Disaster Risk Reduction in Papua New Guinea

Status Report 2019

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About this report

The Disaster Risk Reduction (DRR) report provides a snapshot of the latest DRR progress Papua New Guinea (PNG) has achieved under the four priorities of the Sendai Framework. It also highlights some of the key challenges surrounding the issue of creating coherence among the key global frameworks at the country level; and makes recommendations for strengthening the overall Disaster Risk Management (DRM) governance by government institutions and other stakeholders at national, sub-national, and local levels.

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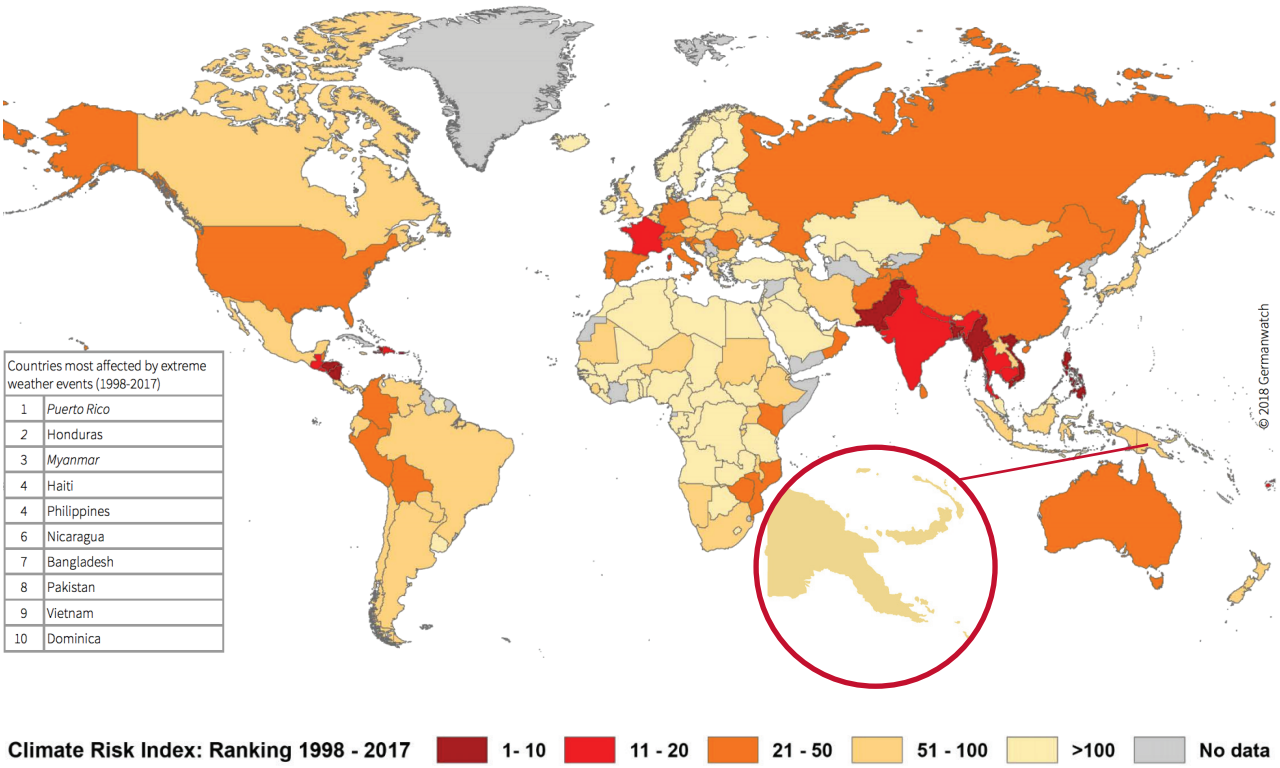
The findings, interpretations, and conclusions expressed in this document do not necessarily reflect the views of UNDRR or of the United Nations Secretariat, partners, and governments, and are based on the inputs received during consultative meetings, individual interviews, and the literature reviews conducted by the research team. While every effort has been made to ensure the accuracy of the information, the document remains open for any corrections in facts, figures and visuals.

UNDRR (2019). Disaster Risk Reduction in Papua New Guinea: Status Report 2019. Bangkok, Thailand, United Nations Office for Disaster Risk Reduction (UNDRR), Regional Office for Asia and the Pacific



(GermanWatch,2019)

POPULATION 2015	
Total Population	6,492,400
Urban Population	494,252 (32.9 %)
Population Density Per Km^2	27
ECONOMIC INDICATORS 2018	
Gross Domestic Product in Current $US	16.8 billion
GDP Per Capita ($US)	2457
GDP Growth (Annual %)	7.7%
HUMAN DEVELOPMENT	
Human Development Index	0.601
HDI Rank	139
Income Level Category	Lower-Middle income

(World Bank, 2019; National Statistics Office, 2016; UNDP, 2019)

Climate Risk Index

Rank 95 / Low Risk*

INFORM Risk Index

Rank 27 / High Risk**

* Climate Risk Index of 2019 analyses the extent to which countries have been affected by weather-related losses between 1998-2017 (GermanWatch, 2019). However, it should be noted that the CRI may not provide an accurate presentation of the future risk due to the fact that it measures data of past events (which may not always be available depending on the country). Thus, for example in the case of Papua New Guinea, low CRI score does not accurately indicate low climate risk in the future.

** INFORM risk index is a global tool which measures the risk of humanitarian crises and disasters based on 50 indicators assessing hazards, vulnerability and capacity (resources available to mitigate the impact) (INFORM, 2019)

1. Introduction

Papua New Guinea is among the largest Pacific island states located in Oceania, covering an area of 462,840 km^2. The country also occupies the eastern half of the island of New Guinea, four additional islands, and encompasses over 600 small islets and atolls. Many of these islands are of volcanic origin, thus being relatively young in geological terms. The geography is characterized by vast valleys and mountain ranges, tropical forests, open plains and coastal ecosystem (CFE-DM, 2019). As a result of this ecological variety, PNG is a home to 7 percent of the world's biodiversity (CEPA, 2018), and most of the landmass is covered by dense forests which are classified among the three largest tropical forests in the world (WWF, 2019). Administratively, the country is divided into four regions and 22 provinces, which are further divided into 87 districts. Additionally, it should be noted that the four main regions are based on geographical divide of the country – the Highlands, Islands, Momase and Southern Regions.

Due to the diversity and availability of natural resources, including oil, gas and minerals, the country's economy has been on an ascending trend as the global demand has grown. Since the early 2000's, the growth of Gross Domestic Product (GDP) per capita has averaged 4 percent, despite export revenues fluctuating depending on the global commodity prices (World Bank, 2019). As of 2014, the key industries driving the growth were agriculture, forestry & fishing (18.8%), mining & quarrying (26.1%) as well as wholesale & retail trade (11%) (figure 1). It is also worth noting that since the beginning of the production of Liquefied Natural Gas in 2014, industrial sectors experienced a boost of 322.6% (National Statistics Office, 2016). Timber has also supported the development; approximately 72.6% of the land mass is covered by primary or naturally regenerating forests, which produced about 4.1 million m^3 of wood for the markets in 2017 (ETTF, 2018).

Despite the progress, challenges remain. The government has acknowledged that efforts and investments directed towards maintaining infrastructure, improving service delivery across the geographically dispersed nation, and turning profit into wealth and prosperity for all in a sustainable manner must be given high priority to guarantee that the development goal of ranking among the top 50 countries in the world on the Human Development Index (HDI) by mid-century will be achieved (Department of Treasury, 2017). Simultaneously, climate change, increasing risks of disasters, flooding and environmental degradation require increasing investments, human capita and planning to mitigate the potential climate change and disaster impacts in the future.

Located in the active Pacific Ring of Fire, PNG is ranked among the most disaster-prone countries due to the geophysical conditions (National Disaster Centre, 2017). Natural hazards, including earthquakes, tsunamis, volcanic activity, cyclones, flooding, landslides and droughts are contributing to the risks; PNG ranks highest in terms of population exposed to severe volcanic risk, and is among the top six countries for the highest percentage of population exposed to earthquakes (GFDRR, 2016). On the INFORM risk index of 2019, PNG has a high-risk ranking (5.6), with lack of coping capacity highlighted as the leading contributor to disaster risks (INFORM, 2019). Adding to the challenges, the intensity of hydrometeorological hazards is projected to grow more severe as a result of climate change.

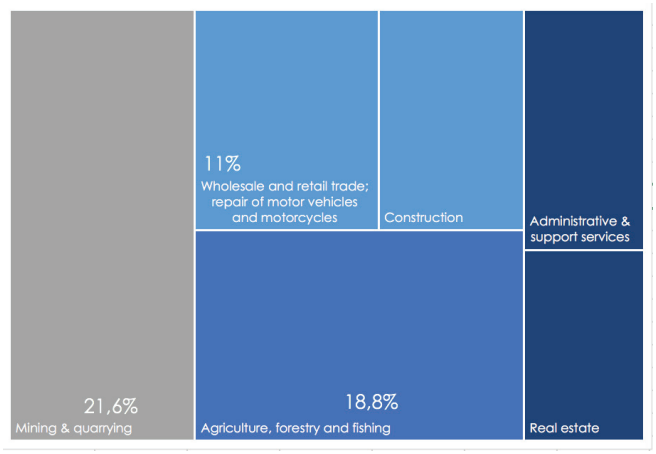


Figure 1. The share of largest contributing industries to the GDP of PNG (National Statistics Office, 2016).

1.1 Demographic Characteristics

According to the Population Census of 2011, the population of Papua New Guinea had reached 7,275,324 people, an increase of 40% since the 2000 census (National Statistical Office, 2011). At the time, approximately 39% of the population lived in the Highlands region, followed by the Momase region with 26% (National Statistical Office, 2011). However, the urbanization rate of PNG has been relatively low at an estimated 13%, and a great majority of the population lives in the rural regions, despite the global urbanization trend (UN-HABITAT, 2010).

The population is also among the most diverse in the world largely due to the mountainous topography and relative isolation of islands which have historically kept communities separate. Over 800 distinct languages are still spoken in the country among various ethnic groups (CFE-DM, 2019). The same dispersed geographical context translates into high costs of logistic and supply management for the government. As a result of remoteness, many face troubles in accessing basic services, including health, education, sanitation and safe water in the rural regions lacking connectivity and infrastructure (UNFPA, 2018), which further impair the process towards sustainable and resilient growth.

To address these issues and to guarantee human-centric development, the National Population Policy (NPP) 2015-2024 has been developed to also ensure that the demographic transition is managed in a sustainable manner (Department of National Planning and Monitoring, 2015). Moreover, the country is set to benefit from a demographic dividend, where the ratio of working age populations greatly exceeds the dependent groups, but only if adequate investments made in health sector, education and job creation for the youth. If managed appropriately, PNG could experience a significant boost in its economy as a result of the dividend. However, given the constraints of remoteness limiting the service delivery for the growing population and their increasing need for services, significant funding and capacity-related obstacles lie ahead (Department of National Planning and Monitoring, 2015).

1.2 Economic Impact of Disasters

Papua New Guinea is rich in natural resources; mining, oil and gas are the cornerstones of the economy and large contributors to exports. Cash crop revenues from products such as cocoa and palm oil are important contributors to the agricultural production as well. However, due to the high prevalence of a plethora of hazards, the economy and the infrastructure are under a constant risk of being affected by disasters, especially now that the rate of development is increasing. For now, and despite the likelihood of hazards affecting the country being high during the past years (81.8% annually), the impact of disasters to the GDP has been minor; median average of the damage as a percentage of the GDP was 0.1% between 1980 and 2016 (Lee, et al., 2018). The overall probability for a severe disaster to materialize in PNG has been estimated to be low (figure 2). However, in the future, the economic implications of disasters may be dire due to the booming fossil fuel and mineral industries, which rely heavily on infrastructure and facilities, and may cause severe secondary hazards such as spills and conflagration.

In February 2018, a 7.5 magnitude earthquake had devastating impacts on the industry, causing damage to the production of liquefied natural gas (LNG) and mining activities in the highland areas, contraction of which also derailed the expansion of non-extractive economy(World Bank, 2019). It was estimated that the GDP slowed down from 2.8% in 2017 to 0.3% in 2018, and the output of oil and gas sector fell an estimated 15% (World Bank, 2019). While oil and gas leaks were avoided, it was stated that the temporal shutdown of industries would have severe impacts on the economy, especially due to extensive damage on the facilities and transport infrastructure which would take time to recover (McQuillan, 2018).

It has been estimated that an average of US$ 85 million annual losses occur as a result of earthquakes and tropical cyclones in PNG, and the country has a 50 percent chance of experiencing a loss exceeding US$ 700 million in the next 50 years (World Bank, 2011). Most of the losses and damages have been expected to take place in areas with high density of assets, including major crops and infrastructure due to high winds, landslides, flooding and seismic activity (World Bank, 2011).

The economic impacts of disasters to households must be acknowledged as well. With over 80 percent of the PNG's population residing in rural regions constrained by geographical isolation, forests and lack of infrastructure, subsistence agriculture, fishing and logging activities are important sources of livelihoods for many (CFE-DM, 2019). However, due to the vulnerability of crops to disasters and climate change, livelihoods of thousands, food security and wellbeing of the population may be impaired severely if the risks are left unmanaged. This would naturally affect the economy as well, which ultimately relies on a functioning, healthy society.

1.3 Social Impact of Disasters

The remoteness of the islands of PNG can create immense challenges for responding to disasters effectively, and lack of local infrastructure or delay in aid delivery may have long lasting impacts on communities in the aftermath of catastrophic events.

This became evident during the Kadovar volcanic eruption in January 2018, when the total population of the Kadovar island were forced to flee to the nearest island of

Rup Rup. The main local food sources on the evacuation site consisted of bananas, coconuts and fishing; however, they were expected to run out approximately in ten days and the fish stocks were likely to be disrupted by the eruption (Ronkentuo, 2018). Despite the East Sepik Provincial Administration dispatching food rations to the affected areas, it was feared that if the supply cannot be maintained, vulnerable groups may resort to negative coping mechanisms such as prostitution, stealing and fighting over scarce resources (Ronkentuo, 2018). Women were also reporting feelings of fear despite gender-based violence not being reported, especially when collecting water from the only well at the site. The social implications were rather unique given the complex setting; evacuees at the Rup Rup island had no hope of returning to their homes, lost their basic household items and had difficulties in accessing clean water and sanitation in the aftermath of the eruption (Ronkentuo, 2018). However, despite the fact that the total population were forced to abandon their homes, among them, women, children and elderly bore the most severe impacts.

Disasters have also resulted in collapse of subsistence food production at a large scale, which threatens human health and survival in PNG. For example, 13 drought events and 8 wide-spread floods resulted in eleven cases of severe food shortages between 1890 and 2009 (Cobon, et al., 2016). Future implications of these estimates are dire; as a result of climate change, the impacts of the weather systems are likely to grow severe, and thus have serious impact on agricultural productivity. In 2015-2016, El Niño-related drought affected about 40 percent of the population, with almost half a million impacted by food shortages (Kuleshov, et al., 2018). This endangers economic growth, human health and wellbeing, and compromises the government's development targets for the next century if the impacts are left unmitigated.

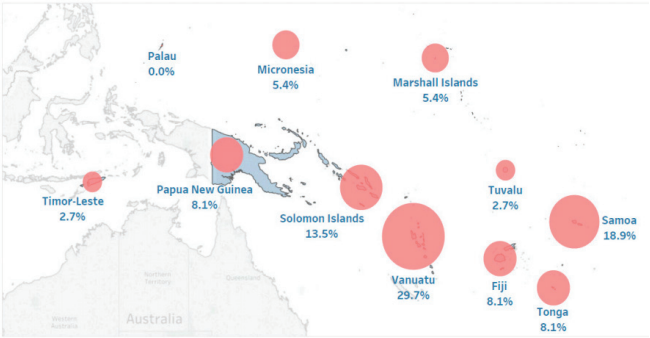


Figure 2. Probability of severe disasters to occur in the Pacific Island Countries (Lee, et al., 2018).

2. Disaster Risk Profile

2.1 Hazards and Climate Change

Papua New Guinea ranks 27th among 189 countries on the INFORM 2019 Index with a score of 5.6 (figure 2). Prevalent hazards include earthquakes, cyclones, storms, volcanic eruptions, riverine and coastal flooding, coastal erosion, epidemics, and droughts. There are 16 active volcanos in PNG, 6 of which are classified as high risk (ACAPS, 2018). Earthquakes are relatively frequent due to the complex fault systems of the Pacific Ring of Fire located in the region. However, exceptions include the Capital District, central

Highlands and the Western Province, which are among locations classified as stable as they are located on the Australian craton (Anton & Gibson, 2008). Still, the collision zone of the Pacific and India-Australia Plates in the East has a high risk of earthquakes to occur, as well as the Ontong Java Plateau subduction zone at the Bougainville-Solomon Trench, which is among the most seismically active regions in the country (Anton & Gibson, 2008). The current understanding of the present fault systems and seismic activity makes it possible to estimate the spatial variability of earthquake risks with a degree of reasonable confidence, but despite the earthquake monitoring, they still have the potential to cause widespread damage across the country. Also, in association with seismic activity, tsunamis are always a concern in PNG, although only three major tsunamis have occurred during the past thousand years (Davies, et al., 2018). However, this rarity of large-scale inundation could result to higher vulnerabilities when past events fade from common memory, and thus, people are less prepared for tsunamis to occur (Davies, et al., 2018).

Droughts occur frequently, often correlating with the El Niño Southern Oscillation. As a country highly reliant on fragile environment, and when over 80% of the population rely on subsistence agriculture, droughts have the potential to cause catastrophic damage due to worsened food security and lessened availability of water (UNDP, 2019). Also, most of the PNG's land area is classified as high risk for coastal and riverine flooding, especially during strong El Niña event, and potentially damaging or life-threatening floods are expected to occur on 10-year intervals (GFDRR, 2019). Between 1990 and 2015, floods have affected almost half a million people across the country (CRED, 2019).

Moreover, landslides in the past have caused large number of casualties and resulted in significant socio-economic impacts on communities (Robbins & Petterson, 2015). Associated with heavy precipitation and earthquakes, landslides and slope failures are common occurrence in the highlands and mountainous regions, with 61 percent of recorded medium-to-large scale events occurring when levels of regional precipitation are high (Robbins & Petterson, 2015). However, lack of baseline data makes landslide prediction difficult, and landslide recording has not yet reached an adequate level (Robbins, 2016). Due to the increasing development of infrastructure, and the increasing number of settlements and production in high risk areas, landslide prediction and mapping should be given high priority in the future (Robbins & Petterson, 2015).

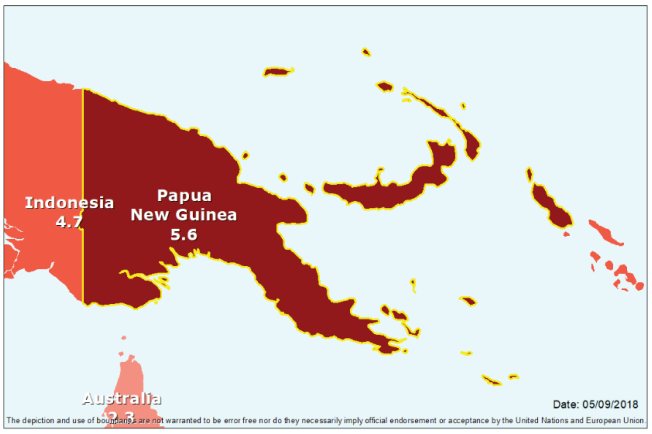
Cyclones and storms are also classified as potentially high-risk events in PNG, with a high chance of potentially damaging wind speeds to occur in the coastal regions (UNDP, 2019). However, the most intense tropical storms, measured on the Saffir-Simpson scale, occur near Bougainville and the Solomon Islands, indicating that the capital region is less prone to severe impacts of storms (OCHA, 2011). This is due to the proximity of the northern parts of PNG to the equator where tropical cyclones rarely occur (Australian AID, 2013).

By 2100, losses projected to follow cyclones are estimated to increase by 14.2%, and by 66.3% in the worst-case climate scenario (Australian AID, 2013). This would translate to average annual losses of US$ 24 million by mid-century (2010 dollars), only in terms of cyclone damage (Australian AID, 2013). Growing intensity of El Niña and El Niño events would also bring increased precipitation, followed by flooding, or conversely, severe droughts depending on the region. These impacts would affect not only the economic development and infrastructure, but would also endanger livelihoods of thousands, the ecological systems, water availability and nutrition.

However, it should be acknowledged that substantial differences exist in the spatial variability of future projected rainfall and extreme temperatures. This indicates that the social adaptive capacities of different communities create diverse vulnerabilities to climate change (Maina, et al., 2016). Hence, a general blanket-plan increasing the communities' resilience is not sufficient; due to the unique characteristics and dependencies of islands and their inhabitants, climate vulnerability must be assessed regionally and in consultation with the local communities.

Climate change and increasing intensity of storms are also likely to contribute to increased loss of biodiversity as a result of the effects of heavy rain, destructive winds, land degradation, ocean acidification among other impacts which affect the environment (and thus, the availability of resources). People living in isolated, insular environments exposed to extreme weather are likely to suffer the impacts due to subsistence livelihoods tied to the ecological systems, and greater considerations for alternative human-coping mechanisms should be given in the future to adequately assess the resilience strategies in the future (Goulding, et al., 2016).

Sea level rise is also a significant concern for an archipelagic nation, as it will likely lead to inundation of low-lying coastal areas, atoll islands, and the warming of the ocean is likely to decrease the number of reefs acting as coastal defenses (UNDP, 2019). Infrastructure, fisheries, forestry and agriculture sectors are likely to be severely affected, and the natural biodiversity of the ecological systems may be permanently damaged following forest and reef losses. Also, prevalence of vector-borne diseases, including malaria and dengue fever, it most likely to grow in hot and humid conditions which allow mosquitos thrive and breed for longer periods of time.



INFORM Risk	Value	Rank
Hazard & Exposure	5.6	27
Vulnerability	4.8	57
Lack of Coping Capacity	7.6	13

Figure 3. Papua New Guinea Risk Profile (INFORM , 2019)

2.2 Exposure

Large portions of PNGs population are exposed to disasters and climate change, risks of which are likely to grow more severe over time. Over 80 percent of the country's population is susceptible to climatic extremes related to the El Niño Southern Oscillation, over half a million people live in coastal villages exposed to sea-level rise, coastal degradation and storm surges, and the country is ranked among the top 6 countries in the Asia-Pacific of population exposed to earthquakes (UNDP, 2019). Over a million people are living in a vicinity of active volcanoes (in a range less than 30 kilometers) (ReliefWeb, 2014). Low connectivity, lack of infrastructure, high levels of poverty and spatial distribution of inequality in a geographically dispersed country adds on to the exposure-related risks (UNDP, 2019).

The INFORM Risk Index of 2019 identifies exposure to tsunamis, earthquakes and flooding as the highest contributors to hazard risks in PNG (INFORM , 2019). As briefly mentioned before, the northern parts of the country are disproportionately exposed to earthquakes due to the proximity of fault zones, and low-lying floodplains and the coastal regions are more exposed to flooding or storm surges. Saltwater intrusion also threatens the fresh water resources in areas where the aquifers or water sources are more exposed to the ocean.

Lack of, or poorly maintained infrastructure contributes to the increasing risks of disaster exposure, as limited access to safe water and sanitation are resulting in large numbers of diarrheal diseases and cholera in the country (Callander, 2017). Faeco-orally transmitted diseases tend to increase in correlation with high precipitation and flooding in areas where sanitation is lacking, and thus the exposure to diseases in the rural regions remains high.

2.3 Socio-economic Vulnerability

Self-reliance and low resilience of communities and households against climate and disaster impacts across the country create numerous vulnerabilities stemming from socio-economic factors. For example, flooding, earthquakes and volcanic eruptions usually result in large numbers of displaced people in a setting which is already troubled by conflicts between tribes. Simultaneously, food shortages and the lack of capacity to manage displacement, recovery and disaster mitigation efforts are likely to amplify disaster impacts for the poor, disabled, elderly, women (especially from marginalized ethnic groups) and children, who are more likely to suffer disproportionately due to inequalities in distribution of aid, gender-based violence and instability often arising in the aftermath of disasters.

An estimated 40% of the people live in poverty, and social inequality persist in the society; for example, rate of malnutrition is still high and gender-based violence is common (UNDP, 2019). Furthermore, the degradation of land and resources, habitat destruction and poor environmental governance as a result of unmanaged development and climate change are drivers of vulnerabilities in PNG, as losses of livelihoods dependent on available resources are pushing households further into poverty. The poor often have lessened capacity to cope, especially if they lack diversified income sources and access to credit, meaning that they are more likely to be severely affected by food instabilities, lack of adequate shelter and other after-effects of disasters. However,

vulnerability and poverty are significantly different depending on the different regions of the country; poverty rates range from low (14.8%) to very high (67.5% in Momase) (Jha & Dang, 2008).

Also, along with the large numbers of poor, 15.7% of the population are estimated to be vulnerable to poverty – indicating that external shocks may affect the population severely if livelihoods are affected (Jha & Dang, 2008). Thus, poverty reduction initiatives should also focus on prevention as well, instead of focusing on addressing the immediate needs (Jha & Dang, 2008).

Lack of healthcare facilities is also a significant concern, especially in the rural regions and in the aftermath of disasters when the needs for quality care are increasing. The majority of the population residing in the rural regions have no access to healthcare facilities, meaning that ill or injured patients may have to travel for over a day to see their community's respective health workers (who may not always be doctors) (Callander, 2017). Due to the lack of healthcare, accessibility and infrastructure, individuals with disabilities are also disproportionately vulnerable to disasters. There are nearly a million people in PNG living with some form of a disability or an impairment, only 2 percent of which receive some form of social support (CFE-DM, 2019). National Policy on Disability 2015-2025 aims to draw focus on the need to include considerations for disabled demographics in the planning sphere.

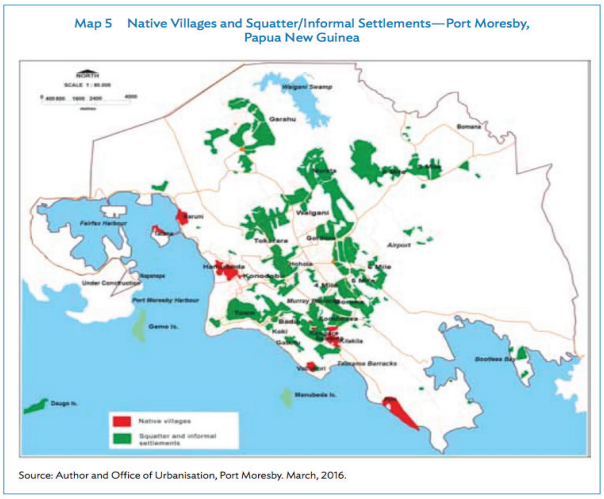


Figure 4 . Native villages (red) and informal settlements (green) in Port Moresby, Office of Urbanization quoted in ADB (2016).

2.4 Physical Vulnerability

In terms of physical vulnerability, the INFORM risk index highlights the quality of physical infrastructure as a significant contributor to lack of coping capacity in the country (INFORM , 2019). Indeed, rapid unplanned urbanization has created issues in the capital, Port Moresby. Migrants tend to gravitate towards urban regions due to larger number of services and opportunities, and as a result, urban informal settlements are growing in numbers, not only in PNG but across the Pacific (figure 4). Often lacking

infrastructure, these settlements are increasingly vulnerable to flooding, earthquakes (due to lack of seismic planning), urban fires and diseases which follow the absence of sanitation. These "village cities" also can cause conflicts due to the fact that the place-based development is largely tied to kinship, ethnicity, social organization, custom-based tenure and clan-groups (ADB, 2016), boundaries of which cannot be distinctly established in tightly-knit settlements.

Also, it should be mentioned that given the rapid rate of oil and gas development, the numbers of vulnerable infrastructure are increasing. For example, the newly established PNG-LNG liquefied natural gas pipeline running through the Southern Highlands, which could triple the country's export revenue by 2020 (UNDP, 2019), is not immune to effects of disasters. Earthquakes and landslides, for example, could cause large-scale disruption to the fossil fuel industry, which also endangers the environment and biodiversity due to the high potential of gas and oil leaks occurring due to damaged infrastructure.

2.5 Future of Disaster Risks in Papua New Guinea

According to future climate projections, the temperatures in Papua New Guinea continue to increase; by 2030, an estimated 0.4 to 1.0 °C increase is possible under a high emissions scenario (PNG National Weather Service, Australian Bureau of Meteorology & CSIRO, 2013). As a result, the number of hot days and warm nights is predicted to increase which may result in more severe droughts or flooding depending on the changes in regional rainfall patterns. Despite the relative certainty in estimations that extreme rainfall is likely to occur more often, future projections and models are inconsistent in PNG (PNG National Weather Service, Australian Bureau of Meteorology & CSIRO, 2013).

Furthermore, the sea level rise under a high emission scenario could reach 15 cm by 2030, indicating that the impacts of flooding and storm surges will be growing in intensity (PNG National Weather Service, Australian Bureau of Meteorology & CSIRO, 2013). This threatens not only the coastal infrastructure, but also the communities, industrial facilities and groundwater resources across the country. The biodiversity is under threat as well; the changes in regional rainfall, increased flooding and ocean acidification are compromising the fragile natural biodiversity, fish stocks, numerous species dependent on the rainforest's stability, not to mention humans sourcing their livelihoods from the environment. Also, the rate of rapid development indicates mounting vulnerabilities to disasters and climate change. Growing numbers of oil and gas production facilities, pipelines, mines, equipment and associated infrastructure (including roads and ports) are increasingly exposed to earthquakes, flooding and landslides. To adequately safeguard these assets and the environment from disaster damage, significant investment and planning should be dedicated to development to guarantee resilience and sustainability of systems in an inherently unstable setting. Growth of industry often correlates with environmental degradation as well, and the protection of the unique natural systems should be among the utmost priorities given the importance of PNG's rainforests as carbon sinks and habitats of numerous endangered species.

3. Disaster Risk Reduction and Climate Action Interventions

A range of hazards affecting Papua New Guinea result in challenges hindering the efforts to manage disaster and climate risks. Lack of resources, capacity, infrastructure, remoteness of islands and high prevalence of poverty contribute to the difficulties as well. However, PNG has invested increasing amount of attention and resources to protect development gains now, and in the future to guarantee that the development targets will be achieved by mid-century, despite the rapidly increasing pace of climate change. The following chapters explore the progress made so far under the Sendai Framework for Disaster Risk Reduction, Sustainable Development Goals and the Paris Climate Agreement, and establish some future priorities based on the findings of this report.

3.1 Sendai Framework for Disaster Risk Reduction

Priority 1. Understanding Disaster Risk. Recognizing challenges in developing individual Pacific Island Countries (PICs) risk profiles, the Pacific Catastrophe Risk Assessment and Financing Initiative (PCRAFI), jointly supported by World Bank, ADB and SPC/SOPAC has provided technical assistance to develop Pacific risk modelling and assessment tools for assessing earthquake and tropical cyclone risks, with detailed exposure information. The project has consolidated eight national databases developed for the Cook Islands, Fiji, Papua New Guinea, Samoa, Solomon Islands, Tonga, Tuvalu and Vanuatu into a regional database, hosted and maintained by the Applied Geoscience and Technology Division of SPC (UNDRR, 2012).

While the lack of a mechanism for baseline data collection is noted as a hindrance, risk assessments at sub-national scale are available with continued support by UNDP. In 2014, Comprehensive Hazard Profiles for all prevalent hazards in 5 highly vulnerable pilot provinces were developed, focusing on climate change-induced coastal and inland flooding in Wewak (East Sepik), Madang (Madang), Lae (Morobe), and Kimbe (West New Britain). The hazard maps aim to support decision making by identifying the present socio-economic and physical vulnerabilities of the communities or regions. (UNDP, 2014). Disaster risk assessment of Autonomous Region of Bougainville (AROB) was conducted in 2017 (UNDP, 2017).

A number of quantitative and qualitative situation analyses and sector-based reports do exist, which could be utilized for risk assessment purposes. These include the Draft 2018-2022 UNDAF document, the 2015 summary report for Papua New Guinea Millennium Development Goals, the 2016 Situational Analysis of Children's and Women's Rights in Papua New Guinea, the national Poverty Profile based on the 2009-2010 household income and expenditure survey (HIES), among other technical and health sector assessment reports (UNFPA, 2017). The Corporate Plan 2015-2019 of the National Statistics Office and the PNG strategy for the development of statistic policy 2017-2026 are considered as concrete steps in statistics management, applicable for DRM progress monitoring as well as disaster risk assessment. However, the authorities conducting risk assessments, data collection, monitoring and analysis are facing difficulties due to lack of technical and human capacity, especially in the remote islands.

Priority 2. Strengthening Disaster Risk Governance to Manage Disaster Risk. As mandated by the Disaster Management Act 1984, the National Disaster Centre (NDC) was established to act as the national focal point for DRM, under the Department of Provincial & Local Level Government Affairs. NDC is mandated to provide necessary and appropriate disaster management services with two divisions: 1) Risk Management, responsible for research, analysis, awareness raising, disaster education and training; and the 2) Community Government Liaison, which handles rapid response and operations (NDC, 2019).

During disasters, NDC advises the National Executive Council, an apex and decision-making body for DRM, on situations which require the declaration of state of emergency. NDC also advises, oversees and facilitates DRM planning at provincial level, assigns responsibilities for disaster-related activities to Departments and other bodies, coordinates departmental relief actions and collates national relief requirements. At provincial level, the Provincial Disaster Committee serves as a pivotal body for provincial DRM in charge of DRM functions and planning in respective jurisdiction. The committee comprises representatives from provincial police office, health office, engineering office, provincial affairs offices, NGOs and Co-opted members (NDC, 2019).

Attempts to enhance the profile of disaster risk governance in the country began in 2008 with DRM situation analysis conducted for PNG, followed by the UNDAC mission review of 2009. In 2010, the Disaster Risk Management (DRM) Mainstreaming Programme for Papua New Guinea (2010) - a package of support and technical assistance to strengthen DRM systems of PNG- was developed in accordance with the commitment by the Pacific Disaster Risk Management Partnership Network to assist Pacific island countries, including PNG on DRM mainstreaming. The document outlines focus areas for DRM priorities including strengthening DRM governance arrangements and capacity for key DRM agencies at national and provincial level, risk information for risk-informed development, and sectoral DRM mainstreaming. One of the important aspects is enhancing DRM interventions at provincial level, under decentralized government (NDC&UNDP, 2010).The National Disaster Risk Reduction and Disaster Risk Management Framework for Action 2005-2015 evolved from these efforts, aligned with the HFA.

The most up-to-date national plan - the National Disaster Risk Reduction Framework 2017-2030 (NDRRF) – aligned with the SFDRR and contributing to the SDGs, articulates country's seven agreed national targets to be achieved by 2030. In consideration of the country's international obligations and commitments, the framework is guided by guiding principles, with government-led DRR, and people-centric DRR by inclusive engagement and partnership, community empowerment, education and awareness and protections of human rights. The framework details out country's Priorities for Action grouped under the 4 Priorities of SFDRR and has dedicated sections to elaborate roles of stakeholders and international cooperation & partnership, as these are critical aspects that complement the government interventions to achieve tangible actions (NDC, 2017). Joint collaboration between NDC and IOM has been instrumental in providing technical support to develop provincial disaster risk management strategies, standard operating procedures and Community-Based Disaster Risk Management plans (IOM, 2019).

IMPLEMENTATION	POLICY	SCOPE	PURPOSE
NATIONAL EXECUTIVE COUNCIL, NATIONAL DISASTER CENTER	National Disaster Management Act 1984 (under review)	National, Provincial	Mandated the institutionalization of DRM at the national level and provincial levels (NDC and the PDCs)
NATIONAL DISASTER CENTER	National Disaster Mitigation Policy 2004	National, Provincial	Shifted the emphasis from responsive disaster management towards proactive preparedness and mitigation
NATIONAL DISASTER CENTER	PNG National Framework for Action 2005	National	High-level, all-encompassing strategic framework for DRM
NATIONAL DISASTER CENTER, PROVINCIAL DISASTER COMMITTEES	National Disaster Risk Management Plan (2012)	National, Provincial, Local	The first comprehensive document to lay out the DRM regulatory and legislative framework for all levels, including sub-national and local operators.
NATIONAL DISASTER CENTER	National Disaster Risk Reduction and Disaster Risk Management Framework for Action (2005-2015)	National, Provincial	Strategic DRM framework aligned with the mandates of Hyogo Framework for Action
NATIONAL DISASTER CENTER, RELEVANT STAKEHOLDERS	National Disaster Risk Management Framework for 2017-2030	National, Provincial, communities and other stakeholders	Joint initiative with the NDC and UNDP to ensure that immediate and long-term disaster risk management challenges are addressed, aligned with SFDRR

Table 1. National disaster and climate risk reduction policies, plans and legislation in PNG

Priority 3. Investing in Disaster Risk Reduction for Resilience. Investing in resilience with proactive disaster preparedness and mitigation measures have been well recognized. To support this, the government has allocated considerable amounts of financial resources towards proactive DRM planning and implementation (NDC, 2010). With UN's advocacy, DRM strategies were integrated in the DSP 2010-2030 and the MTDP 2011-2015, with a national budget allocation of US$33 million over five years (UNDAF, 2012). While there are notable initiatives to make disaster and climate risk investment imperative across the development domain, setting up secured funding from government budget remains a challenge hindering the DRR mainstreaming interventions across sectors.

However, DRR programs in PNG have continuously faced budget constraints, and are often supported by development partners including UNDAF and UNDP, under joint programs and projects under the Annual Budget Framework. To support PNG in accelerating MDGs achievement under the MTDP 2011-2015, the UNDAF 2012-2015 provided considerable financial resources to roll out UN-GoPNG jointly planned development programs under four outcomes areas: Governance for Equitable Development, Social Justice; Protection and Gender Equality; Access to Basic Services;

and Environment, Climate Change and Disaster Risk Management (UNDAF, 2012). The UNDAF 2018-2022 is a main funding mechanism to support PNG to achieve country's priorities under the SDGs, with one of Sub-Outcome aiming to achieve by 2022 empowerment of people, particularly marginalized and vulnerable, to manage climatic risks, develop community resilience and generate development opportunities from protection of land, forests and marine resources (UNDAF, 2017).

As PNG is by and large comprised of communities, most of which are characterized by remoteness, investing in community-led resilience building is highly important, especially to tackle vulnerable conditions of the people in terms of healthcare, education, access to transportation and basic facilities, water and sanitation and income generation. While local communities have skills to cope and adapt, which could be further build upon to enhance resilience, start-up resources are critical to realize people's full potential (Nema, 2017). Various development partners have focused their interventions at community level and support local actors in DRM such as Papua New Guinea: Integrated Water and Sustainable Energy (IWASE) Project supported by GIZ, and Community-Based Disaster Risk Management Plan by IOM.

In recognition of the financial challenges, attempts are underway to strengthen disaster and climate risk financing in the Pacific region (including PNG). The Pacific Catastrophe Risk Assessment and Financing Initiative (PCRAFI) - a disaster risk modeling and assessment tools, is adopted for designing appropriate risk financing options for PICs and to enable market-based financial solutions, with the Pacific Catastrophe Risk Insurance Company (PCRIC), a Pacific-owned insurance company to provide insurance products for earthquake and cyclone to its member countries, with potential to expand the coverage to rural areas and volcanic risk (World Bank, 2018).

Priority 4. Enhancing disaster preparedness for effective response to "Build Back Better" in recovery, rehabilitation and reconstruction. For emergency management, the National Disaster Center is the national leading agency, while Provincial Disaster Committees function as the operational bodies responsible for preparing emergency relief plans and coordinating relief operations. To complement the government system, the UN cluster system is established to co-lead response and humanitarian assistance with the government counterparts across 10 sectors. With emerging challenges that arose in coordination and communication during the El Niño response in 2016, the Highlands Humanitarian Hub (HHH) was formed exclusively for coordination mechanism in the Highlands region with a particular focus on food-security issues and later on expanded its scope of operation to all key emergency clusters. HHH is a multi-stakeholder body, comprising Provincial Disaster Coordination Committees, NGOs, Churches, the Red Cross, and other multilateral organizations (HAG, 2018).

Improving early warning system for floods, especially in highly affected areas of Papua New Guinea's North Coast and Island regions is considered crucial. However, adequate EWS capacity, technology and mechanism for warning dissemination are inadequate. Supported by UNDP PNG, the project on "Early Warning System for Inland and Coastal Flooding" in 5 provinces has been carried out in collaboration with the Office of Climate Change and Development (OCCD) to conduct comprehensive mapping and analysis of existing EWSs and emergency communication networks for inland and coastal flooding, and hence informing the establishment of effective systems, mechanisms and procedures (UNDPPNG, 2015).

In 2018, flood monitoring and early warning system piloted in Bumbu River, Morobe Province was established, which is a notable outcome of joint collaborative work of UNDP, New Zealand's National Institute of Water and Atmospheric Research (NIWA) and the Government of Papua New Guinea (National Disaster Centre, the National Weather Service and the Morobe Provincial Disaster Centre). It is a significant milestone in early warning in PNG to be replicated in other major river systems (UNDP, 2018). Work is also in progress to develop a sub-regional early warning hub in PNG, as proposed by PNG at the second Regional Integrated Multi-Hazard Early Warning System (Rimes). Under this initiative, the hub will generate weather monitoring information, climate and weather forecasts, as well as climate risk analyses for the Pacific countries, which will benefit PNG, especially the PNG Weather Service (PNGNWS) by contributing to the country's early warning systems (The National, 2017).

For post-disaster recovery, the government-led inter-agency rapid assessment is in place, using Papua New Guinea Standardized Multi-Sectoral Rapid Needs Assessment Tool developed by NDC, to conduct immediate assessments mission and submit reports. However, coordination among multi-tier DRM structures and between the government and other stakeholders in response and recovery remain inadequate.

4. Coherence with Sustainable Development Goals & the Paris Climate Agreement

The interlinkages of climate change and development manifest in the country's planning instruments reaffirming the commitments towards addressing climate risk and challenges. Since 2005, PNG emerged as an active party in the global negotiation for Reducing Emissions from Deforestation and forest Degradation (REDD+) and introduced the concept of reduced emissions from deforestation to the UNFCCC33. With abundant natural resources, PNG has become a global lead to vigorously adopt and promote combating climate change with REDD+ and measures to activate carbon abatement opportunities offered by preserving tropical forests.

Formulation of the National Climate Compatible Development Management Policy (NCCDMP) 2014, has been aligned with the Vision 2050 - a long term strategy for advancing sustainable prosperity of the country. With a strong focus on environmental sustainability and climate change, the Vision 2050 outlines Climate-Compatible Development Strategies, comprising key policy areas for climate change mitigation and adaptation and framework for monitoring and evaluation, which resulted in the development of the NCCDMP to achieve Carbon Neutrality by 2050 (CFE-DM, 2019). The policy is also aligned with the Framework for Resilient Development in the Pacific 2017-2030 (FRDP), which underscores a holistic approach for disaster and climate risk, vulnerability reduction, and resilient development in the Pacific to improve and maintain human well-being (Pacific Islands Forum Secretariat & IFRC, 2018).

Constrained by limited resources, disaster and climate risks in PNG have further complicated development issues that have to be tackled in unison. Country's development

strategies including Papua New Guinea Development Strategic plan 2010-2030 have inclusively incorporated disaster and climate as cross-cutting issue in development policies. Disaster and climate risk are given due consideration in translating global development agenda into implementation in country context. Further to the experience from the MDGs implementation with mixed outcomes, PNG has adopted the SDGs with success, starting since 2017 by conducting ground work to localize the SDGs, facilitated by UNFPA and the Department of National Planning and Monitoring (DNPM) as lead agency. SDG linkages to the National Strategies – i.e. Vision 2050, the National strategy for Responsible Sustainable Development (StaRS) have been established with customized SDG indicators for supporting the country's progress tracking system, and further the Road Map of the SDG integration (UNFPA, 2017).

Sectoral Aim	Policies with Linkages to Sendai Framework for Disaster Risk Reduction	Policies with Linkages to Sustainable Development Goals	Policies with Linkages to the Paris Climate Agreement or Environment
National Development	National Disaster Risk Reduction Framework (2017-2030)	Vision 2050 (40-year economic development strategy) PNG Development Strategic Plan (2010-2030) National Strategy for Responsible Sustainable Development	National Climate Compatible Development Management Policy 2014 Medium Term Development Plan 2016-2017
Environmental Protection	Forestry Strategy (up to 2020)	Decree on Environmental and Social Impact Assessment (revised in 2015) Environment Act 2000	National REDD+ Strategy of PNG 2017-2027 Environmentally Sustainable Economic Growth Policy, 2009
Disaster and Climate Risk Reduction	El Niño Response Plan 2016 Papua New Guinea Preparedness Operational Logistics Contingency Plan	Physical Planning Act 1989 National Strategy for Responsible Sustainable Development	PNG Climate-Compatible Development strategy 2014 Forestry and Climate Change Framework for Action 2009-2015
Vulnerability Reduction	National Disaster Risk Reduction Framework (2017-2030) National Disaster Mitigation Policy (2004)	National Food Security Policy (2016-2025) National Policy on Disability 2015-2025 Child Protection Act (2009)	Climate Change Management Act 2015
Urban Development	National Capital District Urban Development Plan 2006 Port Moresby Urban Development Plan (on-going)	National Urbanization Policy National Capital District Urban Development Plan 2006	United Nations Paris Agreement Implementation Act 2016

Table 2. Synergies between the national policies, plans and frameworks by sector

5. Issues in Implementation of the DRR and Climate Policy

DRM system in PNG has been continuously affected by limited resources and capacity to operate from the national to sub-national level. From 2006-2012, the NDC has worked with limited budget of $1.3 million annually, and before that, less than $500,000 (NDC, 2016). At the sub-national level, some Provincial Disaster Committees suffer from lack of resources as well, and most are heavily indebted (Chamberlain, 2019). Thus, due to increasing impacts of changing climate and disaster events, financial loss and recovery costs often exceed the government budget (WorldBank, 2018). Vertical coordination is challenged by the country's unique geographical dispersion, and the government units sometimes lack standard coordination mechanisms. While national DRM plan is available, it is neither widely circulated, nor backed-up by legal framework, hence making country DRM largely relief and response oriented (NDC, 2017).

As disaster risk in PNG is exacerbated by climate-induced factors, there is a need to upscale country's interventions towards a more proactive, robust and sustainable options. Investment in disaster resilient infrastructures and building back better in recovery should be highlighted. Furthermore, exploring long term strategies for relocating displaced populations, enhancing climate monitoring, forecasting capacity and dissemination of early warnings are among key priorities for the country to pursue. Country DRM is still heavily dependent on development partners in terms of technical assistance and funding support.

Hence, concrete interventions for strengthening NDC and sub-national DRM agencies are crucial to ensure that internal DRM capacity is developed and retained within the government machineries with sufficient resource mobilization. Thus, a more holistic approach to address strategic, administrative, managerial and financial aspects of NDC and DRM systems as a whole has to be tactfully formulated and implemented.

6. Stakeholder Analysis

Given the limited local resources and capacity, stakeholder contribution has played an important role in managing disasters and climate risks in Papua New Guinea. The country has received extensive support and long-term contributions from the Secretariat of the Pacific Community's Applied Geoscience and Technology Division (SPC/SOPAC), serving as Pacific regional center that supports DRM initiatives to increase collective regional efforts, as well as individual countries in the Pacific, including PNG. The Secretariat has worked in partnership with various development partners and donors such as USAID, DFAT, European Union, GIZ, UNDP, ADB, World Bank, JICA, and the Pacific Financial Technical Assistance Centre (PFTAC), on different projects and programs, including an open access geospatial data repository for the Pacific Region or PacGeo. The Secretariat also supports the Pacific Island countries in global negotiation including finance issues at the UNFCCC COP (Pacific Islands Forum Secretariat & IFRC, 2018). Additionally, IFRC works with several INGO's, local NGO's, church groups, UN agencies, and government bodies on aid delivery.

UNDP PNG has been instrumental in providing continued technical assistance to the government of PNG and NDC for strengthening DRM systems in terms of developing risk profiles, as well as in mainstreaming DRR, and formulation of DRM plans at national and provincial level. Other active stakeholders include IOM supporting Provincial DRM, CBDRM, and safe housing reconstruction, FAO working in agricultural sector recovery, WFP in distribution of food items for relief and the UNFPA in population development and localization of SDGs.

Secretariat of the Pacific Regional Environment Programme (SPREP), accredited as a Regional Implementing Entity for the Adaptation Fund and the Green Climate Fund (GCF), has supported fund management for climate change adaptation initiatives in the Pacific region (SPREP, 2016). Recently, technical assistance is provided by SPREP to implement the Inform Project, under the Green Environmental Facilities (GEF) to strengthen system management capacity of concerned agencies and to create a regional and national data portals in 14 countries, to enhance the use of environmental data for monitoring the state of the environment (SPREP, 2018).

With regard to emergency response, the Australian Government was the largest donor providing approximate AUD$ 8 million (or $7,984,174) from 2015-2017 for the 2015 El Niño drought and frosts response. The fund supported the work of INGOs such as CARE, Oxfam and World Vision on ASH, public health, agricultural recovery and resilience building activities. The emergency funding was also allocated to local responders under the Church Partnership Program. To ensure effective emergency management, broad contingency plans for assessing and responding to the human impacts of future slow onset disasters and large-scale multi-faceted response in PNG is being developed by DFA (Government of Australia, 2017). The Australian Government is also a major donor to support climate change programs in PNG with estimated funding of AUD$ 115 million in 2015-2018 (CFE-DM, 2019). Exxon Mobile and Oil Search - private companies operating in 2018 earthquake affected areas have been involved in rapid assessments and emergency response as well.

7. Future Priorities

7.1 Challenges

Given the complex setting, multiple challenges persist in managing disaster and climate risks effectively. Among them, remoteness, lack of connectivity, lack of healthcare personnel and facilities is limiting rapid response in the islands. Inadequate funds, insufficient human capacity and lack of detailed risk-information, especially at the sub-national levels, contribute to the issues when it comes to implementing policies and plans and understanding risks which are required to improve proactive risk management and response.

Managing trade-offs between development and sustainability must be carefully managed as well, and not only in Papua New Guinea, but globally. Rapid economic development and associated construction boom may cause environmental degradation, and the mining, gas and oil industry growing in a high-risk setting is likely to contribute to disaster threats in the future. Sustainable planning and management of economic

development require increasing amount of investment and resources, and the resilience of systems should be guaranteed before climate change and disaster impacts begin to materialize. Related to this, encroachment of natural spaces and land clearing, accounting for 46 per cent of deforestation, has resulted in forced displacement in the past. Issues related to the internally displaced are likely to be emphasized in the future due to impact of sea level rise on coastal communities, and as the costs of resettlement rise (Department of National Planning and Monitoring, 2010). Interface of socio-economic, environment and human induced factors, with natural hazards have to be addressed in a more holistic manner, with durable solutions that offer new opportunities for community-based development and interventions.

7.2 Priority Areas of Work

Systematic data collection, analysis, and management is required for risk analyses, situational assessments, projection of future scenarios and planning for effective DRR and CR measures. However, the current systems for data collection and management are fragile and inconsistent, and climate information is being gathered on a project-to-project basis (UNDP, UNEP & GEF, 2016). Establishing central repository for climate related information and vulnerabilities and developing model for data analysis based on technically robust methodology, as well as creating a pool of trained human resources will be a crucial for risk-informed DRR and development interventions. However, to adequately manage the data at all levels, capacity strengthening is required for the relevant stakeholders especially at the sub-national levels. Increasing the availability of data is also important for informing the process of prioritizing investments for the private sector and public planners.

Further localization is required not only to improve data collection and monitoring, but also to increase the capacity of local actors and operators to effectively respond and recover in the aftermath of disasters. They also have an important role in disaster preparedness and climate action given their local contextual knowledge which can be immensely helpful to the national level planners and disaster management authorities. Especially in PNG, a country characterized by remoteness, improving the ability of local communities to effectively manage response and recovery through resilience and capacity building should be emphasized in the future. Also, investing in community-led resilience building is highly important. While local communities have skills to cope and adapt, the existing strengths could be further enhanced (Nema, 2017).

Additionally, improving and reinforcing disaster finance is increasingly important in the light of increasing stressors of climate change and impacts of hydrometeorological hazards faced by the country. DRR programs have often faced budget constraints, and are supported by numerous development partners – however, guaranteeing the sustainability and continuity of actions, especially in terms of poverty reduction and environmental protection, the government should direct resource flows towards managing marine and forest habitats, increasing community resilience, generating opportunities for alternative livelihoods and improving the access to welfare, risk transfers or social protection services.

In this context, poverty reduction initiatives should be conducted and assessed regularly, with a focus on poverty prevention in relation to disasters and climate change as well. Protection mechanisms for alleviating the loss of livelihoods, and response initiatives designed to address the lack of shelter and access to safe water or sanitation is important to alleviate human suffering and to protect those vulnerable to poverty in the aftermath of disasters.

Also, and in relation to development requirements, managing growth in a sustainable and ecologically feasible manner is crucial to guarantee that trade-offs will not reach negative thresholds. Protection of natural ecosystems and the pristine forests are as important as is the developing economy, especially to the people who rely on the environment and oceans as their main source of livelihoods. Unmanaged development endangering undiversified income sources among communities with no access to alternative opportunities are at high risk to end up as the collateral damage of development, alongside with increasing climate and disaster risks which threaten the population. As disaster risk in PNG is exacerbated by climate-induced factors, there is a need to upscale country's interventions towards a more proactive, robust and sustainable options. Investment in disaster resilient infrastructures and building back better in recovery should be highlighted. Furthermore, exploring long term strategies enhancing climate monitoring, forecasting capacity and dissemination of early warnings are among key priorities for the country to pursue.

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