Disaster Risk Reduction in Tuvalu

Status Report

Asian Disaster Preparedness Center

UNDRR
UN Office for Disaster Risk Reduction

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Status Report 2022

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About this report

The disaster risk reduction status report provides a snapshot of the state of disaster risk reduction in Tuvalu under four priorities of the Sendai Framework for Disaster Risk Reduction 2015-2030. It also highlights progress and challenges associated with ensuring coherence with key global frameworks. It also provides recommendations for strengthening disaster risk management governance by government institutions and stakeholders at national and local levels.

This report was prepared by the United Nations Office for Disaster Risk Reduction (UNDRR) with support from the Asian Disaster Preparedness Center (ADPC) and Tonkin + Taylor through country consultations and a desk review of key documents, including legal instruments and disaster risk reduction frameworks, policies, strategies, and plans.

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This report serves as a reference document for implementing and monitoring the Sendai Framework. The findings, interpretations, and conclusions expressed in this document do not necessarily reflect the views of UNDRR or the United Nations Secretariat, partners, and governments. They are based on the inputs received during consultative meetings, individual interviews, and the literature reviews conducted by the research team. The presentation of the material in this report concerning the legal status of any country or territory or its authorities or concerning the delimitations of its frontiers or boundaries, as well as the text and the tables, is intended solely for statistical or analytical convenience and do not necessarily express a judgment about the stage reached by a particular country or area in the development process. 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.

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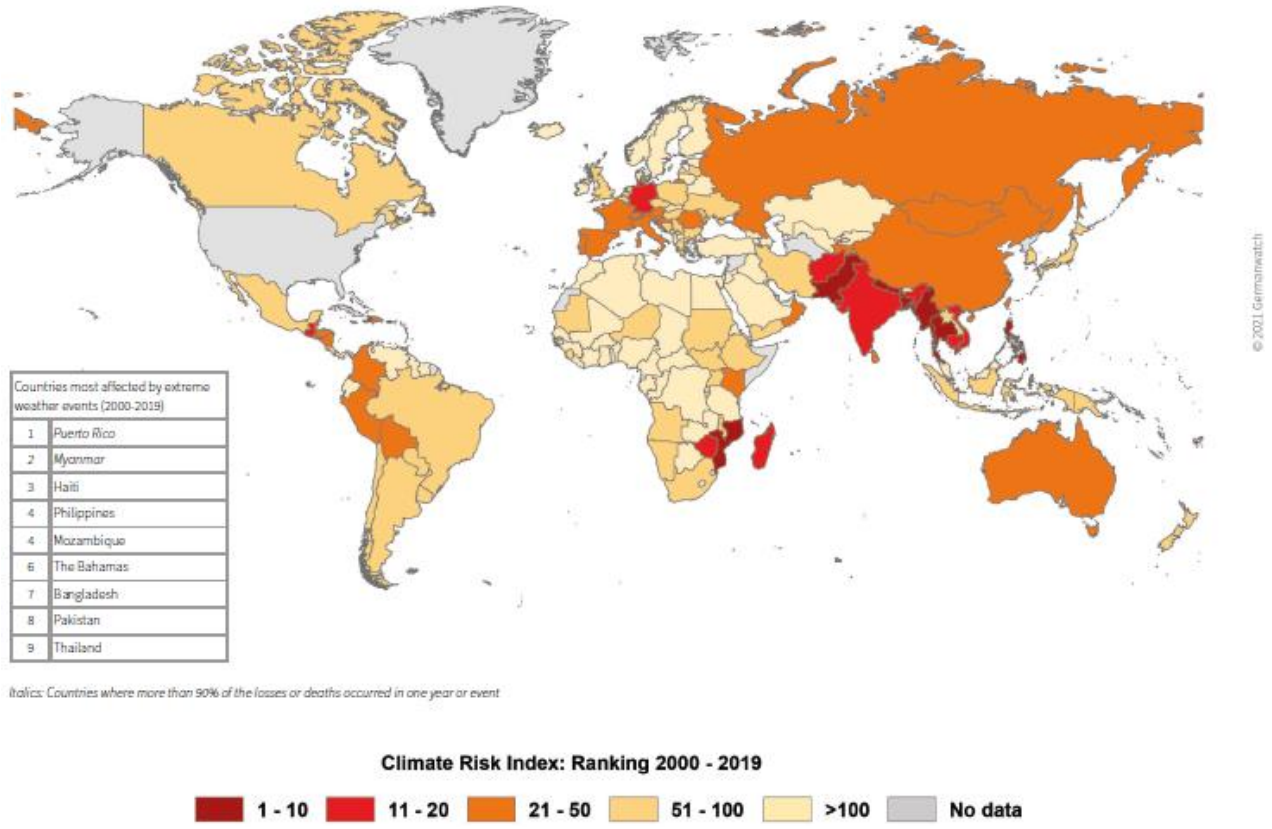

(Germanwatch, 2021)

POPULATION 2020	
Total Population	11 792
Urban Population	7 549 (64.0 %)
Population Density per Km²	393
ECONOMIC INDICATORS	
Gross Domestic Product in Current $US	48.85 million
GDP Per Capita ($US)	4 143
GDP Growth (Annual %)	4.4
HUMAN DEVELOPMENT	
Human Development Index	-
HDI Rank	-
Income Level Category	Upper middle Income

(World Bank, 2022)

Climate Risk Index

–

Rank 125, Score of 113.50*

INFORM Risk Index

–

Rank 104 / Low Risk**

* Climate Risk Index 2000-2019 analyses how countries have been affected by weather-related losses between 2000-2019. (GermanWatch, 2021)

** INFORM risk index is a global tool that measures the risk of humanitarian crises and disasters based on three dimensions: hazard & exposure, vulnerability, and lack of coping capacity. (INFORM, 2021)

1. Introduction

Tuvalu is a small island state located in the Central Pacific, in Polynesia, consisting of nine islands. Six islands are low-lying atolls made up of motu (islets) with mostly infertile soil, and three islands are reef islands. None of the islands are five meters above sea level. While the islands are scattered across 500,000 km^2 of the Pacific Ocean, in total they cover only 26 km^2 of land area. Over half of the total population, 11,792 people as of 2020, is located at the capital island Funafuti, on the Fongafale motu.

There are limited natural resources, fertile soil, and fresh water, which limits economic potential and constrains agricultural production. Therefore, Tuvalu relies mostly on its ocean resources. Fisheries sector is the main contributor to the economy by training seafarers through The Tuvalu Marine Training Institute and by issuing fishing licensing from Distant Water Fishing Nations. There are limited opportunities for employment, and unemployment is hight at 8.49% as of 2016 [World Bank, 2022].

The government plays a dominant role for employment, with the public sector makingup 70% of all employment and accounting for 20% of the gross domestic product (GDP). Figure 1 shows the rest of Tuvalu's GDP breakdown between 2004 and 2009. Community and social services, Finance and real estate, and Agriculture each make up 15% of GDP, while Fishing makes up 7%. The tourism sector currently plays a small role in the economy and is mainly focused in Funafuti on the islet of Fongafale. Tuvalu is expected to invest more money into the sector as it is seen as a conventional source of income in the future. [Gay, 2010]

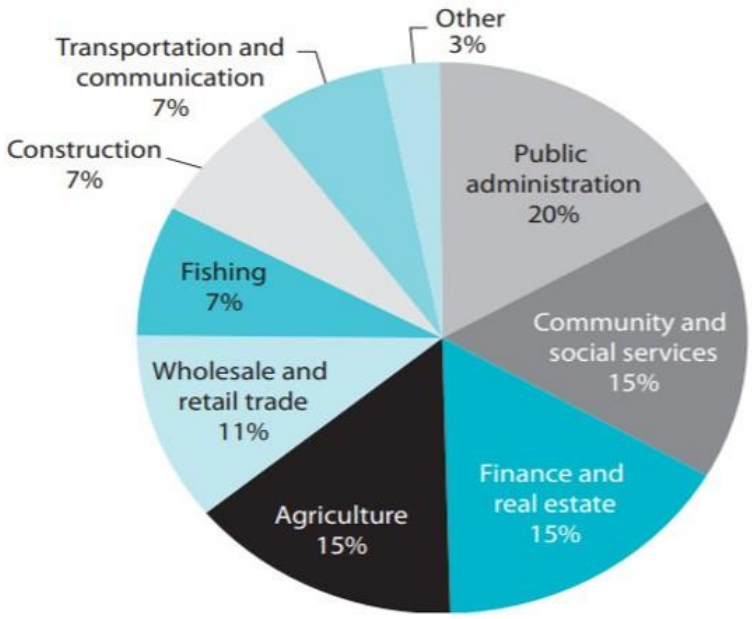

Figure 1. Composition of GDP by major activity, average 2004–2009 (Diagnostic Trade Integration Study) [Gay, 2010]

Tuvalu, like other Pacific countries, has two distinct seasons: a wet and a dry season. Strong seasonal cycles are driven by the South Pacific Convergence Zone (SPCZ) which is strongest during the wet season. Tuvalu is vulnerable to disasters and climate change impacts including tropical cyclones, droughts, sea level rise, and flooding. Rainfall during the wet season can average around 3,000 mm and can exceed 4,000 mm per annum with frequent thunderstorms during the El Niño years. Tropical cyclones tend to affect Tuvalu between November and April. In the 42-year period between the 1969 and 2010 seasons, 35 tropical cyclones developed in or crossed onto the Tuvalu Exclusive Economic Zone, an average of eight cyclones per decade [PACCSAP, 2013; EMDAT-2022.

Tuvalu has various unique species of plants, animals and marine environments. There are over 300 species of plants (65 species are native and the rest, mostly made up of ornamentals and shrubs, have been introduced). While there are no recorded native land mammals, there are various indigenous birds, lizards, insects, and land crabs that have been confirmed to be endemic. Habitat modification, such as through extensive planting of coconuts and other food plants, is the main reason indigenous plants are rare.

In 2020 Tuvalu released its National Strategy for Sustainable Development 2021-2030. It has five strategic priority areas:

1) Enabling environment
2) Economic development
3) Social development
4) Island and culture development
5) Infrastructure development.

1.1 Demographic Characteristics

In 2020, Tuvalu recorded a total population of 11,792 which is a 12.1% increase since 2010. Of the total population, 64% live in urban areas (a growth rate of 2.4% annually). Tuvalu has become more urban than rural, with 4,492 people living in Funafuti and 586 people living in Savave Village. The population consists of 49.5% male and 50.5% female (Index Mundi, 2021). Most of the population of Tuvalu (86.8%) are of Tuvaluan descent with a small percentage (12.3%) who consider themselves to be part-Tuvaluan descent. Only 0.9% are a part of other ethnic groups. 25–54-year-olds represent more than 37% of the population as of 2020. However, this number is a bit different when comparing the urban area to the outer islands. The number of children aged 0-14 years on the outer islands was considerably higher than on the Funafuti. It is same for the population of 60 years and older. This is because a majority of those of working age move to urban areas for work and other opportunities. An implication of this is a higher dependency ratio for the outer islands compared to Funafuti. [World Bank 2022][World Population Review, 2022][Index Mundi, 2021]

Gender equality is still an issue, and there is a lot to be done in the area of the sustainable development goal (SDG) number five, Achieve gender equality and empower all women and girls. Since the independence, only two women have been elected the o national Parliament and very few women run as candidates. In the general election in 2015, of 29 candidates, three were women of which only one got elected. While women and men share around the same amount of jobs engaged in agriculture and livestock, males greatly outnumber women in fishing while women greatly outnumber men in handicraft production. There is a prevalence of intimate partner violence in which four in ten women have experienced physical, sexual or emotional abuse by their partner. [Pacific Women in Politics, 2015]

1.2 Economic Impact of Disasters

Tuvalu relies on subsistence agriculture and fishing. Currently the government revenues come from the income of the capital of the Tuvalu Trust Fund (TTF) and from fishing licenses fees paid by foreign vessels. For families, income is derived mainly from remittances from seafarers. Tuvalu's extreme geographic characteristics, economic smallness and limited natural resources is the main factor for why it is considered to be in the top 10 most economically vulnerable countries in 2015. There is a 16.2% likelihood of a disaster affecting the county per year which is relatively low in comparison to the rest of the Pacific Island Countries (PICs). However, the percent of population affected is the highest of the PICs at 42.6%. [United Nations Economic and Social Council, 2015]

A large proportion of the country live in poor households that reside near areas prone to cyclones. They are mostly in weak structured homes. In 2015, Tropical Cyclone (TC) Pam was over 1,400 km from Tuvalu, yet it brought strong winds and storm surges that affected people and their homes. Nearly 20% of GDP was lost due to the damage of TC Pam on properties, appliances and loss to plantations and livestock. Furthermore, these poor households often face a slower recovery due to financial constraints. Figure 2 shows that the most significant stressor on households is cyclones followed by droughts and floods. Monetary issues were also a high contributor to household stress.

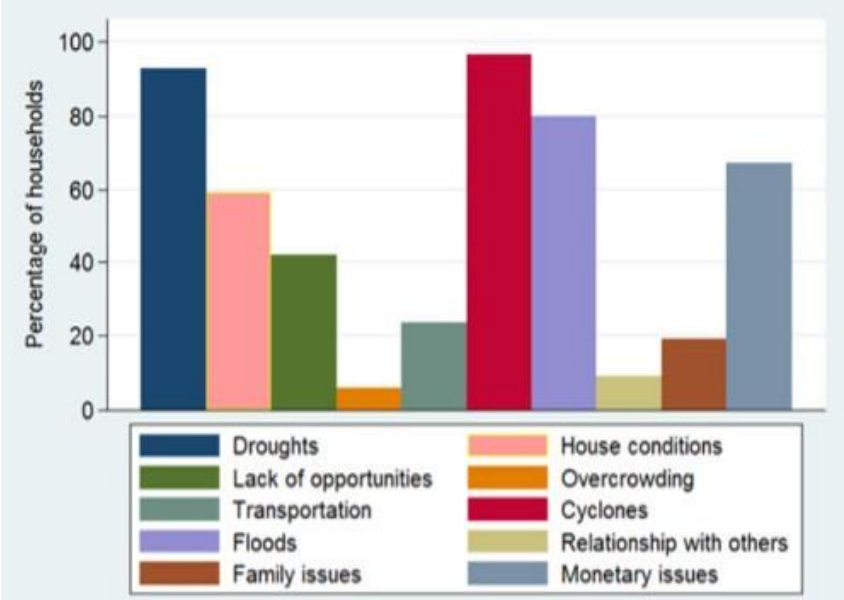

Figure 2. Multiple stressors affecting households from TC Pam [Lee, Zhang, & Nguyen, 2018]

Droughts have a large impact on the economy. Tuvalu relies almost entirely on rainfall catchments as shown in Figure 3. In September 2011, the Government of Tuvalu declared a state of emergency due to water shortages caused by the second worst drought on record for Tuvalu. During this period rationing of communal water supplies was in effect and many families coped by relying on brackish well water for bathing and washing of clothes and toilet flushing [Sinclair, Atumurirava, & Samuela, 2011].

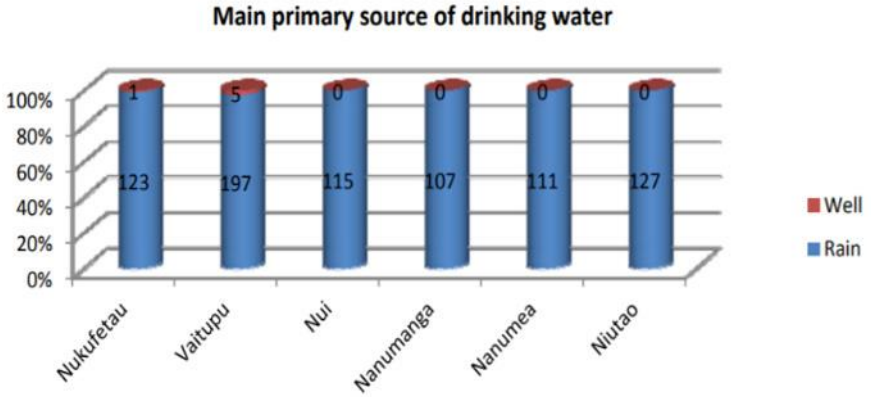

Figure 3. Main primary source for drinking water by island [Sinclair, Atumurirava, & Samuela, 2011].

Flooding is having an impact on the economy by affecting coastal areas, access to fresh water, farming, and people's health. Flooding, inundation and salinity intrusion, which is enhanced by the porosity of the soil, is destroying pulaka crops. Pulaka is similar to taro and is a very common root crop in the outer islands. The floods have also led to a decrease in the yield of fruit trees such as

coconut, banana, and breadfruit. Furthermore, coastal floods, caused by king tides, destroyed many houses and made serious impacts on near shore infrastructure. For example, during 2004–2006, king tides flooded homes and 40% of the airstrip. Tuvalu's economy is strongly based on imports and with the airstrip not functioning, this led to many economic woes.

1.3 Social Impact of Disasters

Tropical cyclones, even if they do not make landfall, can cause damage and large social impacts to people. The vulnerability of households to cyclone impacts and being at the forefront of sea-level rise and climate change is a concern for the population, especially for the poor who typically effect the most. In the case of TC Pam, the poor represented nearly 75% of the total losses and suffered far more damage relative to than the non-poor households. This could especially be seen in Funafuti where those who make less money rent houses that are more vulnerable to disasters such as living in near-coastal areas and narrow parts of the islands. Furthermore, the losses and damages of poor households is 93 times their monthly income where non-poor households are 15 times their monthly income. The poor were most likely also not to have insurance or any kind of savings, making it much more challenging to recover from TC Pam. Tropical Cyclone Tino caused storm surges, flooding, and inundation in 2020. People living along the western coastlines on all islands moved inland. People faced problems with food supply, the buildings of the Community Fisheries Centre were impacted, batteries in the solar power system were damaged, the health clinic on Nanumaga was completely damaged.

Droughts typically occur during the dry spell period, between June and September, the impact can vary. Agriculture can be affected the most, with many plants and crops having a low yield. This can add un-needed stress to many who rely on these traditional foods as their main source of nutrition. While the effects of a dry spell can result in disease, positive health behaviours are being practiced extensively and has drastically decreased the prevalence of diarrhoea cases, acute respiratory infections and other diseases associated with water scarcity. During a time of reduced rainfall which is the primary water source for households, water rationing is put into effect.

2. Disaster Risk Profile

2.1 Governance and Institutional Mechanism

Through the Disaster Management Act (2007), National Disaster Management Office (NDMO) /Department of Disaster Management (DDM) was established to coordinate disaster mitigation, preparedness, response, and recovery activities. National Disaster Committee (NDC) is the multi-agency advisory and coordination body established to advise the disaster management authorities while implementing their respective activities.

National Disaster Preparedness Working Group (NDPWG) has responsibilities to assist NDC during emergency response operations, promote community awareness, and develop annual training plans for the government and communities. Island Disaster Committees (IDCs) are responsible for coordinating and managing risks of disasters on the islands and act as a connection between the national government and community in all the disaster related issues.

Department of Climate Change (DCC) (previously Department of Climate Change and Disaster (DCCD)) is responsible for implementing climate change adaptation and mitigation activities. National Advisory Council on Climate Change (NACCC) was established to advise the Prime Minister's Office on implementing necessary activities to tackle the impacts of climate change.

Development partners such as the Asian Development Bank (ADB), European Union, Australia, Japan, New Zealand, World Bank, United Nations Agencies, Council of Regional Organisations in the Pacific (CROP) agencies and others provide development assistance to Tuvalu. Tuvalu Red Cross, ADB, SPC, UNICEF, FAO, UNDP, civil society, and others assist the communities in disaster preparedness, response, and recovery activities [Government of Tuvalu, 2020].

Tuvalu Meteorological Service (TMS), the country's National Meteorological and Hydrological Service (NMHS), is the main risk monitoring agency in the country. TMS is responsible to observe and record meteorological observations and provide weather forecasts and climate outlooks for government sectors and the public. Delivering information on ocean behaviour is also a responsibility of TMS.

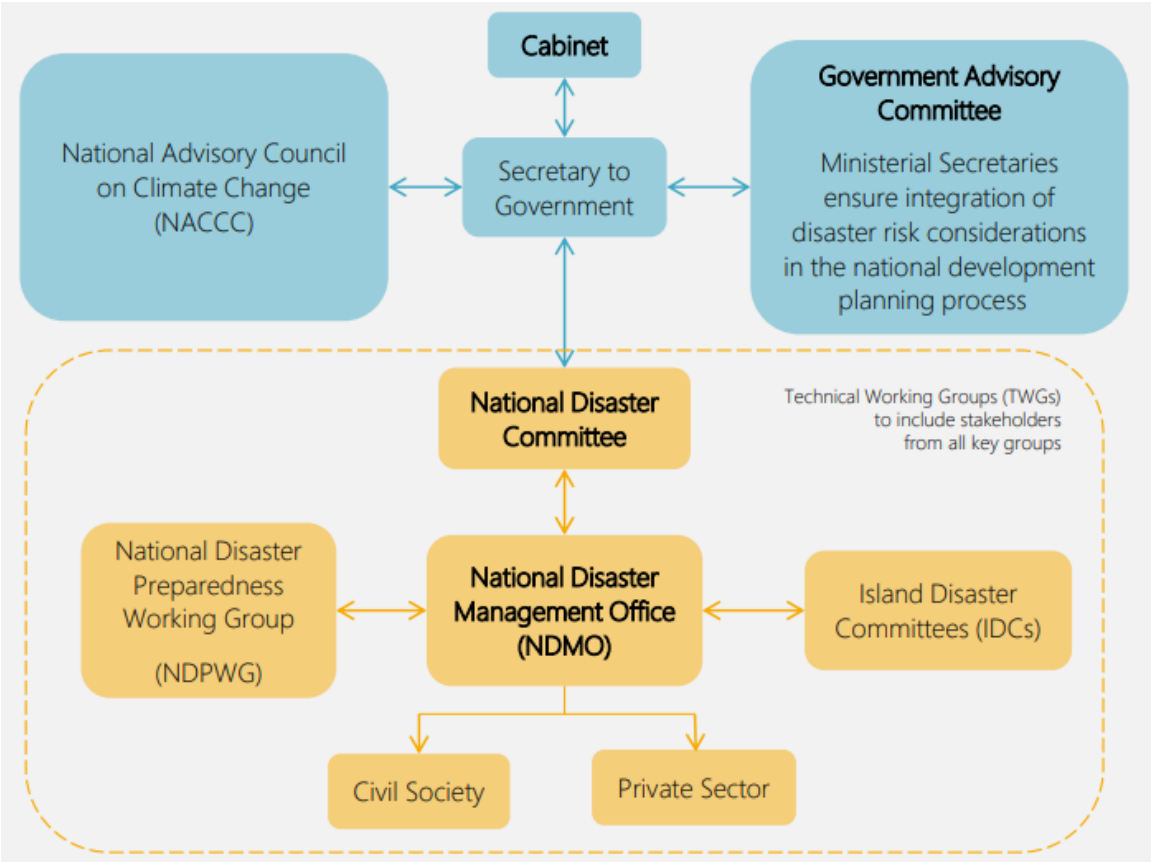

Figure 4: DRM Governance Structure and Relationships [SPC, 2021]

The Pacific Islands Meteorological Strategy (PIMS) 2017-2026 provides the development priorities of the NMHSs in the region and sets out direction for strengthening them. In 2020, Tuvalu Integrated Vulnerability Assessment report was published as the result of a joint initiative between the Department of Climate of the Government of Tuvalu and the National Adaptation Plan (NAP) Global Network. Policies related to disaster risk reduction which have enhanced the disaster risk governance are presented in the table below.

Legislation/Policy	Scope	Purpose
National Action Plan to Combat Land Degradation and Drought (2006)	National, Local	Have a better understanding of the causes and consequences of land degradation, strategies and prioritize sustainable developmentplans, and describe current projectprofiles.
National Adaptation Programme of Action (2007)	National, Local	Identifying adaptation needs that are consistent with the National Strategy for Sustainable Development
National Disaster Management Act (2008)	National, Local	Create the national Disaster Committee and National Disaster Management Office to ensure strategies and policies are implemented dealing with disaster related affairs.
Environment ProtectionAct (2008)	National, Local	Provide a mechanism for the development of environment policyand law by promoting a clean and healthy environment.
National Strategic ActionPlan for Climate Change and Disaster Risk Management (2012-	National, Local	To implement actions of the Tuvalu Climate Change Policy by determining responsible agencies, costs, and monitoring and evaluation of the policy.

Legislation/Policy	Scope	Purpose
2016)		
Te Kaniva: Tuvalu Climate Change Policy (2012-2021)	National, Local	Policy to help strengthen current and future vulnerabilities, improvethe understanding of climate change data, and planning for effective disaster preparedness, response and recovery.
Te Kakeega Ill: national Strategy for Sustainable Development (2016-2020)	National, Local	Overarching framework for other policies that focuses on good governance, outer islanddevelopment, private sector, human resources, natural resources, and infrastructure.
Infrastructure Strategy and Investment Plan (2017)	National, Local	The Plan identifies investment needs and priorities for economicinfrastructure and assesses the financial resources essential for implementation.
Te Kete: Tuvalu National Strategy for Sustainable Development 2021-2030	National, Local	It is a high-level planning and result oriented strategic plan to build peaceful, resilient, and prosperous country. It includes five strategic priority areas: the enabling environment for sustainable development; economic development; social development and inclusion; islands and culture; and infrastructure development.

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

2.2 Hazard and Exposure

Tuvalu is the fourth smallest nation in the world, and one of the most isolated island nations with an average elevation of only 1.83 meters, making it one of the most vulnerable countries in the world to disasters and the impacts of climate change. Like other countries in the South Pacific Convergence Zone, Tuvalu experiences various hazards that affect the country, especially during the wet season. The most common hazards include tropical cyclones, sea level rise, flooding, drought and extreme heat, and epidemic. [Government of Tuvalu, 2015]

Tropical cyclone season is between November and April and typically does not occur outside this season. Data collected between 1969 and 2007 have shown that 33 tropical cyclones passed within 400 km of Funafuti, which averages around eight cyclones per decade. However, frequency has ranged from zero in some seasons to three that occurred between 1997 and 1998. These cyclones also generate storm surges and swells that result in flooding and cause massive damage to homes and infrastructure. Tropical cyclones are forecasted to be more intense but less frequent. [Australian Aid, 2020]

Earthquakes are a very lo risk hazard, as Tuvalu is located in a relatively quiet seismic area. The last earthquake of reasonable size (magnitude 5.4) that was felt in the country was in 2015. Reports show that there is a 2% chance that Tuvalu will experience at least one potentially damaging earthquake in the next 50 years. A tsunami hazard is considered a medium risk because of the country's geographic location. It is predicted that in the next 50 years, there is more than 10% chance of a potentially destructive tsunami occurring in Tuvalu. [Volcano Discovery, 2015][ThinkHazard, 2022].

Droughts associated with a precipitation deficit frequently occur in the country (World Bank, 2021). They are linked with an El Nino event and typically occur during the dry season between the months of August and October. It is forecasted that in the next five years more than 25% chance of at least one period of prolonged exposure to extreme heat, resulting in heat stress may occur in Tuvalu. However, on the other hand, droughts are expected to decrease in incidence to eight to nine times every 20 years in 2030 under all emission scenarios. This is expected to

decrease further to six to seven times by 2090. Severe droughts will remain relatively constant at once to twice every 20 years. [ThinkHazard, 2022][PCCSP, 2014][World Bank, 2021]

The country has a tropical climate with temperatures around 27 ºC to 29 ºC through the year. The maximum temperature has increased at a rate of 0.21ºC per decade since 1950. The average temperature is projected to increase approximately 1.4 ºC by 2050 and 2.9 ºC by the end of the century under high emission scenarios. The number of days with rainfall is projected to have its annual and seasonal average increase due to the intensification of the SPCZ. The intensity and frequency of extreme rainfall is expected to increase. The temperature increase is still expected to be significant, but much lower than the worldwide average. [Australian Bureau of Meteorology and CSIRO, 2011] [World Bank, 2021] [GFDRR, 2019].

Sea level rise is a significant concern for an atoll nation. According to satellite data sea level has risen near Tuvalu by about 5 mm per year since 1993. The increase in sea levels near Tuvalu is larger than the global average of 2.8–3.6 mm per year. The sea level change by 2100 under high emission scenario is around 73 cm to 83cm. The sea-level rise combined with natural year-to-year changes will increase the impact of storm surges and coastal flooding. Figure 5 shows the observed sea-level records with projections for various emission scenarios until 2150. [Australian Bureau of Meteorology and CSIRO, 2011][NASA, 2022]

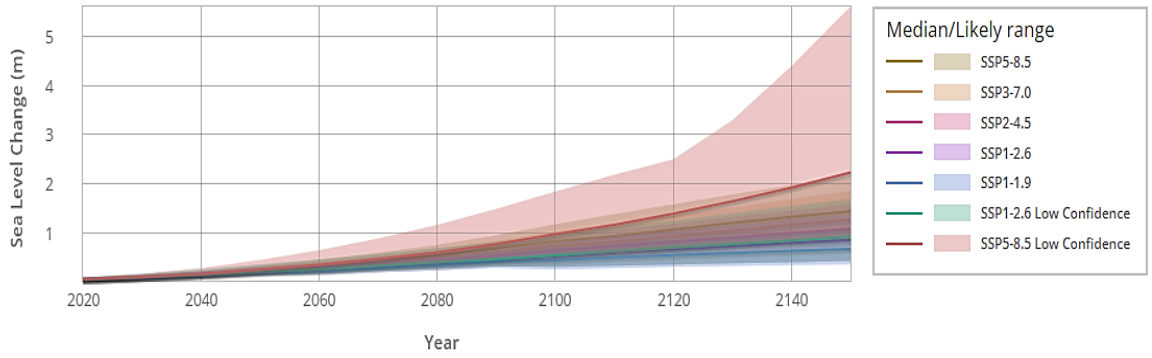

Figure 5. Observed and projected relative sea-level change near Tuvalu (NASA, 2022).

Coastal flooding has transpired over the years due to king tides pushing waves of salt water over low sections of the atolls and disrupting roads, increasing soil salinity, contaminating groundwater, and enhancing coastal erosion. These king tides are occurring every year where the maximum wave heights are continuing to increase making them more serious and causing more damage. In 2006, the Tuvalu government assisted victims whose homes were flooded with water from these king tides. King tide events can last for hours or even days with the highest recorded sea level at 3.44 m in 2006. Exposure to climate and disaster risks is further exacerbated given that areas of the central portion of Fongafale are already below high spring tide level and that saline flooding of low-lying areas occurs regularly and is expected to become more frequent and extensive over time. [Australian Aid, 2020][Department of Environment, 2007][Lin, Ho, & Cheng, 2014]

Ocean acidification is expected to increase over the next century, contributing to more damaging tides; reef ecosystems like coral and mangroves will progressively degrade. Ocean acidification will also have an impact on fishing which is a staple in the Tuvalu diet. [Australian Aid, 2020]

There is a positive correlation between annual average temperature and rates of diarrheal disease. It is predicted that climate change will increase the prevalence of diarrheal diseases and other climate-related diseases such as respiratory and vector-borne diseases. WHO estimates diarrheal disease accounts for 13% of all deaths of children in Tuvalu. Skin infections have also been observed to be on the rise and are estimated to increase due to climate change. [World Health Organization, 2015] [Urbano, Maclellan, Ruff, & Blashki, 2010]

Tuvalu's risk of pandemic such as COVID-19 is assessed as high; however, as of April 2022, there are no cases of COVID-19 in Tuvalu, as the country rapidly closed its borders to inbound travellers to prevent disease outbreaks [World Health Organization, 2022].

2.3 Socio-economic Vulnerability

Social protections and access to economic resources and opportunities are mitigating factors against disaster and climate impacts. It is reported that 26.3% (as of 2010) of the population in Tuvalu lived below the poverty line, as the country relies heavily on the imported food and fuel. Nevertheless, 0.33% of income poverty was estimated in 2019, which shows a decrease in the poverty rate over the years. [IOM, 2020]

Tuvalu's remoteness makes imports, exports, and tourism expensive. Tuvalu ranks the second-highest recipient of overseas development assistance in the world as it mostly relies on foreign aid. Revenue is also generated through taxes, custom duties, postage stamp sales, fishing, and dot TV domain licenses. Fishing accounts for nearly all of Tuvalu's exports. These economic conditions make Tuvalu highly susceptible to global economic shocks and adds to its vulnerability. [IOM, 2020]

Droughts can cause severe problems for agriculture and water sectors, especially in more densely populated areas like Funafuti. Increased drought frequency will result in crop yield losses of 60% pulaka and coconut, 50% banana and 50% root crops and breadfruit. [Department of Environment, 2007]

The land availability is limited due to the characteristics of an atoll island. Low fertility of the land, salinization of the soil due to sea level rise and saltwater intrusion of groundwater lens adds to food production woes. Food production in Funafuti is limited, and most of the local food available in the capital comes from the outer islands. Prevailing disinterest in local food production, the convenience of imported foods, unreliable inter-island shipping and climatic changes negatively affect food security in Tuvalu. Unpredictable weather patterns, soil salinity, variable rainfall, and water salinity pose severe challenges for growing nutritious food in the country.

Income is predominantly derived from remittances, from seafarers, seasonal workers participating in the Recognized Seasonal Employer (RSE) Scheme and Seasonal Worker Program (SWP), and Tuvaluans who have permanently migrated. Other sources of household income include rental income, pension, sale of handicrafts, crops, fish and livestock, and business and investments. The population predominantly engages in subsistence agriculture and fishing on the outer islands.

Employment opportunities are limited and more so in the outer islands in comparison to Funafuti. As of 2017, the employment-population rate in Tuvalu was nearly 33%, while the unemployment rate was 28.5%. The labour force participation in 2017 was 49.3%, with a higher participation rate among men than women (70.5% and 39%, respectively). Gender dimensions in Tuvaluan society also contribute to differentiated vulnerabilities. According to the Tuvalu Demographic and Health Survey (TDHS), approximately 60% of employed women earned less than their partners. [IOM, 2020] [Central Statistics Division (TCSD), SPC and Macro International Inc., 2007]

Significant disparities in income were also noted between Funafuti and the outer islands. The disparity in income levels between Funafuti and the outer islands is a result of a lack of access to economic opportunities because of remoteness, irregular domestic shipping services, poor public service delivery and infrastructure facilities that limit entrepreneurial activities. High telecommunication and electricity costs also strain households' budgets.

About 4.5% of the population in Tuvalu has a disability. The most common disability was reported to be mobility issues, followed by sight, memory, self-care, communication, and hearing. People with disabilities on the atoll nation are faced with disproportionate number of challenges in responding to disasters in comparison to their able-bodied counterparts. [Tavola, 2018]

The climate change impacts are likely to disproportionately affect the communities and

households that rely on manual labour jobs, farming, and poorer businesses. It is reported that women are among the highest risk groups. Gender-based differences in time use, access to assets and credit, treatment by institutions, and limited access to policy discussions and decision making for women are key factors for the differences in vulnerabilities between women and men. [World Bank, 2021]

2.4 Physical Vulnerability

Nestled in the central South Pacific, south of the equator, Tuvalu is removed from major international markets and shipping lines. Tuvalu's nine islands flung over a distance of 700 kilometres are characterized by small land areas and low elevations. Niulakita Island has the highest observed point in the country, 4.6 meters above mean sea level, while the other islands are substantially lower. Tuvalu's low elevation, and smallland size makes it susceptible to the effects of sea level rise, storm surges and coastal erosion. [ADB, 2014] [Taupo, Cuffe, & Noy, 2018]

The geophysical nature of the atoll makes Tuvaluans living along the coastline. Settlement patterns influenced by engineering works during World War II and rapid development and population growth since 1974 have led to the habitation inswamp lands and lands especially vulnerable to flooding. Most Tuvaluans are living in areas not exceeding three metres in elevation, in what would be considered hazardous conditions elsewhere. Given the low elevation and coastal nature of the settlement patterns, communities have a high degree of exposure to the impacts of sea level rise. Additionally, settlement patterns in Tuvalu occupy shoreline and swampland areas, creating heightened conditions of vulnerability for these coastal communities. [Yamano, et al., 2007]

Of Tuvalu's 18,900 m of vulnerable coastline, 9,000 m, or almost 50%, is in Funafuti. However, despite the level of exposure to hazards affecting the coastline, Tuvalu does not have a single engineered coastal protection infrastructure project that could withstand current and future impacts of sea level rise and intensifying tropical storms. Coastal protection that does exist tends to be ad-hoc and incapable of withstanding storm surges, resulting in a severely degraded shoreline. Without coastal protection, storm surges like the one in 2010 that affected 30% of country households will continue to wreak havoc. More recently, the storm surge generated by Tropical Cyclone Pam generated US$92 million in damage to infrastructure and crops around the country. The island of Nui was flooded; its water sources were contaminated and completely cut off from the world for three days. [Government of Tuvalu and UNDP, 2016]

Government buildings, critical infrastructure, and airports are located along the coastline and exposed to storm surges and flooding. Construction and sand mining in the coastal areas weakened the coastal defences and increased the vulnerability to storm surges. [Climate Change Knowledge Portal, 2022]

Infrastructure standards also play a part in coastal resiliency. Tuvalu's current building code, enacted in 1990, was done so without a set of regulations to make the policy binding (ADB, 2014). Given the degree of destruction of public buildings and houses by Tropical Cyclone Pam, the Government of Tuvalu has embarked on a legislative review of the code and developing supporting regulations. [ADB, 2014]

Sea level rise and extreme heat are significant concerns for an atoll nation. Climate change is increasing the prevalence of extreme weather events that will lead to further inundation of the atoll islands. Furthermore, reefs, acting as a coastal defence, are likely to decrease with ocean acidification. Coastal erosion will increase as the number of healthy reefs decrease leading to infrastructure, fisheries, and agriculture sectors being affected as well as the natural biodiversity of the ecological systems. Impacts on human health are also expected to become more prevalent. For example, longer periods of drought will limit the availability of fresh water and make it more challenging to maintain proper sanitation techniques. [World Bank, 2021]

The freshwater supply in Tuvalu is heavily dependent on rainfall. The groundwater is saline and unsuitable for drinking, and the rising sea level increases the concerns of salt intrusion into the groundwater. The risk of damaging the water supply infrastructure from natural hazards is exacerbated by the increase in sea-level. [World Bank, 2021]

Tuvalu is one of the least connected countries in the pacific region (as of 2018) as access to quality connectivity continues to be a major challenge for the country. In 2018, around 57% of the population had access to internet, and 4G (mobile internet) and 3G (mobile voice) services were only available in Funafuti and the outer islands had only access to 2G services. [IOM, 2020]

2.5 Cultural Vulnerability

The country has a rich and vibrant culture, particularly in intangible cultural heritage such as "the practices representations, expressions, knowledge, skills – as well as the instruments, objectives, artefacts and cultural spaces associated therewith – that communities, groups and, in some cases, individuals recognize as part of their heritage". [Government of Tuvalu, 2018]

Cultural values provide a traditional safety net for building resilient communities in Tuvalu. The impacts of climate change and other hazards severely affect the communities, heritage, and culture in Tuvalu. The sites with historic and cultural values are at risk of being damaged or lost due to sea level rise and other impacts of climate change. Also, it is reported that the customs and values are eroding over time due to modernisation, limited sharing of deals at family level, and limited engagement of youth and the younger generation in learning. [Government of Tuvalu, 2016] [Heather Lazrus, 2015]

Social norms still have patriarchal overtones. While Tuvaluan law grants equal opportunities for men and women, there are institutional disparities in accessing equal opportunities (Saitala Kofe & Taomia, 2006). In general, women are predominantly perceived as caregivers and seen responsible for household duties. Women's role in local decision-making through the Falekaupule (local government) is also limited. Progress has been made in amending the Falekaupule Act to allow for the inclusion of women in traditional decision-making processes. However, it is reported that each island's traditional structure still takes precedence and is often exclusionary to women. [Saitala Kofe &Taomia, 2006] [UNFPA, 2014]

3. Progress in Sendai Framework for Disaster Risk Reduction

To illustrate the government's will and commitment to protect the population and the country from future disasters, the following sections shed light on Tuvalu's process in disaster risk reduction (DRR) and climate change adaptation (CCA), as mandated and guided by the global policy frameworks: Sendai Framework for Disaster Risk Reduction (SFDRR), Sustainable Development Goals (SDGs) and the Paris Climate Agreement. This section is organised by four priority areas of SFDRR, in which focused actions are required within and across sectors by states at local, national, regional, and global levels.

Priority 1. Understanding Disaster Risk. Small island states are highly prone to disasters and their remoteness often leads them to have a challenging time collecting and analysing risk information. This issue is exacerbated for atoll island countries, like Tuvalu, because of the limited resources and capacity to conduct such assessments. These assessments should be used to create disaster risk policies which are based on vulnerability, capacity, exposure of persons and assets, hazard characteristics, and the environment.

Tuvalu has collected, analysed, and managed some data with support from international NGOs. A vulnerability profile was created for Tuvalu in 2012 by the UN Committee for Development Policy (CDP) by analysing data on human capital and economic vulnerability criterion every three years since 1986. Other assessments such as Ending Violence Against Womenand Girls , supported by United Nations Development Fund for Women, collected data in 15 Pacific Islands Countries that looked at gender-based violence and accessed support services and justice for women and girls. The data supported an understanding the challenges in addressing violence against women and girls, barriers to violence prevention, and recommendations for addressing violence against women. The Central Statistic Division (CSD) teamed up with the Pacific Community (SPC) and conducted the Household Income and Expenditure Surveyto analyse the expenditure and income of households in Tuvalu. The main objective of this survey was to create a report that was useful to policymakers and planners to make informed decisions on poverty, economic activity, and food consumption patterns. [UNIFEM, 2010] [Government of Tuvalu - Central Statistics Division, 2010]

Priority 2. Strengthening Disaster Risk Governance to Manage Disaster Risk. Tuvalu's national development plan, Te Kete Tuvalu National Strategy for Sustainable Development 2021-2030, is the platform upon which Tuvalu will be able to overcome the socio-economic challenges and environmental crises under pandemics. It also considers unexpected crisis so that people will be able to live sustainable livelihoods. "Te Kete" symbolizes how Tuvalu stores and preserves their traditional knowledge and wealth to support the daily needs and wellbeing of the communities in Tuvalu whilst simultaneously building a resilient future.

The Disaster Management Act (2007) established the National Disaster Committee (NDC) and National Disaster Management Office (NDMO) to prepare, respond, and recover the communities in Tuvalu from the disasters.

The Tuvalu National Strategic Action Plan (NSAP) for Climate Change and Disaster Risk Management 2012 – 2016 is the implementation strategy of the Tuvalu Climate Change Policy. NSAP provided a priority-based programme of actions for the government to implement over five years.

Priority 3. Investing in Disaster Risk Reduction for Resilience. Tuvalu's NSAP estimated a total of AU$8 million to implement its seven goals. Tuvalu's in-kind contributions was around 21% of the resource costs while the remaining 79% was planned to source from development partners. While many countries lack the data and means to determine DRM and DRR projects financial needs, Tuvalu, with the help of the Secretariat of the Pacific Regional Environment Programme

(SPREP) and SPC, was able to determine the indicative costing of the NSAP. [Government of Kiribati, 2012]

The Green Climate Fund is supporting Tuvalu with US$36 million for the implementation of the 2017 Tuvalu Coastal Adaptation Project, which aims to strengthen human resources and knowledge for coastal management, reduce vulnerability of coastal infrastructure and establish a mechanism for long-term adaptation efforts. [United Nations Development Programme, 2017]

Tuvalu has received assistance in the forms of funding and capacity to work towards its Te Kakeega III's goals. These stakeholders include the Asian Development Bank (ADB), DFAT, USAID, UNDP, and many others. The New Zealand Foreign Affairs and Trade is supporting Tuvalu with NZ$38.33 million during 2018 – 2021 to help with economic growth and improving the infrastructure and services are more resilience to climate change and well managed (New Zealand Foreign Affairs and Trade, 2019). Official Development Assistance (ODA) was also provided by the World Bank, which contributed US$466,275 to support adaptation to climate change, and Japan contributed US$3.2 million to construct water cisterns for schools and construction of outer island medical facilities in 2007–2008. [United Nations Department of Economic and Social Affairs, 2009] [Government of Tuvalu, 2020]

Australian Government supported Tuvalu over the several years in building resilience across the nation. Bilateral funding of $6.6 million AUD was contributed to Tuvalu to improve governance and fiscal resilience, education, and human resources and enhance resilience to environmental and climate change impacts. [Australian Government - Department of Foreign Affairs and Trade, 2018]

Recently, DFAT with UNDP are assisting Tuvalu in their second National Adaptation Programme of Action (NAPA) with AU$4.2 million AUD in funding from 2013–2017.The second NAPA looks at implementing community early warning systems and integrating climate change into Island Strategic Plans. ADB is also supporting Tuvalu in a situation analysis with US$3.61 million in funding from 2013–2017 that investigates identifying climate change into budgetary processes as well as monitoring and evaluation. [Manley, et al., 2016]

For better water management in the outer islands, the Rainwater Catchment Enhancement Project was started to improve access to freshwater supplies to meet the basic needs of the people in the northern islands. This includes improving water storage and water capture systems for current housing designs. The estimated costs for the project being US$940,000 which the Tuvalu Public Works Division with the Department of Environment are the key implementation organisations [Department of Environment, 2006].

Priority 4. Enhancing disaster preparedness for effective response to "Build Back Better" in recovery, rehabilitation and reconstruction. Tuvalu understands that Investment in "Build Back Better" in recovery, rehabilitation and reconstruction is critical to boost the social, health, economic and environmental resilience over the long term. However, it requires assistance and cooperation from the internationalcommunity. For example, after TC Pam damaged a large portion of the country's GDP, agriculture, housing, and coastal protection were Tuvalu's top priority areas for its recovery. The World Bank approved a US$3 million grant to reduce the gap of a US$17 million plan to ensure infrastructure is more resilient to future disasters. [World Bank, 2015]

A resilience pilot project run by the Tuvalu Red Cross aims to create awareness in the Teone Community in Funafuti on local weather and the actions that must be taken during adverse weather conditions such as drought or cyclones. The project has also offered the community with portable radios to get weather updates, roofing iron to secure their houses and prevent leaking during heavy rainfalls, educational posters, and a notice board containing tide tables and weather information. [Avanitele, 2017]

Adverse weather conditions such as drought are difficult to predict as they are slow onset hazards and can last over time. SPREP, SPC, the Australian Bureau of Meteorology, the Climate Change Centre and the TMS are working together to develop an 'early action rainfall watch' (EARWatch) that can provide alerts to authorities to assist in preparedness activities for drought such as information on storing water. Cyclone early warning systems such as the Offshore Wave

Forecasting Modelling software predicts wave height and wave events with a lead time of up to three to five days. This software was created by SPC with the support of Government of Germany, in part,to assist Tuvalu after TC Pam. While the Offshore Wave Forecasting Modelling software cannot assist with inundation events, it can help communities prepare and evacuate properly to prevent loss of life. [Warrick, 2018] [Salele-Sefo, 2019]

4. Coherence with Sustainable Development Goals and The Paris Agreement

4.1 Strategic Coherence

Strategic coherence explores whether DRR and CCA are explicitly addressed jointly or if there is an aim to strengthen the relationship and linkages between the two fields. [UNDRR, 2020]

In Tuvalu's newest Te Kete Tuvalu National Strategy for Sustainable Development 2021-2030, the various strategies are not linked with the SDGs, the SAMOA pathway, and the Paris Climate Agreement, when the previous strategy TE KAKEEGA III National Strategy for Sustainable Development 2016 to 2020 had these links. The Intended Nationally Determined Contributions (2015) does not contain any actions related to DRR. [Government of Tuvalu, 2020][Government of Tuvalu, 2016]

Tuvalu's NSAP looks to implement the Tuvalu Climate Change Policy goals which all link with the SDGs and the Paris Climate Agreement. Goals like 'Ensuring Energy Security and a Low Carbon Future for Tuvalu' looks to enhance access to safe, secure, clean, and affordable energy supplies is directly related to SDG goal 7 and the Paris Climate Agreement. Goal 6 of the NSAP, 'Planning for Effective Disaster Preparedness, Response and Recovery, looks to include vulnerable populations and those with special needs and prepare for disasters at all levels, including the island community, to deal with climate change. While Tuvalu is highly committed to the SDGs and the Paris Climate Agreement, it still needs appropriate monitoring and evaluation mechanisms to measure progress against these international agreements. [Government of Tuvalu, 2016]

Sectoral Aim	Policies with Linkages to Sendai Framework forDisaster Risk Reduction	Policies with Linkagesto Sustainable Development Goals	Policies with Linkages to the Paris Climate Agreement for Environment
National Development	National Adaptation Program of Action (2007)	Infrastructure Strategy and Investment Plan (2007)	Te Kaniva: Tuvalu Climate Change Policy (2012)
	National Strategic Action Plan for Climate Change and Disaster Risk Management (2012-2016)		
	Te Kakeega III: National Strategy for Sustainable Development (2016-2020)	Te Kakeega III: National Strategy for Sustainable Development (2016-2020)	Te Kakeega III: National Strategy for Sustainable Development (2016-2020)
	Tuvalu National Gender Policy	Tuvalu National Gender Policy	Tuvalu National Gender Policy
Environmental Protection	Environment ProtectionAct (2008)	Environment ProtectionAct (2008)	Te Kakeega III: National Strategy for Sustainable Development (2016-2020)
	National AdaptationProgram of	National AdaptationProgram	Te Kaniva: Tuvalu Climate

Sectoral Aim	Policies with Linkages to Sendai Framework forDisaster Risk Reduction	Policies with Linkagesto Sustainable Development Goals	Policies with Linkages to the Paris Climate Agreement for Environment
Disaster and Climate Risk Reduction	Action (2007) National Strategic ActionPlan for Climate Change and Disaster Risk Management (2012-2016)	of Action (2007) Te Kaniva: Tuvalu Climate Change Policy (2012)	Change Policy (2012) Te Kakeega lll: National Strategy for Sustainable Development (2016-2020)
Vulnerability Reduction	National Strategic ActionPlan for Climate Change and Disaster Risk Management (2012-2016)	Tuvalu National GenderPolicy: Strategic Plan ofAction 2014-2016 Tuvalu National Human Rights Action Plan 2016-2020 National Strategic ActionPlan for Climate Change and Disaster Risk Management (2012-2016)	Te Kaniva: Tuvalu Climate Change Policy (2012) National Strategic Action Plan for Climate Change and Disaster Risk Management (2012-2016)
Land Use Planning	Te Kaniva: Tuvalu Climate Change Policy (2012) Te Kakeega lll: National Strategy for Sustainable Development (2016-2020)	National Action Planto Combat Land Degradation and Drought (2006) Te Kakeega lll: National Strategy for Sustainable Development (2016-2020)	Te Kaniva: Tuvalu Climate Change Policy (2012)

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

4.2 Conceptual Coherence

Conceptual coherence explores how countries link DRR and CCA conceptually, through the concept of risk and resilience. The vision of Te Kete-Tuvalu National Strategy for Sustainable Development 2021-2030 and Te Kaniva- Tuvalu Climate Change Policy 2012 are to enhance the resilience of Tuvalu with a focus on addressing climate and disaster risks. Tuvalu is aware of the socio-economic factors and vulnerabilities that create the risks, and the synergies and distinctions between DRR and CCA are well documented. Tuvalu has a good conceptual coherence and implements the integrated approach wherever needed. [UNDRR, 2020]

4.3 Operational Coherence

Operational coherence looks at measures and activities that bring together disaster risk reduction and climate change adaptation practices, to which extent planning is cross-sectoral. National Strategic Action Plan for Climate Change and Disaster Risk Management (2012-2016) includes

various DRR and CCA outcomes across seven thematic goals based on Tuvalu's climate change and disaster risks context. Te Kete-Tuvalu National Strategy for Sustainable Development 2021-2030 includes various DRR and CCA outcomes under five strategic priority areas. For instance, Strategic Priority Area 1: Enabling Environment consists of the National Outcome: "Climate Change and Disaster Resilience improved". A strong coherence is observed in Tuvalu under this dimension. [UNDRR, 2020] [Government of Tuvalu, 2016] [Government of Tuvalu, 2020]

4.4 Institutional Coherence

Institutional coherence analyses whether coordination between DRR and CCA is envisioned and if and how institutional arrangements support coherence. In Tuvalu, the lead agency for implementing DRR activities is NDMO under the Ministry of Public Works, Infrastructure, Environment, Labour, Meteorology and Disaster, and for CCA activities is the Department of Climate Change (DCC) (previously known as the Department of Climate Change and Disaster (DCCD)) under the Ministry of Finance. Given the DRR and CCA activities are implemented under different ministries, there is a partial institutional coherence in Tuvalu, and efforts such as platforms for engagement (e.g., conferences, seminars) and the establishment of the CCA and DRR Steering Committee need to be taken to enhance the integrated approach. [UNDRR, 2020]

4.5 Financial Coherence

Financial coherence explores whether and how funding strategies and investments bring together DRR and CCA. The National Strategic Action Plan for Climate Change and Disaster Risk Management (2012-2016) includes financial costs, in-kind contributions, and contingency costs for implementing each goal. However, a detailed costed action plan i.e., costs for implementing each activity was not provided. Also, the Te Kete-Tuvalu National Strategy for Sustainable Development 2021-2030, Intended Nationally Determined Contributions, does not include cost for implementing the key strategic actions of the national outcomes. [UNDRR, 2020] [Government of Tuvalu, 2012]

5. Challenges and Priorities

5.1 Challenges for Disaster Risk Reduction Implementation

Tuvalu has a good understanding of the challenges and the priority areas. The seven goals of Tuvalu Climate Change Policy (2012) was aligned with the challenges of the country. For example, Goal 1 – "Strengthening Adaptation Actions to Address Current and Future Vulnerabilities" lists key issues such as health and socio-economic cost and implications of climate change, water management issues, and lack of opportunity to diversify livelihoods or income generation. These challenges are exacerbated for the people living below the poverty line. Goal 5 – "Ensuring Energy Security and Low Carbon Future for Tuvalu" highlights key issues such as the country's heavy reliance on fossil fuels, lack of appropriate legislation, and the costs of renewable energy. While Tuvalu produces very few emissions compared to the rest of the world, reducing their greenhouse gas emissions is still challenging. Also, the construction in Tuvalu rarely follows building codes which poses a serious threat to the physical assets during the impacts of disasters and climate change.

Technical capacity is the largest challenge for Tuvalu in implementing the DRR activities. Each island has an Island Disaster Committee (IDC), whose main function is to coordinate disaster-related measures and to act as the communication point between the NDC and the local community. IDCs have limited technical capacity to manage disaster events and re-build their community. The lack of financial capacity contributes to the deficiency in the technical capacity in Tuvalu. Many who seek tertiary education attend the University of the South Pacific (USP), but the number of graduates returning exceeds the employment capacity in Tuvalu. Therefore, many graduates either find work outside of Tuvalu (considered over-qualified) or are employed in the private sector. [Government of Tuvalu, 2016]

The lack of coordinated planning among responsible agencies is another challenge faced by the country in implementing DRR activities. For instance, Te Kakeega II was not translated to the local language, and there was no participatory process to involve local communities in the planning and implementing projects and programmes. There are difficulties in translating information from English to the local language, as some of the technical terms do not accurate translation into the Tuvaluan language. As a result, local people find some times hard to understand. Also, the country's budget allocation for public awareness activities is limited.

Accessing advanced forecasting systems and information communication and technology systems faces several barriers. These barriers include shortage of land for infrastructure development, lack of research capacity, limited data, lack of investment and financing instruments, limited national revenue, and lack of technical knowledge in installing, maintaining, and repairing technologies (Government of Tuvalu, 2015). There is a lack of on-site waste treatment technologies for solid and liquid waste in the country. [Government of Tuvalu, 2015]

Tuvalu's climate is generally unfavourable for agricultural activities . Based on observed and projected climate changes, most cultivated lands and assets will continue to be less productive due to a combination of sea level rise, soil salinization, and coastal erosion, and flooding. Reduced freshwater availability, combined with increased salinity intrusion into groundwater, is likely to challenge Tuvaluans' food security. Furthermore, the current land tenure system limits the availability of land for agriculture, making labour-intensive production restricted to small plots. There are also water supply challenges, mainly when droughts occur. The rainfall decreases during the drought period, which significantly affects the agriculture as well as the availability of drinking water.

5.2 Priority Areas of Work

Hazard Mitigation: Stopping the acceleration of coastal erosion is a component of the highest priority strategy in the Te Kakeega III, Climate Change. The Government of Tuvalu has established a Minerals Unit to oversee, survey, and analyse aggregates and look into matters about seabed minerals. The island of Kaupule is currently being monitored witha concentration on surveying foreshores and coastlines and mapping areas of coastal erosion and accretion. In the current strategy, "Climate Change and Disaster ResilienceIncreased" is listed as a national outcome.

Engagement and Partnership: Tuvalu is looking to improve the private sector as a priority as it offers large potential to improve the economy and capacity building. While the private sector has been doing well in the recent years, more can be done to support businesses thrive. The housing market is seen by the Government of Tuvalu as a potential opportunity, especially on Funafuti. Currently, the rental market accounts for 40% of the total permanent housing, which creates an inflated rental market. The hope of disposing of government housing is to stimulate economic growth, accelerate the private real estate market, and free up government capital for other priority areas. [Government of Tuvalu, 2016]

Enhancement of Multi-Hazard Early Warning System: As per the assessment of multi-hazard early warning systems in Tuvalu, it has been observed that more attention is required for further development of key pillars of early warning systems, namely risk knowledge (risk-informed early warning systems), monitoring (hydrological monitoring systems), forecasting and warning and cross-cutting theme of governance (risk-informed policies and plans, financing and sustainability). Human resources at TMS, such as assistant weather forecasters, need more advanced training. They currently have the basic knowledge. Better trained assistant forecaster would improve the forecasting service of the TMS. More understanding and expertise are needed in meteorology to interpret and work on forecast and warningsystems. [UNISDR, 2006] [WMO, 2017] [Fakhruddin et al., 2021)

Enhancement of Earth Observation: There is a need to upgrade the automatic weather and ocean observations system (i.e. AWS) as TMS lacks more advanced weather forecasting models and instruments for accurate weather forecasting.

Enhancement of IT and Communications: Improving the internet connectivity of the TMS could enhance risk communication as they are the leading organisation in the country responsible for risk monitoring. Besides, the outer islands of Tuvalu have only one Chatty Beetle per island, which is available either at the island council office or at the island hall. When a Chatty Beetle receive a message, an alarm is activated; however, it is considered "not loud", especially when people are in their houses. Installing a siren onto Chatty Beetle would significantly increase the sound of the alerts.

Assessing Climate Financing: In the Pacific region, climate finance is mainly accessed through multilateral and bilateral donor organisations. Nearly 86% of the climate finance in the Pacific region is delivered through project-type interventions, while only 1% is channelled as direct budget support and 1% for sector budget support. Tuvalu needs significant financial resources to adapt to the adverse effects and reduce the impacts of climate change. Tuvalu can access finance from national, regional, and international public and private financiers/donors. There is wide-ranging literature on the opportunities and challenges for accessing and mobilising climate finance in PICs, including Tuvalu. Moreover, there is a range of current guidelines that are focused on strengthening climate finance access. [Green Growth Knowledge, 2017] [Secretariat of the Pacific Regional Environment Programme, 2022] [PIFS, 2018]

Community Awareness: The community needs to have relevant information and tools to improve their resilience to climate change and natural hazards. Conducting community awareness programmes, annual emergency drills, and improving the CCA and DRR education in the curriculum is necessary. Investing in education is another top priority. The need for capacity building and having a diversely skilled labour force is essential. The Government of Tuvalu is planning to increase education and human resources funding to target gaps in the labour force domestically

and throughout the Pacific. To do this secondary, technical, and tertiary education, the government will go through national certification and increase its standards to be recognised by other countries. Also, it needs to ensure the community has access to relevant, responsive, and accessible educational and employment pathways. [Government of Tuvalu, 2016] [New Zealand Foreign Affairs and Trade, 2021]

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