and are relative to the period 1986-2005

	2030		2050		2070		2090	
	(in)	(cm)	(in)	(cm)	(in)	(cm)	(in)	(cm)
Very low emissions scenario	3.1–6.7	8–17	5.5–11.8	14–30	7.9–17.3	20–44	9.8–23.2	25–59
Low emissions scenario	3.1–6.7	8–17	5.9–12.2	15–31	9.1–18.9	23–48	11.8–26.4	30–67
Medium emissions scenario	3.1–6.7	8–17	5.5–11.8	14–30	8.7–18.5	22–47	12.2–26.8	31–68
Very high emissions scenario	3.1–7.1	8–18	6.7–13.8	17–35	11.0–22.8	28–58	16.2–34.6	41–88

Ocean Acidification

About one quarter of the carbon dioxide emitted from human activities each year is absorbed by the oceans. As the extra carbon dioxide reacts with sea water it causes the ocean to become slightly more acidic. This impacts the growth of corals and organisms that construct their skeletons 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 Palau’s waters.

The acidity level of sea waters in the Palau region will continue to increase over the 21st century, with the greatest change under the very high emissions scenario (Kuleshov et al. 2013). 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.

Warmer Temperatures

Annual and seasonal maximum and minimum temperatures have increased at Koror since 1951. Maximum annual temperatures have increased at a rate of 0.36°F (0.2°C) per decade and mean temperatures have increased at 0.18°F (0.10°C) per decade (Figure 8). The number of warm days and warm nights has increased since 1952. These temperature increases are consistent with the global pattern of warming (Gupta 2019).

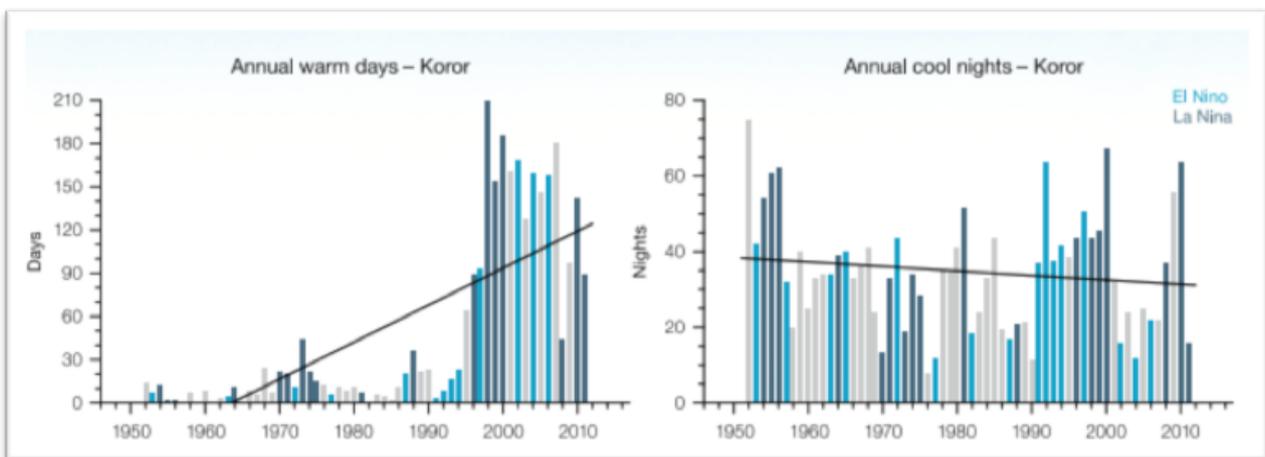


Figure 8 Annual total number of warm days at Koror. Light blue, dark blue and grey bars indicate El Niño, La Niña and neutral years respectively. No bars indicate that data is not available. Solid black lines show the trends.

<https://www.pacificclimatechangescience.org/>

Loss of Income

Damage to the environment such as coral bleaching could adversely affect the tourist industry, which is the backbone of the economy. Warming seas caused an extreme coral bleaching event in Palau in 1997 and 1998. Approximately one-third of Palau’s corals died, with coral mortality as high as 90% in some areas. Increased ocean temperatures may alter the migratory patterns of fish populations in Palau’s waters, putting the fishing industry at risk (UNDP 2017).

Loss of traditional knowledge

Loss of traditional ecological knowledge in Palau is concerning local populations. As western technologies and modernisation becomes dominant, and the local population using such traditional practices less over time, it is likely such traditions may risk gone and forgotten altogether. An excerpt below best captures the overwhelming importance of ensuring maintenance of traditional knowledge in Palau.

“As Globalization arrives, our worldview as Pacific Island peoples will soon be overwhelmed. The world will so become plural community with the loss of characteristics that have defined us for centuries. For me as [a] Palauan, there [are] things that we Palauans do that I would trade readily now for better approaches from other cultures and societies. These are the characteristics of Palauism. But I will not trade my Palauness: the philosophy of living that has carved our lives and made us survive for the millennia. Things like respect, communal, perseverance, hope, harmony, and a sense of environmental wellness. If Micronesians are not careful, we will lose what made us survive.” Dr Stevenson Kuardei MD 2012.

3.5 Measures to Manage Impacts

Among other disaster-related documents, Palau developed the National Disaster and Risk Management Framework 2010 (NDRMF), mandated by Executive Order No.287, which outlined priorities and processes for managing disasters and disaster risk. These policy actions and interventions remain valid for implementation including through future R2R investments and planning. The framework provides for existing actions covering infrastructure, capacity building and planning to manage disaster risks, and details are given below:

Infrastructure

- Establishment of the National Emergency Management Office (NEMO) as the central coordinating agency for Disaster Management.
- Maintenance by NEMO of resources and systems to monitor, evaluate, warn, and cope with the effects of a disaster.
- Construction of a NEMO Emergency Operation Centre with Communication Room, Training Room/Briefing Room, Resting Area, and office spaces for personnel.
- Palau National Weather Office weather tracking systems which are linked to international weather tracking systems.
- Emergency communication, early warning and alerting systems using multiple media.
- Tools and technologies in place such as Geographical Information Systems (GIS), satellite imagery, computer modelling software and long-term climate predictions.
- Identification of evacuation shelters in each community.
- Improved solid waste management and recycling.

Education and Capacity Building

- Delivery of training programmes through national, regional, or international training providers.
- Formal and informal disaster risk management education and awareness programmes offered by the National Weather Office and Palau Red Cross Society, among others.
- Promotion of the 3Rs (reduce, reuse, and recycle).

Planning and Evaluation

- Development of response plans by government departments, private sector, and media organisations to coordinate national disaster management.
- Evaluation and reporting by NEMO on levels of disaster preparedness within departments, sectors, agencies, and communities.
- Disaster risk assessment processes within agencies tasked with permitting development and major capital investments.
- Development of a NDRMF and a Recovery Plan for Super Typhoon Bopha and Haiyan.

Participation in the Pacific Island Emergency Management Alliance and activities and capacity building to improve interoperability and cohesiveness between key response agencies. (<https://www.pacificclimatechange.net>)

4. INSTITUTIONAL, LEGAL AND POLICY FACTORS

4.1 Institutional Setting

4.1.1 Sector-based Laws

This section describes the legislative, policy documents that provide the appropriate mandates for the institutions responsible for the different sectors.

A gender analysis of the legislations and policy documents was not undertaken as part of the IDA. An effective gender analysis will require assessment of each of the Palau R2R sites in terms of the local level structures as well as the state and national institutional and legal mechanisms that affect participation of women/men/ youth and the most vulnerable in communities.

Palau is one of only seven countries in the world not a signatory of the Convention on the Elimination of all forms of Discrimination against Women (CEDAW). However, the Constitution guarantees the rights of all citizens, and such rights are part of the Pacific Platform for Action and reflected in the Pacific Gender Equality Declaration (2012) and the 2030 Agenda for Sustainable Development. There is a National Gender Mainstreaming Policy (2018), which amongst other objectives, ensures the integration of gender perspectives in national, state and sector level policies, legislations, strategies, and programmes (Palau National Government 2018).

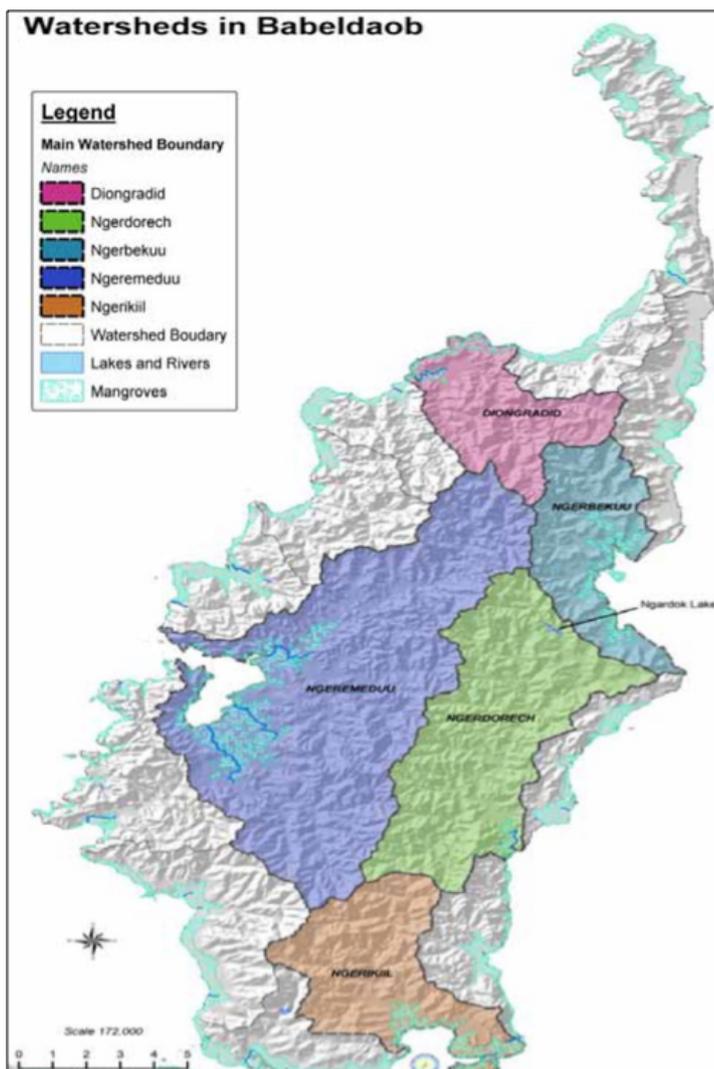
Environment

The Ministry of Natural Resources, Environment and Tourism (MNRET) oversees enforcing most environmental legislation and policies. The nation's biodiversity, as well as its status as a marine hot spot contributes immensely to the nation's successful tourism sector (ADB 2016). The Environment Quality Protection Act 1981 is regarded as the most important legal policy aimed at safeguarding Palau's unique and aesthetically beautiful environment. The Environmental Quality Protection Board (EQPB) was created under this Act.

The EQPB is a semi-autonomous agency and an executive branch of the government of the Republic of Palau. It is responsible for the protection and proper conservation of quality of the environment and its resources to ensure sustainable economic and social development proceeds in a manner that will not jeopardise Palau's future possibilities or opportunities. The Environment Quality Protection Act of 1981 works with other acts such as the Endangered Species Act and the Protected Areas Network Act 2003 to ensure sustainable development in the country.

The R2R investments and planning falls within the mandate of the MNET and EQPB and the laws and policies that govern their operations.

Fresh Water



Palau's primary source of water is surface water, which is supplemented by rainwater. Ground water is a secondary source of drinking water; however, it has not been fully developed due to maintenance issues, water quality issues, and limited well yields in certain areas (Nath et al. 2005). The EQPB also has jurisdiction over water resources. The Protected Areas Network Act 2003 and the Environment Protection and Conservation Act work in conjunction with the Palau Natural Resources Act to assist the country in establishing clean water sources. However, no legislation requiring buffer zones around streams and other wetlands exists yet, even though this has been discussed (Michael and Rogger 2014). The watershed of Negerikiil is the most important in terms of providing water to most Palau's citizens who reside in Koror.

Figure 9: Palau watersheds

Coastal Areas

The establishment of protected marine and coastal areas began in the 1990s, with legislations enacted to recover resources that had been lost due to threats posed by climate change and in particular, development on the island of Babeldaob (Callaghan 1994). The Palauan Constitution, as well as various laws regarding land use (Sustainable Land Management Policy), fishing activities (Marine Protection Act 1994), natural resources and protected areas combine to ensure Palau's coastal areas are developed sustainably. The Constitution gives the power to manage coastal fisheries in the zone up to 12 nautical miles offshore to the 16 states that make up the country. The balancing of nutritional, tourism and export benefits of coastal resources is a major issue affecting Palau's coastal fisheries and marine management strategy. It was recommended that priority be given to meeting the nation's consumption needs of marine resources, with fish being exported only if reserves permit (Callaghan 1994). Management of coastal areas is overseen by the Ministry of Natural Resources, Environment and Tourism and supported by NGOs such as The Palau Conservation Society (PCS).

Terrestrial Land areas

The individual states own most of the land and sea areas in Palau (Public Land). Reefs, mangroves, and other areas below high tide are state-owned (Michael and Rogger 2014). There are also customary and private landowners who lease or buy land; these are usually coastal land areas. All land transactions and development require state permission. Protected areas are established with the help of states. Under the Protected Areas Network Act, Palau has established itself as a leader in biodiversity and its conservation. The 2012 Sustainable Land Management Policy, endorsed by elected and traditional leaders aims to improve land use practices and reduce land degradation by prioritising comprehensive Land Use Planning. The policy also aims at restructuring the tourism industry from a high impact mass tourism model to a low-impact, high-value niche tourism model (PINZ 2008).

Forest

The commercial forestry industry in Palau is largely undeveloped due to the absence of sustainable forest stocks and inaccessibility due to the terrain, of the present stocks. However, the Bureau of Agriculture's Forestry Unit has been promoting the development of small-scale plantations for wood production for several years. The Protected Area Network and the Environment Protection and Conservation Act protect some of Palau's forest areas, which are managed by the Bureau of Agriculture and Forest as well as the Palau Conservation Society. Palau was previously probably almost completely forested; today, forest cover is only about 75% (Cole et al. 1987). This trend can be accredited to the nation's low population density.

Agriculture

The Bureau of Agriculture seeks to promote the expansion of the agriculture sector to meet domestic consumption and drive down the reliance of imported food. The agriculture sector in Palau is not as productive nor as robust as the tourism sector. A lack of data adds to the challenge of informed planning (FAO 2013). The Palau government has placed incentives through a Free Trade Zone as well as tax incentives to stimulate the sector. The United States of America followed by Taiwan are seen as the key players in helping improve this sector in the form of aid money and technical expertise. The Pacific Community (SPC) also assists through the Pacific Agriculture Policy Project. One of the other key policies under the Bureau of Agriculture is the Biosecurity Border Control Act 2013, which regulates and minimises any potential invasive threats from entering the country.

Minerals

Palau does not currently have any operational mines and there is limited information on policies and legislations for minerals. Since the bauxite and phosphate mines by German and Japanese administrations (1899–1945), no mining for precious resources has taken place aside from the extraction of gravel, sand, and coral via dredging (Otohe and Maiara 2000). Dredging activities are monitored by the EQPB.

Disaster and Climate Change

Climate change is listed as one of the major threats to Palau. The Palau Climate Change Policy 2015 is one of the formal policies which inform preparation of disaster and climate change related legislations aimed at building Palau resilience. There is currently no focal point for climate change within the Palau Government, thus the Office of Environment Response and Coordination is tasked with the role of coordinating with the environment sector to implement the policy. The following table captures relevant policies/legislation titles and the respective focal institutions.

Table 9 Summary of Palau legislation relevant to the management of the catchment, coastal and marine environment, and resources

Policy/Legislation Title	Year enacted	National Focal Institution	Coordination Mechanism
Marine Protection Act (Revised)	2014	Bureau of Marine Resources	Bureau of Marine Resources
Protected Area Network Act (Revised)	2006	Bureau of Marine Resource and Environmental Quality Protection Board	Environmental Quality Protection Board
Environment Quality Protection Act	2010	Environmental Quality Protection Board	Environmental Quality Protection Board
Palau Climate change Policy 2015	2015	Office of Environment Response and Coordination	Office of Environment Response and Coordination

Linkages between policies

Palau has a Policy and Planning Program, which works to improve and link legislations to conservation and sustainable management. The National Master Development Plan, or Palau 2020, was developed as an important piece of the broader legislative framework to facilitate the long-term goal of sustainable development. In the Palau 2020, the country upholds gender equality, social inclusion in disaster risk management and under Palau’s Sustainable Development pathway, Goal 5 aims to achieve gender equality and empower all women and girls.

The Policy and Planning Program has three main objectives which synergise with the National Master Development Plan.

- i. Champion land and resource use planning in Babeldaob.
- ii. Advocate for comprehensive legislative and policy framework in support of sustainable land use.
- iii. Assist key partners and resource owners to identify key tourism regulatory objectives in support of national environment policies.

Multilateral Environmental Agreements (MEAs)

Pacific Island countries (PICs) have ratified many MEAs, which largely form the basis to legally respond to many environmental problems. PICs continue to develop policies and laws that are domestic in origin and scope, but there is a trend toward harmonisation among countries because of benchmarking against international standards, adopting best environmental practices, and sharing lessons learned, just as there is with MEA's.

SPREP supports countries in carrying out their MEA responsibilities through activities such as negotiation preparation and technical support at major MEA meetings. SPREP also serves as the Secretariat for two international MEAs: the Noumea Convention on Marine Pollution and the Waigani Convention on Transboundary Transport of Hazardous Waste. SPREP assists with environmental legislative reviews, policy formulation, and the drafting of environmental laws on a national level.

MEAs are agreements between states that can be in the form of “soft-law,” which establishes non-legally binding principles that parties will follow when considering actions that affect a specific environmental issue, or “hard-law,” which specifies legally binding actions to be taken to achieve an environmental goal.

Palau is party to major international and regional MEAs and considers appropriate to progress gender equality and reporting mechanisms to ensure compliance at the regional level (see Table 10). Palau relies on development partners to assist and supplement the nation's budget in achieving its development goals. The multilateral and bilateral partners (e.g., USA) of Palau provide critical aid value, which supplements GDP.

Multilateral agreements play a critical role in the setting of environment laws and conventions. Multilateral Agreements focus on linking their mandate and strategies to contribute to sustainable development (UNEP 2016).

Table 10 Major multilateral environmental agreements signed by Palau (UNEP 2016).

Name of Convention	Focus Area	National/ Regional Focal Institution
Noumea Convention	Protection of natural resources and environment of the South Pacific region. Prevent, reduce, and control pollution.	Secretariat of the Pacific Regional Environment Programme (SPREP)
Convention on International Trade in Endangered Species (CITES) of Wild Fauna and Flora	The convention states the importance of protecting endangered plants and animals. Aim is to ensure that international trade in specimens of wild animals and plants does not threaten the survival of the species in the wild.	Jointly served by United Nations Environment Programme (UNEP) and International Union for Conservation of Nature (IUCN).

Name of Convention	Focus Area	National/ Regional Focal Institution
World Heritage Convention (2002)	Rock Islands of the Southern Lagoon is Palau's first World Heritage site, and this includes marine lakes, coral reef features and shallow lagoon.	The Secretariat of this Convention is administered by United Nations Educational, Scientific and Cultural Organisation (UNESCO)
Convention on Biological Diversity (CBD) (1998)	The Conservation of Biological Diversity; the sustainable use of its components; and the fair and equitable sharing of benefits arising out of the utilization of genetic resources	The project was funded under the Global Environment Facility's (GEF) Enabling Activities, administered by the United Nations Development Programme (UNDP). Overseeing the project was the Palau National Environmental Protection Centre
Micronesia Challenge Initiative (2006)	Micronesian territories to "effectively conserve at least 30% of the near-shore marine resources and 20% of the terrestrial resources across Micronesia by 2002	National Government of Palau
Ramsar Convention on Wetlands (2003)	Lake Ngardok Nature Reserve is Palau's first Ramsar site (2003).	Secretariat of the Pacific Regional Environment Programme (SPREP)

4.2 Constraints and Limitations

This section briefly describes the capacity shortfalls in the context of the absence of appropriate institutional arrangements/bodies, human resources, equipment, etc.

Priority Capacity Strengths

Palau's people are perhaps its greatest strength in terms of stretching to comply with the Rio Conventions. Palau's culture reflects genuine respect for the environment, as well as traditional knowledge of how to treat the land and the sea so that both can continue to provide for the people's needs, as well as an appreciation for the beauty of these tropical islands. This respect is reflected in the national and state governments, as well as the private sector and Palau's numerous environmental non-governmental organisations. Given Palau's population and size, it has many organisations tasked with environmental protection.

Another national strength is that, despite numerous ecological issues, the country has maintained a pristine environment. While there is much work to be done to ensure that Palau's ecosystems are not degraded, there is little rehabilitation work required. Palau's work should primarily be focused on prevention if it can quickly enact and enforce appropriate laws and regulations.

Priority Capacity Constraints

The lack of a comprehensive environmental framework in Palau, which includes the necessary variety of policies as well as designated implementation and enforcement agencies, is the most significant constraint. Only a comprehensive approach can ensure that new proposals are assessed for their environmental impact, particularly those that appear to have no environmental consequences at first glance. For example, Palau has many foreign workers and the ability to accommodate and provide standard services is limited. The situation is particularly dire given the shortage and inability to deliver on housing, transportation, utility services (sewage, electricity, water, telephone, cable TV, etc.), food (much of which is imported), and consumer goods for this additional population.

When it comes to labour issues, however, environmental impacts are not a required part of the decision-making process. Another stumbling block is the lack of financial and human resources. While recognising the benefits of having numerous agencies, organisations and people working on environmental issues, often face with competition on limited personnel and funding resources.

Priority Capacity Needs

The human resources available in a small country like Palau are limited. Local people need to undergo training to expand the nation's capacity and develop Palau's pool of skilled workers and qualified experts. These trainings are to ensure that men, women, youth are equally addressed, and that capacity is built and strengthened at all levels of government and private sector and communities.

The reporting requirements of United Nations programmes are straining current personnel and the finances. Fund allocations agreed for certain sectors or specific infrastructure related activities are being directed to supporting preparation and publishing of reports. In the environment sector it is reported that professionals find large portions of their time spent generating the necessary reports, and little time doing field work, research, and other non-office work.

Accordingly, the Palau National Congress (Olbiil Era Kelulau) signed and ratified United Nations Conventions showcase the country's commitments to conservation efforts. However, the challenge is implementing commitments which normally require sustainable resources. This results in a situation of unfunded mandates, unmet expectations, and incomplete implementation.

Failure to coordinate the actual implementation of the various conventions results in a variety of agencies performing duplicative work in some areas which in turn lead to no work done and completed and nothing to report back as required under the relevant conventions. The lesson is to prepare and submit policy analysis and options to inform political decisions particularly if the benefits outweigh the costs. It is also always necessary to have sufficient funding to deliver on the obligations and commitments and ensure that the funds reach the people who will be carrying out the implementation (www.undp.org – National Capacity Needs Self-Assessment for Environmental Management 2007).

Note: Capacity Constraints in Target Areas are tabulated in Annex 2.

4.3 Public and Stakeholder Participation

Relation of Environmental NGOs with other CSO and Stakeholder groups

The Palau Conservation Society (PCS) was established in 1994, and like other non-profit/non-government organisation, PCS works with communities (traditional landowners) to help establish protected areas, facilitate community-based management plans, develop, and support sustainable resource use policies and practices, and increase environmental management skills, knowledge, and awareness (PCS 2016). PCS has been actively involved in the establishment of both marine and terrestrial areas in Palau. In 2016, 46 sites were formally designated and protected. Palau's 16 States have legislated or traditionally decreed protected areas.

Other environmental NGOs that work to safeguard Palau's environment are the Coral Reef Research Foundation, and Palau International Coral Reef Centre. The Micronesian Shark Foundation Palau studies sharks throughout Micronesia. The Nature Conservancy is an international NGO and is involved with several projects in Palau, including the Micronesia Challenge.

Structure of public environmental organisations

The Ministry of Natural Resources, Environment and Tourism (MNRET) is one of the leading forces for environmental organisations in Palau. The Ministries come under the executive branch of Parliament, which is headed by the President, who is the Chief of State and Head of Government. Each Ministry is assigned a head who reports to the President. Ministries are further broken down into Bureaus. The Ministry of Natural Resources, Environment and Tourism is made up of the following Bureaus:

- i. Bureau of Agriculture
- ii. Bureau of Marine Resources
- iii. Bureau of Tourism
- iv. Protected Areas Network

The individual Bureaus work to promote, protect and manage the natural resources of Palau in areas of agriculture, marine resources, tourism, and environment. Each Bureau has governing legislations under the constitution of Palau. Legislations at times involve more than one party to implement it. For example, the Environmental Quality Protection Act, though overseen by the EQPB, requires the participation of Ministry of Natural Resources, Environment & Tourism, Bureau of Public Works, and Bureau of Health to implement the policies. Table 11 outlines the coordination mechanisms and responsibilities for implementing the legislations.

Table 11: Relevant Institutional Legal Factors

Policy/Legislation Title		Marine Protection Act
Coordinating Mechanism		<ul style="list-style-type: none"> Ministry of Natural Resources, Environment & Tourism (Bureau of Marine Resources)
Objectives		<ul style="list-style-type: none"> Promote sustainably and develop the marine resources of the Republic while also preserving the livelihood of the commercial fishermen of the Republic. to help prevent the depletion of Palau's marine resource, the export of all living resources that inhabit Palau's waters is to be banned.
Tasks		<ul style="list-style-type: none"> promoting, exploring, exploiting, developing, protecting, and managing the natural resources of the Republic, in areas of marine and fisheries
Activity Areas		<ul style="list-style-type: none"> Marine Resources Development Fishery Management
Policy/Legislation Title		Protected Area Network (PAN) Act
Coordinating Mechanism		<ul style="list-style-type: none"> Ministry of Natural Resources, Environment & Tourism PAN management committee Environmental Quality Protection Board
Objectives		<ul style="list-style-type: none"> to provide rules and regulations outlining the process for an area's designation as part of the Protected Areas Network, and to enforce such regulations To establish criteria for the selection of an area to be included in the Protected Area Network To investigate and develop mechanisms for sustainable financing of protected areas in the Protected Area Network. provide technical assistance to state governments for management of their protected areas
Tasks		<ul style="list-style-type: none"> Provides for the protection, conservation, and management of the environment in a sustainable manner, and explicitly supports the conservation and management of Biodiversity through provisions to establish Protected Areas and regulate or prohibit activities within these protected areas Protect 30% of its near-shore marine environment and 20% of its terrestrial environment by 2020.
Activity Areas		<ul style="list-style-type: none"> Respective states marine and terrestrial protected areas
Policy/Legislation Title		Environmental Quality Protection Act
Coordinating Mechanism		<ul style="list-style-type: none"> Environmental Quality Protection Board Ministry of Natural Resources, Environment & Tourism Bureau of Public Works Bureau of Health

Objectives	<ul style="list-style-type: none"> • safeguard the quality of the environment • and ensure sustainable economic and social development proceeds in a manner that will not jeopardize Palau’s future possibilities or opportunities. • to achieve, maintain and restore such levels of air, land and water quality as will protect human health, welfare, and safety • implementation of a National Water Resources Management Plan, and appropriate controls over the utilization of the water resources • prevent injury to plant and animal life and property, and as will foster the comfort and convenience of its people and their enjoyment of the environment, health, life
Tasks	<ul style="list-style-type: none"> • Earthmoving • Marine and Fresh Water Quality • Toilet and Wastewater Disposal Facilities • Solid Waste Management • Pesticides • Public Water Supply Systems • Environmental Impact Statements, • Air Pollution Control • Ozone Depleting Substances
Activity Areas	<ul style="list-style-type: none"> • Environment, Biodiversity and Public water supply management.
Policy/Legislation Title	Endangered Species Act
Coordinating Mechanism	<ul style="list-style-type: none"> • Environment Quality Protection board • Palau Conservation Society • Ministry of Natural Resources, Environment & Tourism
Objectives	<ul style="list-style-type: none"> • Foster the well-being of these plants and animals by whatever means necessary to prevent the extinction of any species or subspecies from our islands or the water surrounding them.
Tasks	<ul style="list-style-type: none"> • Regulate any trade of any animal/plant species • Importation of endangered species. • Importation of exotic plants and animals • Identification for species to be protected
Activity Areas	<ul style="list-style-type: none"> • Wild Fauna and Flora • Management and conservation of endanger species • Building resilience to climate change and natural disasters • Conservation of natural ecology • Water conservation and responsible usage

Policy/Legislation Title	<ul style="list-style-type: none"> • Palau Climate Change Policy 2015
Coordinating Mechanism	<ul style="list-style-type: none"> • Office of Environment Response and Coordination • National Climate Change Coordinator (UNFCCC Focal Point) • National Emergency Management Office
Objectives	<ul style="list-style-type: none"> • Happy, healthy, sustainable, and resilient Palauan communities in a changing world • Mitigate effects of climate change
Tasks	<ul style="list-style-type: none"> • Climate change adaptation • Disaster Risk Management • institutional Mechanisms for Effective Policy Implementation
Activity Areas	

Environmental NGO membership

Palau Conservation Society, Coral Reef Research Foundation, Palau International Coral Reef Centre, The Micronesian Shark Foundation and Nature Conservancy are a few of the well-established NGOs in Palau. These organisations contribute immensely to the healthy state of Palau general environment via technical assistance and advice to the government. The NGOs play a pivotal role in keeping the various environment initiatives alive, via securing funding to assist in the maintenance of the many conservation programs.

There is very little information present on legislations and policies which act as a guideline to how NGOs are to be established and work in Palau. It is noted that the NGOs mentioned work closely with the Ministry of Natural Resources, Environment & Tourism, and the Environment Quality Protection Board (Ridep-Morris 2004).

Pacific Islands Association of Non-Government Organisation (PIANGO) is involved in building the civil society sector throughout the Pacific. Palau is currently listed as an interim member in PIANGO with the Palau community action agency as its interim representative to PIANGO. Association with PIANGO ensures that the Civil Society Organisations voices and efforts are heard through the strengthening CSO Platform in the Pacific.

5. NATIONAL PRIORITY ISSUES

Key Problems, Sectors, and Immediate Causes

Palau Islands Priority Problems:

The following six environmental problems were identified as priority issues of concern during the brief stakeholders' consultation, extensive desk-top research, and literature review. These issues are largely related to water, waste, fishing, and biodiversity loss.

- i. Marine Resource Depletion
- ii. Illegal fishing practices
- iii. Biodiversity Loss
- iv. Solid and Liquid Waste Management
- v. Deterioration of water quality
- vi. Ecosystem Degradation – near shore, terrestrial and surface water, inland flora and fauna, lagoon flora and fauna and wetlands

Table 12 provides an overview of the identified environmental problems, along with the environmental and socio-economic impacts and the identified causes of the existing problems.

Table 12: Identified causes of the existing problems along with the environmental and socio-economic impacts (Office of Environmental Response and Coordination, 2007)

Issue 1: Marine Resource Depletion	
Environmental Impacts	Socio-economic Impacts
<ul style="list-style-type: none"> • Fish nursery decline • Habitat loss • Loss of coral species and organism's dependent on corals • Depletion of inshore fisheries • Declining catches 	<ul style="list-style-type: none"> • Low economic value of fisheries to domestic economy at present time
Immediate/Underlying Causes	Root Causes
<ul style="list-style-type: none"> • People collecting resources in the marine environment with new and more effective gear, traditional methods no longer being used because they tend to limit catch. • More and more people harvesting resources for monetary income rather than solely for locally subsistence uses. 	<ul style="list-style-type: none"> • Over-harvest • Abrogation of traditional conservation practices • Ineffectual management of fishery resources by traditional, state, and national leaders. • Projects such as road building, mangrove filling and dredging • Natural disasters • Climate change: sea-level rise, increased water temperature.

Linkage to other Environmental Problems	Geographical Location
<ul style="list-style-type: none"> Decline in harvests due to dead coral, algal fouling, siltation, pollution, too many collectors, coral dredging, fewer species, oil from boats and lower water levels 	<ul style="list-style-type: none"> Aimeliik, Airai, Koror, Ngaraard, Ngardmau, Ngaremlengui, Ngatpang
<ul style="list-style-type: none"> Sectors responsible: 	<ul style="list-style-type: none"> Tourism industry Subsistence farmers, local businesses Fisheries sector/ Bureau of Marine Resources
Issue 2: Illegal Fishing Practices	
Environmental Impacts:	Socio-economic Impacts:
<ul style="list-style-type: none"> Depleted fish stocks Over-harvesting of vital coastal and pelagic fisheries 	<ul style="list-style-type: none"> Decline in fishing industry Reduced commercial value of fishing in Palau's economy Destruction or degradation of food source for Palauans Income source for fishermen and families greatly impacted Reduction in abundance of fish stocks means inadequate supply of fish to feed locals and visitors, unhealthy and unsustainable use of fish, less or no opportunities for locals and visitors to view and appreciate abundance and variety of fishes. Illegal, unreported, and unregulated (IUU) fishing and bycatch Competition for depleted fish stocks
<ul style="list-style-type: none"> Immediate Causes: Constrained resources including lack of capacity Lack of enforcement and legislations Strong consumer demand Weak monitoring of vessels 	<ul style="list-style-type: none"> Root Causes Lack of resources and financing into programme initiatives to combat illegal fishing in Palau's EEZ Ineffective international management of Pacific tuna supply
<ul style="list-style-type: none"> Sectors responsible: 	<ul style="list-style-type: none"> Foreign vessels Maritime Safety Authority Bureau of Marine Resources Naval authority
Issue 3: Biodiversity Loss	
Environmental Impacts:	Socio-economic Impacts:
<ul style="list-style-type: none"> Loss of terrestrial habitat Decline in native and endemic species Species loss from overhunting or unsustainable harvesting practices Degradation of riparian zones and sedimentation 	<ul style="list-style-type: none"> Contamination of freshwater lenses Major economic impacts on major production sectors caused by poorly managed mining operations

<ul style="list-style-type: none"> • Immediate Causes: • Population growth • Natural resource consumption and unsustainable harvesting practices • Coastal/ riparian zone erosion • Increased transport and trade have brought invasive species 	<ul style="list-style-type: none"> • Root Causes • Economic growth driving unsustainable resource use and extraction • Loss of traditional knowledge and the lack of understanding about the traditional environment • Economic incentives contradict environmental priorities • Climate change: sea-level rise
<ul style="list-style-type: none"> • Linkage to other Environmental Problems • Severe localised impacts on fresh water and soil loss by forest conversion for agriculture and unsustainable logging 	<ul style="list-style-type: none"> • Sectors responsible • Tourism Industry • Trade Industry • Biosecurity department • Ministry of Agriculture • Forestry • Environment

Issue 4: Waste Management

Environmental Impacts:	Socio-economic impacts:
<ul style="list-style-type: none"> • Haphazard sewage discharges threatening environmental and public health • Removal of vegetation and fragmentation of habitats and forests • Toxic gas builds up • Interference with other utilities 	<ul style="list-style-type: none"> • Inundation of taro farms and home sites with untreated sewage • Increases bio-erosion rates by boring bivalves and sponges and increase bacterial infections in corals
<p style="text-align: center;">Immediate Causes:</p> <ul style="list-style-type: none"> • Deterioration of Koror sewer system • Frequent sewage overflows, infiltration, and exfiltration from sewers. 	<p style="text-align: center;">Root Causes</p> <ul style="list-style-type: none"> • Poor overall land use planning and unresolved land rights issues • Inadequate sanitation (master) planning • Lack of public awareness • Lack of financing • Inadequate technical capacity • Ineffective institutional arrangements
<p style="text-align: center;">Linkage to other Environmental Problems</p> <ul style="list-style-type: none"> • Exposure to pathogens in sewage and sludge • Sanitation issues • Degradation of water quality • Nutrient input from sewage outfalls degrades reef systems by favouring algal growth and suspension feeding animals rather than corals 	<p style="text-align: center;">Geographical locations</p> <ul style="list-style-type: none"> • Koror and Airai communities • Ordomele Hamlet

<ul style="list-style-type: none"> • Sectors responsible 	<ul style="list-style-type: none"> • Tourism industry • Infrastructure Department • Municipalities
Issue 5: Deterioration of water quality	
<p style="text-align: center;">Environmental Impacts</p> <ul style="list-style-type: none"> • Reduced coastal marine water quality • Reduced freshwater quality • Odour nuisance • Public health risk from exposure to untreated sewerage • Adverse construction impacts • Over 90% of tested rainwater catchments are contaminated with faecal and total coliform bacteria. 	<p style="text-align: center;">Socio-economic Impacts</p> <ul style="list-style-type: none"> • Inconsistent water quality and supply means 67% of population relies on rainwater catchments as their main source of drinking water • Only 20% of water facilities can provide the public with water that is consistently chlorinated. •
<p style="text-align: center;">Immediate Causes</p> <ul style="list-style-type: none"> • Untreated sewer discharge • Eutrophication of water bodies • Increasing development, poor land use • Land reclamation 	<p style="text-align: center;">Root Causes</p> <ul style="list-style-type: none"> • Man-made contamination and drought • Poor infrastructure/construction • Deforestation in combination with heavy rainfall • Urbanization leading to sewage treatment and waste disposal facilities becoming overburdened. • Lack of water conservation awareness and low water utility bills
<ul style="list-style-type: none"> • Linkage to other Environmental Problems • Degradation of reef systems 	<ul style="list-style-type: none"> • Sectors responsible • Tourism sector • Infrastructure department • Water sector • Municipalities
Issue 6: Ecosystem degradation- near shore, terrestrial and surface water, inland flora and fauna, lagoon flora and fauna and wetlands	
<p style="text-align: center;">Environmental Impacts</p>	<p style="text-align: center;">Socio-economic Impacts</p>
<ul style="list-style-type: none"> • Sediment contamination of rivers • Loss of vegetation (incl. productive crops and trees during demarcation) • Soil erosion and silt generation 	<ul style="list-style-type: none"> • Taro patches not as productive as they were • Presence of construction workers during Infrastructural operations: <ul style="list-style-type: none"> • Social disruption • Spread of communicable diseases including STIs and HIV/AIDS • Relocation of houses • Impacts on fisheries

<p style="text-align: center;">Immediate Causes</p> <ul style="list-style-type: none"> • Land clearing being cut and filled to create new land for buildings • Ongoing development • Population influx to coastal areas and urban centres 	<p style="text-align: center;">Root causes</p> <ul style="list-style-type: none"> • Sub-urbanization • Unplanned development • Infrastructure developments (road building, mangrove filling and dredging)
<p style="text-align: center;">Linkage to Environmental Problems</p> <ul style="list-style-type: none"> • Unprecedented amounts of sedimentation into near-shore areas • Turbidity in near-shore and reef environments downstream • Depletes marine resources • Contributes to climate change: impacts on rainfall, groundwater depletion or carbon emission 	<p style="text-align: center;">Geographical location</p> <ul style="list-style-type: none"> • Airai (Southernmost state on Babeldaob)
<p style="text-align: center;">Key sectors contribution</p>	<p style="text-align: center;">Infrastructure developments</p>

6. OPTIONS FOR REFORM AND ACTION

This section sets out to identify and evaluate priority options for reform and action, which simply respond to priority issues outlined in earlier sections. This would be part of the next steps and the way forward of the IDA to provides the factual basis for the formulation of a Strategic Action Plan (SAP) for Ridge to Reef.

The excerpt below provides an excellent reminder of the importance of the interactive process of upskilling and empowering local communities and people who are directly responsible for making real changes in addressing priority issues through policy reform and action. This is a powerful message reminding us that behavioural changes cannot but just fixed with expensive fancy equipment and short-term training, but that of a full interactive cycle of upskilling and empowering.

“The ultimate success of projects and initiatives to combat pollution throughout the Pacific relies on empowering island populations to better manage the problems themselves. It’s not enough to give them equipment, show them how to use it and then leave them to it. The key to making real change is to upskill the people, to build their knowledge and understanding. That’s quite an iterative process, and one that takes time.” (Dr. Julie Hall, NIWA regional manager)

The following table presents the highlighted issues and options for reform in no order of priority, for the way forward.

Table 13 Issues and options for reform for the way forward

PROBLEM	OPTIONS FOR REFORM
Marine Resource Depletion	<ul style="list-style-type: none"> • Bureau of Marine Resources should work with specific communities and municipalities on moratoriums and designing target management plans – local workshops designed to promote sustainable and non-destructive fishing methods are one way of increasing community awareness of the problems. • Provision of alternative income generating options for fishermen and resource users. • Harsher penalties. • Reviewing of legislations and relevant policies. • Establish monitoring and inspection centres by the Bureau of Marine Resources at main jetties and landing zones to inspect harvested stocks.
Illegal fishing practices	<ul style="list-style-type: none"> • Research is needed to increase understanding of the situation in Palau, and the region. • Collaboration within the region is necessary to increase awareness of the extent of the problem. A more comprehensive and in-depth survey of illegal fishing in the Pacific is needed to determine country-specific needs for education, training, and planning. • Increased and effective enforcement of existing laws. • Provision of alternative income generating options for the fishermen.

<p>Biodiversity Loss</p>	<ul style="list-style-type: none"> • Long-term planning. • Ongoing training and capacity building – provide training to staff of the Ministry of Agriculture and to farmers’ organisations and individual; and training on methods to reduce water runoff and settle sediments before they enter streams. • Cultivation of crops such as bananas and other plants without the use of pesticides or fertilisers, which will significantly reduce soil erosion. • Ensuring that community-level decision-makers are given the knowledge and the right tools to make informed decisions.
<p>Ecosystem Degradation – near shore, terrestrial and surface water, inland flora and fauna, lagoon flora and fauna and wetlands</p>	<ul style="list-style-type: none"> • Long-term planning. • Empowering community level decision makers. • Coral reef restoration to restore natural breakwater functions, reducing wave energy. • Mangrove afforestation, reforestation, restoration, conservation as a natural buffer.
<p>Deterioration of water quality</p>	<ul style="list-style-type: none"> • Reviewing of policies. • People taking ownership of the environmental issues, ensuring that viable and appropriate long-range plans are followed. • Improved water management. • Capacity building - lack of capacity and expertise including human and technical resources in the water sector, both government and private sector.
<p>Solid and Liquid Waste Management</p>	<ul style="list-style-type: none"> • Site containment. • Amendments and standardising building and construction laws. • Government investment into facilities and technical expertise. • Strengthening laws and regulations against non-point water source pollution.

7. FINDINGS AND RECOMMENDATIONS

The diagnostic analysis of the environmental problems in Palau involves identification and quantification of data collected from the relevant expertise and stakeholders in the IDA workshop, and from a thorough desktop review.

- i. Reviewing of policies and stronger enforcement measures, building local capacity and technical expertise, and tighter stakeholder collaborations could be preliminary measures towards addressing and mitigating these problems and should include: harsher penalties and fines on companies and institutions that practice illegal fishing practices and illegal waste discharges into the lagoon and coastal areas; reduced use of fertilisers; and increased controls/penalties for animal waste and septic seepages from communities and households. There is also a need to review and document traditional management and resource use mechanisms to complement enforcement mechanisms already in place and enhance compliance by community members.
- ii. Awareness workshops/materials and capacity building (on a consistent basis) is necessary particularly for marine resource and other resource users, landowners, tourism operators, resource owners and users and other stakeholders. Materials should be simple and easily translated to help men, women, and youths in communities. This task should be conducted by the relevant authorities with government investment into facilities/resources and technical expertise.
- iii. There is a need for review and support for pilot testing of water quality, monitoring for agricultural chemicals (pesticides), and analysis to determine if these are having a significant negative impact on the lagoon or reefs. Ground truth results and data through necessary socio-economic and biological assessments and environmental impact assessments.
- iv. Transparency and close collaborations between stakeholders are pivotal for addressing the existing environmental and socio-economic problems and to strengthen the use of R2R approaches in the policy, regulatory and institutional frameworks governing land and resource use in Palau. It is also important to acknowledge and use traditional institutions and leaders, who in most cases are women, to ensure closer collaborations and ensure that risks and problems are addressed.
- v. Tax incentives or disincentives on imported eco-tourism products, for example a rebate on environmentally friendly products (bicycles, solar systems, sewage systems, etc.) and/or higher taxes on environmentally harmful products (e.g., quad bikes that degrade remote areas).
- vi. Building laws/codes – there is perhaps a need for technical and administrative expertise on infrastructure and standardisation of building and construction laws/codes – for cyclone resistance and for minimising of wastewater and septic discharges into the environment.

Key Sectors Contributing to the Problem

Tourism is the most common sector contributing to all the six identified environmental problems i.e., marine source depletion, illegal fishing practices, biodiversity losses, ecosystem degradation, deterioration of water quality and solid and liquid waste management. This is followed by infrastructure and development sectors. Minor common contributing sectors to the problem include municipalities, agriculture, and the trade industry.

Linkage to other environmental problems

The environmental problems identified above also contributes to other arising matters faced by the members of the community daily. Listed below are some of the issues that are directly linked to the above-mentioned environmental problems.

- Decline in harvests due to dead coral, algal fouling, siltation, pollution, too many collectors, coral dredging, fewer species, oil from boats and lower water levels.
- Severe localised impacts on fresh water and soil loss by forest conversion for agriculture and unsustainable logging
- Exposure to pathogens in sewage and sludge
- Sanitation issues
- Degradation of water quality
- Nutrient input from sewage outfalls degrades reef systems by favouring algal growth and suspension feeding animals rather than corals

Geographical location of impacts

The most common geographical locations to be impacted by the six identified environmental problems are Aimeliik, Airai, Koror, Ngaraard, Ngardmau, Ngaremlengui and Ngatpang. Other locations impacted are Airai (North-state) and Ordomei.

Airai North state and Ordomei were affected by two out of the six environmental problems. The rest of the geographical locations are impacted by one of six of the identified environmental problems.

Relevant institutional legal factors

Policy and legislative frameworks and mechanisms relevant to Palau's environmental problems are outlined in Table 12, several important ones mentioned below:

- The Marine Protection Act focuses on the development of marine resources and fishery management.
- The Protected Area Network (PAN) Act looks after the respective states and focuses on the marine and terrestrial protected areas.
- The Environment Quality Protection Act focuses on the environment, biodiversity, and public water supply management.
- The Endangered Species Act focuses on the wild fauna and flora, management, and conservation of endangered species, building resilience to climate change and natural disasters, conservation of natural ecology and water conservation and responsible usage.

Moreover, the consideration of the inclusion of the Gender Policy when working with Environmental Legislations is highly suggested.

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ANNEX 1

List of environmental problems

Water systems	Exploitation of resources (living/non-living)	Global changes	Habitat and community modification	Pollution
Deterioration of water quality	Decline in commercial fish stocks	Coastal erosion	Habitat and biodiversity changes	Eutrophication
Changes in hydrological flow	Deforestation	Changes in hydrological cycles	Invasive species	Microbiological
Stress on ground and surface water resources	Deterioration of soil productivity	Increase in catastrophic events	Land degradation	Solid and liquid waste management
		Flooding	Ecosystem degradation (nearshore, terrestrial, surface water)	Suspended solids
		Sea level changes		

Criteria for prioritising environmental problems

Table 14: Criteria list for national prioritisation exercise

Criteria	Weighting (1 – 4)
Whole-of-island nature of a problem – geographical and temporal scale.	1 = no importance 2 = low importance 3 = moderate importance 4 = high importance
Future risk of the problem – (in 10 years)	1 = no importance 2 = low importance 3 = moderate importance 4 = high importance
Relationship with other environmental problems.	1 = no importance 2 = low importance 3 = moderate importance 4 = high importance
Expected multiple benefits that might be achieved by addressing a problem.	1 = no importance 2 = low importance 3 = moderate importance 4 = high importance
Progress in addressing this problem at the national level	1 = high progress 2 = moderate progress 3 = low progress 4 = no progress
Urgency of addressing this problem	1 = no urgency 2 = low urgency 3 = moderate urgency 4 = high urgency

Table 15: Criteria list for located priority site

Criteria	Rating	Weighting (1 – 4)	Score
Size of the affected area (as percentage of the total national land area)	1- < 10sq.km 2- 10 to 100sq.km 3- 100 to 1000sq.km 4- 1000 to 10,000sq.km 5- >10,000sq.km	1 = no importance 2 = low importance 3 = moderate importance 4 = high importance	
Affected population (as percentage of national population)	1- < 1000 2- 1000 to 10,000 3- 10,000 to 100,000 4- 100,000 to 500,000 5- >500,000		
Extent to which the natural catchment, aquifer or receiving coastal and marine waters support the livelihood of local communities (e.g., subsistence or commercial farming, forestry, mining, tourism, fisheries)	1- very low importance (<10%) 2- low importance (10-30%) 3- average importance (30-50%) 4- important (50-80%) 5- very important (>80%)		
Extent to which the natural catchment, aquifer or receiving coastal and marine waters support the national development (e.g., commercial farming, forestry, mining, tourism, fisheries)	1- very low importance (<10%) 2- low importance (10-30%) 3- average importance (30-50%) 4- important (50-80%) 5- very important (>80%)		
Extent to which the site is a recognized government priority (refer to National Sustainable Development Strategy, or other strategic action plans e.g., NEAPs)	1- no, not a priority 2- yes, low priority 3- yes, medium priority 4- yes, high priority 5- yes, very high priority		
Extent to which the site is of regional and/or global significance and priority (see WWF ecoregions, IUCN categories, UNESCO world heritage sites, etc.)	1- no, not a priority 2- yes, low priority 3- yes, medium priority 4- yes, high priority 5- yes, very high priority		
Degree of Degradation at the site (e.g., type of degradation)	1- very low 2- low 3- average 4- high 5- extremely high		
Extent of degradation on catchment and/or aquifer and any receiving coastal and marine resources and systems	1- very low 2- low 3- average 4- high 5- extremely high		

Criteria	Rating	Weighting (1 – 4)	Score
Cultural or traditional value of the site	1- very low 2- low 3- average 4- high 5- extremely high		
Extent of community management at the site	1- very low 2- low 3- average 4- high 5- extremely high		

Template for cause and impacts

Environmental Problem	Environmental Impacts and socio-economic consequences	Rank	Sector	Rank

Criteria for prioritising identified options for reform and action

Criteria	Rating	Weighting (1 – 4)	Score
Level of certainty that implementation will produce the expected/desired outcome		1 = no importance 2 = low importance 3 = moderate importance 4 = high importance	
Level of expected impact			
Feasibility of implementation			
Nationally appropriate approach			
Others			

ANNEX 2

3.1 Comprehensive Analysis of Capacity Constraints in Area of Biodiversity

Obligations	Capacity Constraints
<i>Effective National Biodiversity Planning</i>	<ul style="list-style-type: none"> ▪ Lack of understanding by decision makers that biodiversity protection should be a high-priority consideration for all legislation, not only environmental legislation. ▪ Weak/no comprehensive biodiversity policy and legislation, particularly in areas of biotechnology and biosafety. ▪ Weak framework for cooperation in matters related to biodiversity.
<i>In-situ and ex-situ conservation of biological diversity</i>	<ul style="list-style-type: none"> ▪ Lack of human resources capacity for biodiversity conservation and sustainable use. ▪ Low institutional capacity of public, NGO, CBO, PVO agencies for the conservation and sustainable use of biodiversity.
<i>Identification and Monitoring of components of biological diversity</i>	<ul style="list-style-type: none"> ▪ General lack of, or weak capacity for, assessment, identification and monitoring of components of biodiversity. ▪ No comprehensive standardized baseline data, criteria and indicators so biodiversity can be measured and monitored. ▪ Lack of a biodiversity assessment and monitoring program and systems. ▪ General lack of taxonomic expertise at the national level for biodiversity characterization, conservation and sustainable use.
<i>Economically and socially sound incentive measures</i>	<ul style="list-style-type: none"> ▪ No explicit strategy, policy or program on incentive measures for biodiversity conservation and sustainable use.

	<ul style="list-style-type: none"> ▪ Some existing policies act as perverse incentives. ▪ Lack of a national incentive program to induce compliance. ▪ No capacity development / building in incentive measures.
<i>Scientific and technical research and training</i>	<ul style="list-style-type: none"> ▪ Lack of data in the structure and function of ecosystems. ▪ Lack of relevant socio – economic and policy planning capacity and data. ▪ Lack of human resources, resulting in a lack of technical expertise necessary to carry out activities prioritized in the NBSAP.
<i>Promotion and encouragement of understanding of the importance of biodiversity</i>	<ul style="list-style-type: none"> ▪ Lack of effective enforcement of the laws especially with regards to wildlife and poor understanding of biodiversity conservation and sustainable use issues and practices. ▪ Inadequate environmental education campaign efforts. ▪ No / little biodiversity teaching in schools.
<i>Implement the Cartagena Protocol on Biosafety</i>	<ul style="list-style-type: none"> ▪ Poor capacity in biotechnology as well as poor awareness of the impact of products of biotechnology on human health and the environment. ▪ No comprehensive legislative and policy framework to guide the use of biotechnology in the country. ▪ No national institutional structure to regulate and monitor the use of biotechnology and biosafety issues.
<i>Control of Alien Invasive Species</i>	<ul style="list-style-type: none"> ▪ Poor understanding and information on status of invasive alien species and their impact on biodiversity as well as the methods to eradicate them. ▪ Lack of a comprehensive legal and legislative framework on invasive alien species including non- enforcement of existing laws.
<i>Promotion of access and benefit sharing</i>	<ul style="list-style-type: none"> ▪ No legislative policy or administrative measures to facilitate ABS in the use of genetic resources as well as lack of ABS negotiation skills. ▪ Lack of national capacity to implement a regulatory regime on ABS.
<i>General Implementation</i>	<ul style="list-style-type: none"> ▪ No national body charged with coordinating the NBSAP to ensure that all aspects of the plan are being addressed and that minimizes the duplication of effort. ▪ Lack of adequate financial assistance.

3.2 Capacity Constraints in Area of Climate Change

As for the specifics in the area of climate change, Palau's constraints are reflected in the following table. Constraints listed may be relevant to more than one objective.

Objective	Constraint
<i>Address rising sea level problems</i>	<ul style="list-style-type: none"> • Need for sea level rise measurements. • Lack of human resources. • Lack of financial resources. • Lack of vulnerability studies for coastal infrastructure.
<i>Address coral bleaching problems</i>	<ul style="list-style-type: none"> • No policy on coral reef protection.
<i>Prevent flooding and landslides from storms</i>	<ul style="list-style-type: none"> • Lack of hazard planning and implementation of strategies for flooding and landslides.
<i>Promote energy efficiency</i>	<ul style="list-style-type: none"> • Lack of funding to construct or remodel structures to be energy efficient. • No building codes to incorporate energy efficiency or structural strength. • Lack incentives to develop alternative energy systems; • Lack of incentives to construct energy efficient structures; • Inadequate energy policy regulations.
<i>Prepare for problems associated with drought</i>	<ul style="list-style-type: none"> • Lack of funding to improve water distribution and storage. • Lack of data regarding uncontrolled fires. • No forestry policy or regulations. • Lack of capacity and equipment for firefighting.
<i>Adapt to a warmer ocean</i>	<ul style="list-style-type: none"> • Lack of capacity to analyze real time meteorological data.
<i>Raise awareness of climate change issues and prevention strategies</i>	<ul style="list-style-type: none"> • Lack of financial and technical resources to address the sector implementation and community-based assistance needed to mitigate and/or adapt to the impacts of climate change. • No clearly defined implementation focal point.
<i>Address spread of invasive species</i>	<ul style="list-style-type: none"> • Need for vulnerability studies of vector born diseases. • Inability to protect against the introduction of new invasive species and to mitigate the effects of invasive species already present; • Vulnerability to vector born diseases.
<i>Promote adaptive technologies and planning</i>	<ul style="list-style-type: none"> • Lack of or failure to implement land use plans. • Lack of forestry policy and regulations.

	<ul style="list-style-type: none"> • Lack of land use plans or implementation of existing plans • No national capacity for urban planning.
<i>Prepare for the loss of coastlines</i>	<ul style="list-style-type: none"> • Need for vulnerability studies for coastal infrastructure.
<i>General Implementation</i>	<ul style="list-style-type: none"> • No national body charged with coordinating implementation efforts. • Lack of capacity to measure green house gas emissions. • Lack of capacity to analyze real time meteorological data.

3.3 Capacity Constraints in Area of Land Degradation

The problems of land degradation present additional challenges. The following table sets out some of those challenges and the constraints Palau faces. As with the constraints noted in earlier sections of this Report, listed constraints may be relevant to more than one action step.

Action Steps	Constraints
<i>Provide enabling conditions for prevention of land degradation</i>	<ul style="list-style-type: none"> • Need for education of legislators, community development officers, and general public. • No national body charged with coordinating implementation efforts. • Land tenure (ownership) issues. • Lack of comprehensive legislative framework for land degradation issues.
<i>Establish land degradation inventory and conduct regular monitoring</i>	<ul style="list-style-type: none"> • No national land degradation policy. • Various government offices, agencies and NGO's are beginning to gather data on one or more aspects of land degradation, but more comprehensive data needs to be collected and then shared with others the environmental field. • Frequent landslides and resulting soil erosion along the Compact Road. • Increased secondary road construction in Babeldaob, frequently resulting in soil erosion and watershed degradation. • Limited capacity to conduct land degradation mapping and monitoring. • Lack of equipment for soil testing.
<i>Promote agroforestry</i>	<ul style="list-style-type: none"> • No forestry management act.

	<ul style="list-style-type: none"> • No trained foresters. • No money for training of foresters. • Need to identify appropriate regulatory agency and have it issue needed regulations. • Lack of forestry policy and regulations. • Lack of agroforestry promotion. • Lack of capacity and equipment for firefighting.
<i>Monitor and mitigate impact of drought</i>	<ul style="list-style-type: none"> • Need to identify appropriate regulatory agency. • Need government policy and mandate. • Need money to monitor and conduct mitigation activities, once identified. • Need human resources – experts and/or persons with some background in this area.
<i>Prevent land degradation</i>	<ul style="list-style-type: none"> • Need to identify and/or train experts. • Experts need to educate the public. • Experts need to educate planners of government and private sector construction efforts to anticipate and prevent degradation issues such as runoff and erosion. • Need money to conduct individual and community education efforts. • No one mapping locations of forest and agricultural fires, which data could be used in a Geographic Information System to prevent future fires through better planning, runoff prevention and erosion control. • Lack of agricultural policies, regulations, guidelines and permitting processes.
<i>Rehabilitate degraded land</i>	<ul style="list-style-type: none"> • No technical expertise. Need experts. • No equipment to test soil. • Need money. • Need to plan to rehabilitate entire ecosystems. • Need to educate the public of linkages to health. • No guidelines or assistance programs for rehabilitation of degraded land.
<i>Improve the water delivery system and promote water conservation</i>	<ul style="list-style-type: none"> • Need engineers. • Need money to upgrade water system. • Need a just water billing system. • Need to educate the public.
<i>Monitor and evaluate climatic variations</i>	<ul style="list-style-type: none"> • Limited capacity to analyze climate data within Palau. • Need for guidelines and permits prior to development, whether commercial, residential or agricultural.
<i>Empower local communities and institutions</i>	<ul style="list-style-type: none"> • States fail to put landscaping conditions on use of public leases. • Landscaping services not available in Palau. • Institutions, like USDA and banks, fail to put

ANNEX 3

Table 1 – Generic Environmental Impacts of Infrastructure

Activities associated with construction and operation of infrastructure	Potential environmental impact (if unmitigated)
Aggregate and other materials extraction	Removal of beach gravels removes shoreline protection, changes littoral drift & accelerates erosion Removal of corals damages reef and depletes marine resources Extraction of river gravels from the beds or active channels of rivers changes hydrology Extraction from quarries or borrow pits leaves unusable land, exposed water table
Works in, or adjacent to, rivers and streams and in the vicinity of the coast	Effects on river structure including: - Changes to river water flows, including levels and velocity - Changes to channel depth, structure & location resulting from excavations, embedding new structures - Changes to riverbanks caused by destabilization (through equipment and traffic) - Damage to floodplain areas within meandering river systems affecting flood cycles, temporary flood storage, release of flood waters and loss of soil fertility through loss of flood silt Increased turbidity of river waters due to gravel extraction and bridge construction Increased siltation Construction materials are washed out into rivers and other areas
Run-off, discharges, generation of liquid wastes	Increased siltation, construction materials washed out into rivers, water bodies, or coast Potential contamination of water supply sources incl. groundwater Coral reefs are affected by increased turbidity and sedimentation (from rivers)
Encroachment and/or disturbance of marine and terrestrial habitats	Impacts on fisheries Direct impacts on coastal ecosystems including; coral reefs, coastal wetlands, mangroves, intertidal areas, seagrass beds, and rocky coasts Runoff and rivers carry turbid waters to coral reefs offshore Terrestrial habitats become more fragmented Loss of primary forests Endemic, rare or endangered species affected Workers poach animals Interference with migration patterns of certain species Protected areas affected

