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CLIMATE CHANGE IMPACTS ON HEALTH AND LIVELIHOODS:

TIMOR-LESTE ASSESSMENT

IFRC

Climate Centre

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EXECUTIVE SUMMARY

Due to global warming, Timor-Leste will experience a shift to an even hotter climate with hot days and nights becoming the norm (*highly likely*). Extreme rainfall events will become more intense and more frequent (*likely*). While people in Timor-Leste are used to its tropical climate, without adaptation measures the drastic increase in temperatures and intense rainfall events will impact water resources and increase vulnerability to flash floods and landslides (*likely*). General rainfall trends are uncertain and depend on El Niño/La Niña changes, but research suggests the wet season will become wetter, while the dry season's rainfall remains stable/decreases slightly by the end of the century (*low certainty*). Tropical cyclones will decrease in frequency but increase in intensity (*likely*), and sea level continues to rise (*certain*) – exposing coastal areas to more storms, tidal surges and strong winds.

The impacts these changes will have on livelihoods and health, without substantial global action and national adaptation, are significant. Climate change has the potential to trigger wide-ranging and strong negative feedback loops between livelihoods and health.

On the one hand, a loss of livelihoods will negatively impact people's ability to afford healthcare and nutritious foods. The predominantly (subsistence) agriculture-based society in Timor-Leste is highly sensitive to changes in the onset of the rainy season, land erosion due to heavy rainfall and reductions in yield due to high temperatures and drought. There is a strong link with agriculture and poverty in Timor-Leste, and nationally two-fifths of the population live in poverty (especially high in Oecussi and the northeastern agriculture zone), which limits household's ability to overcome climate impacts. Women face a disproportionate burden as they depend comparatively more on low diversified climate-sensitive livelihoods, face more institutional barriers and shoulder caring responsibilities at the same time. Reductions in traditional crop suitability, higher chances of crop failure and few livelihood alternatives may increase the already high food insecurity, in rural and urban areas. Other urban climate risks include damage to houses and workplaces from floods, strong winds and landslides.

Climate change impacts on health will include heat exhaustion, malnutrition and increased food insecurity, the emergence of vector-borne diseases such as Dengue Fever, and an increased burden of waterborne diseases. This, in turn, will not just put increased pressure on health facilities but will reduce people's ability to work and earn a livelihood. Malnutrition, triggered by annual food deficits, is already the single biggest contributor to death in Timor-Leste – especially affecting children and pregnant women. As the intensity and frequency of heavy rainfall events increases and higher intensity cyclones are predicted, mortality and injury may increase and access to healthcare facilities may be disturbed more often and for longer periods. Higher temperatures, changing rainfall patterns and water scarcity will impact the

production of farm and marine foods, deepen vulnerabilities and the impoverishment of at-risk populations, and increase distress migration to urban areas.

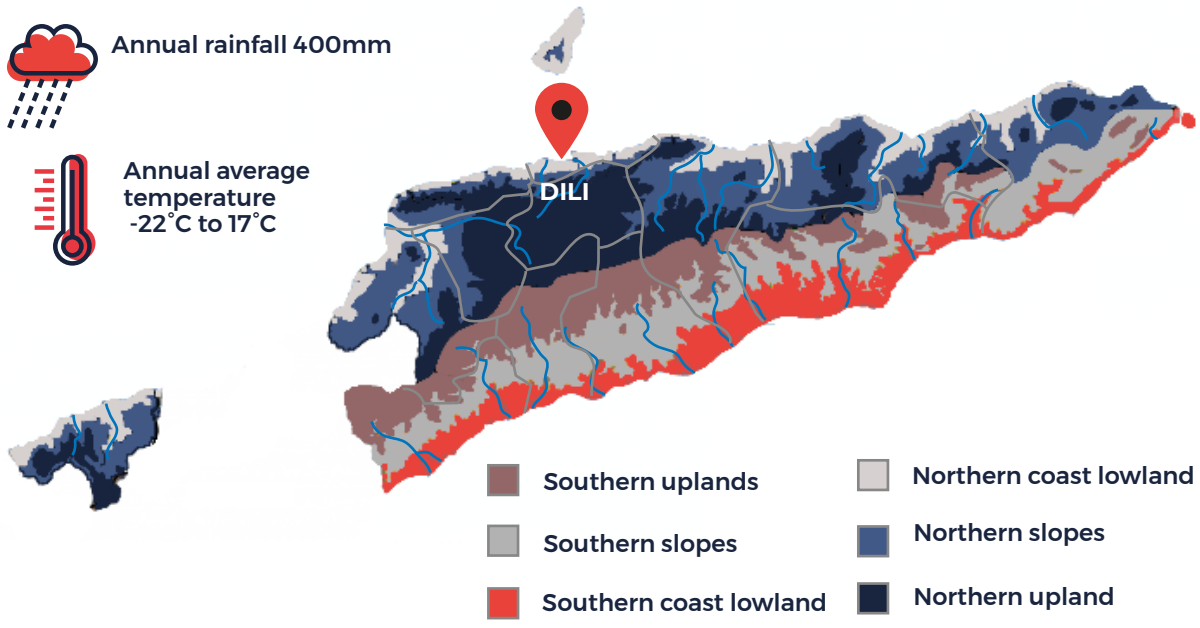
The urgency to act is clear. The purpose of the report is to act as a reference document on the likely impacts – direct and indirect – of the climate crisis on the wellbeing of people in terms of their health and livelihoods. The intention is that this report can act as a springboard for planning and implementing activities and programmes focused on climate action and adaptation. Some recommendations and opportunities for action have been offered, however, these should be considered as only a starting point to further complement and expand existing programmes and projects. Cross-sector and widespread collaboration between National Societies, government agencies and services, the private sector, NGOs, civil societies and our communities is key as no one organization alone can tackle the increased risks posed by climate change nor alleviate the exacerbated risks of vulnerable populations. Together, acting now, with the evidence at hand, it is possible to avert the most dire consequences of the climate crisis.

1. CLIMATE PROFILE AND PROJECTIONS

1.1. CLIMATE

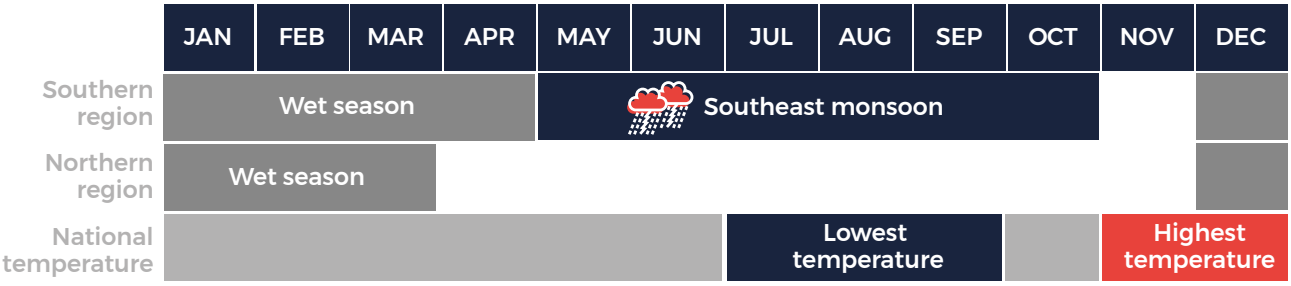
Timor-Leste is a mountainous island nation in South-East Asia that comprises the eastern half of the island of Timor[1] and several smaller islands. Timor-Leste's climate is tropical, with high temperatures in the daytime and nighttime all year round along with high humidity (70–80 per cent) (WBCCKP 2020). Daily and seasonal temperatures are fairly constant at 25°C, but vary depending on altitude (see Figure 1). Rainfall is determined by the western Pacific monsoon with a principal wet season that affects both the southern and northern regions of the island in December–April (See Table 1). The southern parts of the island receive rainfall seven to nine months out of the year, due to an additional rainfall season determined by the southeast monsoon (May–October), which is important for agriculture. However, the southeast monsoon brings relatively less intense rainfall across the southern coast and southern slopes as compared to the northwest monsoon (UNDP 2013; WBCCKP 2020). The northern part of the country receives no rain for almost eight months of the year (WBCCKP 2020) and has only a single rainfall season that prevails from December–April (UNDP, 2013).

Figure 1. Map of Timor-Leste with elevation, temperature and precipitation, Source: ANU 2020



1 The western half is part of Indonesia.

Table 1. Seasonal calendar



1.2. CLIMATE CHANGE TRENDS

OBSERVED CHANGES	SHORT-TERM PROJECTIONS (2020–2039)	LONG- TERM PROJECTIONS (UP TO 2100)
TEMPERATURE	**TEMPERATURE**	**TEMPERATURE**
Temperature has increased by 0.5–0.8°C over the past century and temperature change is accelerating (WBCCKP 2020). Timor-Leste is already a hot country, and the historical trend indicates increasing high daily temperatures.	For monthly average, minimum and maximum temperature, all models predict a **slight increase** of 0.60–0.75°C across all months in the short-term under the high global emissions scenario, resulting in slightly higher monthly changes (WBCCKP 2020).	**Average air temperatures will continue to increase.** Under a high emission scenario, the annual mean temperature is projected to increase in the range of 1.0–2.0°C by 2050, 1.7–3.1°C by 2070s and 4.0–4.2 °C by 2090 (PACCSAP 2015).
RAINFALL	**RAINFALL**	**RAINFALL**
Annual rainfall has decreased at the rate of 40mm per decade (UNDP 2013) and the decline is mostly observed in the principal wet season of December–February (WBCCKP 2020). Natural climatic variability such as El Niño events historically determine rainfall (PACCSAP 2015; SNC 2020).	Projections for annual rainfall are difficult to establish due to natural variability and large model uncertainty (PACCSAP 2015; SNC 2020). In the near-term, a minor decrease in precipitation for the wet season (December–May) is projected, but this is determined by climate variability more than climate change (SNC 2020; WBCCKP 2020). **The difference between the driest and the wettest month is projected to increase** (WBCCKP 2020).	Long-term projections suggest annual rainfall by 2050–2080 may increase slightly(4–6 per cent) (NAPA 2010; UNDP 2013) or decrease (SNC 2020). By the end of the century, there may be **an increase in wet season rainfall**, especially in the mountainous inland (USAID 2017). A **decrease in dry season rainfall** with a mild drying effect over the June–August period may lead to a prolonged drought season (UNDP 2013; WBCCKP 2020).

OBSERVED CHANGES	SHORT-TERM PROJECTIONS (2020–2039)	LONG- TERM PROJECTIONS (UP TO 2100)
SEA LEVEL	**SEA LEVEL**	**SEA LEVEL**
Since 1993, **mean sea level in Timor-Leste has been rising at the rate 9mm per year** – above the global average of 2.8–3.6 mm per year (PACCSAP 2015).	Under a high emission scenario, the projected absolute changes in the annual **mean sea level will be in the range 9–18 cm by 2030** (PACCSAP 2015).	**Sea level is expected to continue to rise** to 18–34cm by 2050, 30–58cm by 2070 and 43–88cm by 2090 compared to the baseline (PACCSAP 2015).
EXTREME EVENTS	**EXTREME EVENTS**	**EXTREME EVENTS**
EXTREME RAINFALL		
Extreme weather events have become more frequent and intense, especially heavy rainfall. This increases the risk of flash floods and landslides (NAPA 2010).	Projections show a s**lightly increasing trend in rainfall intensity** (amount of rain falling during an event). The portion of rain falling during 'very wet days' is projected to increase by 11.3–30 per cent (WBCCKP 2020).	**The intensity and frequency of heavy rainfall events is projected to continue to increase in the long-term.** A current one-in-20-year daily rainfall event will become a one-in-7-year event under RCP2.6 and a one-in-5-year event for RCP8.5 by 2090 (PACCSAP 2015).
CYCLONES		
There has been a **decrease in the number of tropical cyclones** in the region; however, the strongest cyclones are getting stronger (NAPA 2010).	Short-term projections for cyclone frequency and intensity are not available. Influences on cyclone activity are sea-surface temperature, sea-level rise, air temperature and several regional and global climate systems.	**The number of tropical cyclones is likely to decrease in future; however, those that occur will be of higher intensity i.e., higher wind speed** (USAID 2017), causing floods due to tidal surges and swells across the southern coast.
DROUGHT		
Historically **drought conditions** occur frequently, often during El Niño events (SNC 2020). No historical trends are available.	Drought projections differ across climate scenarios because of rainfall and El Niño projection uncertainty. **In the short-term drought frequency and intensity is expected to remain stable** (PACCSAP 2015).	Long-term trends indicate a **drying climate with a higher likelihood of drought** (WBCCKP 2020). The decrease in the dry season rainfall may bring longer dry periods, mostly affecting the already drier northern part of the country (PACCSAP 2015). Droughts may also become more severe (SNC 2020).

OBSERVED CHANGES	SHORT-TERM PROJECTIONS (2020–2039)	LONG- TERM PROJECTIONS (UP TO 2100)
EXTREME TEMPERATURES		
Hot days and extremely hot days predominantly affect low-lying coastal areas. Hot days mainly occur in October–December (GFDR 2021).	**There may be a large increase (12–21 days) in the number of hot days (above 35°C) and in tropical nights (36–43 days)**, especially during the monsoon months. In line with this trend, warm spells and heatwaves are both expected to increase in the short-term already (USAID 2017; WBCCKP 2020).	Extremely hot days will become more 'normal' and by 2090 the temperature of a one-in-20-year hot day is projected to increase by 0.9°C for RCP2.6 (very low emissions) and 3°C for RCP8.5 (very high emissions) (PACCSAP 2015)

1.3. CLIMATIC VARIABILITY AND EXTREME WEATHER

While climate change may drive changes in people's exposure to and the frequency of natural hazards, existing natural climate variability also affects weather and extreme events. Rainfall in Timor-Leste is predominantly influenced by the western Pacific monsoon, El Niño/La Niña (the El Niño Southern Oscillation (ENSO)) conditions, altitude and coastal effects (UNDP 2013; PACCSAP 2015).

- ENSO conditions strongly affect the wet season over Timor-Leste. During El Niño, monsoon onset is often delayed and the wet season ends earlier, leading to a shorter wet season and less rainfall across the country. Therefore, **El Niño events are strongly associated with droughts in Timor-Leste**. Northern coastal areas have been more prone to drought. During **La Niña, the wet season is extended, bringing more rainfall, stronger winds, floods and landslides** to most of the country's steeply mountainous territories (and especially to the eastern zone) (UNDP 2013; PACCSAP 2015). El Niño and La Niña events will continue to occur in the future, but there is little consensus on whether these events will change in intensity or frequency (SNC 2020).
- **Floods** (both riverine and flash floods) are Timor-Leste's most frequent natural hazard (CEDMHA 2019). The typical flood season in Timor-Leste occurs in December–March, with the majority of floods occurring in January and February (UNDP 2013). The steep-sloping terrain and short, fast-flowing rivers make Timor-Leste geographically vulnerable. Construction on flood plains, land management and more intense rainfall and drier soils all increase flood risk.
- While **tropical cyclone** activity is generally low in Timor-Leste, tropical storms can bring strong winds and heavy rainfall to the country with devastating effects (UNDP 2013). More tropical cyclones are observed during La Niña than in El Niño years (UNDP 2013). The number of tropical cyclones is likely to decrease in future, but increase in intensity i.e., higher wind speed (USAID 2017), causing floods due to tidal surges and swells along the southern coast.

SUMMARY: PAST CLIMATE TRENDS AND FUTURE CLIMATE PROJECTIONS

Due to global warming, Timor-Leste will experience a shift to an even hotter climate with hot days and nights becoming the norm. Heatwaves and warm spells will increase dramatically in the next 20 years and beyond. While people in Timor-Leste are used to its tropical climate, the drastic increase in days with temperatures above 35°C and tropical nights will require adaptive efforts. Extreme rainfall events will become more intense and more frequent. The steep slopes and short fast-flowing rivers, in combination with more intense rainfall events, may increase the risk of loss of life/injury and damages during flash floods and landslides. Despite high projection uncertainty, models suggest the wet season will become wetter, while the dry season's rainfall remains stable/decreases slightly. This means the difference between seasons will become even more pronounced. Tropical cyclones will decrease in frequency but increase in intensity, and sea level continues to rise – exposing coastal areas to more storms, tidal surges and strong winds.

RECOMMENDATIONS

1. Raise awareness of the main climate change stressors and shocks for the different regions, and provide communities with access to risk maps.
2. Enhance the dissemination of weather alerts, forecasts and climate projections to reach the 'last mile' so people remain aware and prepared.
3. Integrate ENSO forecasts and seasonal forecasts into programmes-related planning work, especially for health, Water, Sanitation and Hygiene (WASH), livelihoods and Disaster Risk Reduction (DRR).

2. MOST VULNERABLE POPULATIONS

2.1 POOR HOUSEHOLDS

Despite achieving lower middle-income status, poverty levels remain high in Timor-Leste with 40 per cent of the population living below the national poverty line, which impacts the capacity of poor people to respond to or prepare for climate change-related hazards (NAPA 2010; ADB 2020). Poor households face limited access to healthcare, comparatively greater economic and livelihood losses, and have less (financial) means to overcome climate shocks. Geographical isolation and lack of infrastructure for connectivity are among the factors that influence poverty as people here have lower living standards and are, therefore, more susceptible to climate shocks and slow-onset risks such as sea-level rise (UNDP and GCF 2019). Regional climate change differences add to these challenges (see climate change trends in section 1). The highest poverty rates can be found in rural areas, particularly in Oecussi (above 60 per cent) and the northeastern upland agriculture zone, mainly due to a limited connectivity to markets (WFP 2016). The World Food Programme (2016) considers low resilience to climate change impacts as a composite of poverty, limited land availability, low livelihood diversity and high climate sensitivity of income (See Figure 2). While rural areas are typically more vulnerable, poverty appears to be rising in urban areas too due to migration (Molyneux *et al.* 2012). Climate change is a risk multiplier and heat stress, more intense droughts and cyclones as well as a higher frequency of extreme rainfall and consequent floods further threaten the fragile health and livelihoods status of the poorest households.

2.2 WOMEN AND CHILDREN

Women are more vulnerable to climate shocks because they lack ownership and control of assets, hardly occupy leadership positions within the districts and have very little representation even at local-level on decision-making platforms (UNDP and GCF 2019). The different impacts of disasters on women's health, livelihoods and welfare are not incorporated into relief and response policies (UNDP and GCF 2019). Gender-based inequalities are also inadequately assessed and factored into more recent climate change adaptation policy processes. Women shoulder traditional responsibilities as caregivers for children, the elderly and family members with disabilities (World Bank 2019); they are also responsible for ensuring food and water security in this role too. In rural areas, women are more dependent on climate-sensitive natural resources with limited alternative livelihood opportunities as well as a low involvement in decision-making (World Bank 2019). Women are considered particularly vulnerable among subsistence agricultural workers as, on average, they already produce 15 per cent less output than their male counterparts due to socio-political factors such as lower literacy and limited access to tools, labour and farming

inputs (Gavalyugova *et al.* 2018). Children can face lifelong consequences from climate change through malnutrition, limited access to fresh drinking water, and exposure to extreme heat. Timor-Leste has one of the youngest populations in the world, with a high dependency ratio (UN 2018). Climate impacts affecting children may have long-term consequences for their personal development and the development of Timor-Leste as a whole.

2.3 LOW-INCOME HOUSEHOLDS

Both slow and rapid onset climate disasters strain households' resources. For poor or low-income households, studies indicate that recovery is slower and families may use more negative coping strategies compared to more affluent households, which may enforce a negative cycle of poverty (IPCC 2014; World Bank 2017a). For instance, a higher rate of poverty in 37 rural settlements around the Northern, Western and Southern Divisions of Fiji has resulted from 8,500 residents being affected by El Niño-related droughts, which reduced their resilience to face subsequent hazards (World Bank 2017a). Although Fiji has lower poverty rates compared to other Pacific island states, 22 per cent of the general population, 16 per cent of the urban population and 29 per cent of the population in rural areas live below the national poverty line (HIES 2015). Furthermore, the World Bank (2017) predicts more frequent climate-related disasters may push an extra 32,400 people (3.8 per cent of the population) into poverty each year by 2050 as assets are damaged, work opportunities are lost and their health may be affected.

2.4 PERSONS WITH DISABILITIES AND THE ELDERLY

Persons with disabilities worldwide are two to four times more likely to die in a disaster (UNDP 2018). Persons with disabilities and the elderly are more vulnerable to climate change impacts because of their special needs, limited mobility and lower socioeconomic resilience to shocks, which can increase the vulnerability of individuals and also of their caregivers. Caregivers are often women, already facing their own socioeconomic and institutional challenges and climate change impacts put an extra burden on them. The majority of people living with disabilities and those over the age of 60 live in Baucau, Dili and Ermera municipalities (GDS 2018). Apart from worsening disasters, lower food and water availability, a higher disease burden and loss of many livelihoods also affect this social group and their caregivers more acutely.

SUMMARY: MOST VULNERABLE POPULATIONS

The multi-hazard environment of Timor-Leste exposes households to multiple climate shocks and risks such as floods, landslides, sea-level rise and higher temperatures. Being dependent on climate-sensitive natural resources (e.g. rainfed farming, fishing, forest-based livelihoods) increases people's vulnerability, while low income/poverty limits households' ability to overcome climate impacts. Women face a disproportionate burden as they depend comparatively more on climate-sensitive livelihoods and have more caring responsibilities for other vulnerable members of the household. Children may experience long-term effects of climatic events and slow-onset change through malnutrition, water scarcity and heat impacts. People with disabilities and the elderly are more vulnerable due to their limited mobility and often reduced capacity to overcome shocks. These groups are not mutually exclusive. Overlaps between them are especially concerning, such as poor or single women living with disabilities in remote areas.

RECOMMENDATIONS

1. Impacts from climate change are highly linked to geographic location and require context-specific, locally adapted risk reduction strategies, early warning, and awareness generation plans.
2. Include the voices of vulnerable groups in community assessments and in community-based health and livelihoods committees.
3. Prioritize intersectionality and the use of disaggregated data to plan and design programmes locally.

3. HOW WILL LIVELIHOODS BE AFFECTED BY CLIMATE CHANGE?

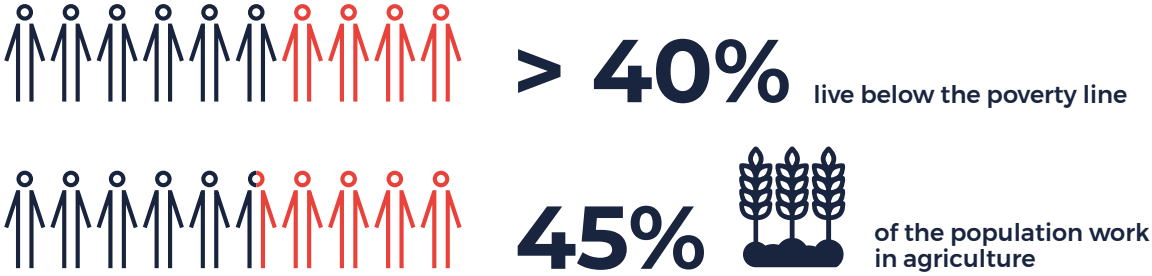
According to the IPCC (2014), there is high confidence that climate change, climate variability, and climate-related hazards exacerbate other stressors, worsen existing poverty, deepen inequalities, trigger new vulnerabilities and typically have negative outcomes on livelihoods.

The following sections briefly outline the main livelihood strategies in Timor-Leste and, in particular, the vulnerabilities to climate change. In the case of Timor-Leste, farm-based livelihoods (supporting 80 per cent of the population) are particularly sensitive to climate change. A summary of the impacts of climate change on livelihoods in Timor-Leste is shown in Annex B.

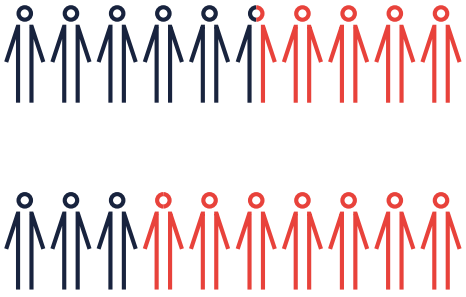
3.1. COUNTRY LIVELIHOODS PROFILE

Although the Government mainly relies on the oil and gas industry for revenue, and despite rapid urbanization, Timor-Leste is still a predominantly agrarian society. There is a strong link between poverty and agriculture in Timor-Leste – on average, 80 per cent of the poor rely on agriculture for their livelihoods (Molyneux *et al.* 2012). Subsistence agriculture includes farm crops and produce from home gardens, livestock, fisheries and forest products. Due to the dominance of rainfed agriculture, rainfall changes are the major climatic driver of livelihood vulnerability (WFP 2016). Moreover, subsistence foodstuff dependency is high, which signifies low diversification of livelihoods and higher vulnerability to climate impacts. However, there is a declining trend in the share of subsistence production in the agricultural sector (from 78.7 per cent in 2013 to 53 per cent in 2016), signalling a shift to market-oriented production (ILO 2020). The other important sector in Timor-Leste is the services industry, which includes retail and public sector jobs (ILO 2017).

Figure 2. Employment statistics. Source: ILO 2017



Importantly, the informal sector remains large in Timor-Leste – non-agricultural informal employment was 53 per cent in 2013 (ILO 2020). Vulnerable employment (own-account and contributing family workers) is high too – 71 per cent in 2018 (ILO 2020). Those in informal and vulnerable employment have limited access to social safety nets, lower income security and limited insurance against health and safety hazards, which make them vulnerable to disaster and slow-onset climate impacts. Women, migrants and other vulnerable groups, who may be excluded from formal labour opportunities, may be forced to take these informal low-quality jobs (ILO 2020).



3.2. AGRICULTURE, LIVESTOCK AND FISHERIES

The majority of those engaged in farm work grow maize (88 per cent) and cassava (81 per cent), while rice production is an important staple for food security and coffee is the main cash/export crop (WFP 2016). General projections suggest that the combined effects of changes in climate would result in a reduction of maize yield of 5–20 per cent from the current yield depending on climate scenarios, along with increasing crop failures due to extreme climate events (INC 2014). Eighty per cent of households also hold **livestock** – especially in the eastern regions and Oecussi (WFP 2016; SNC 2020). **Fisheries** are relatively underdeveloped in Timor-Leste, and only play a role in subsistence food and livelihood activities on Atauro Island and particular communities along the northern coast. Fishing in the south is limited by wave activity (WFP 2016).

The growing season is largely determined by **rainfall**, as irrigation infrastructure coverage is very low. In the east, Oecussi and coastal regions historical trends show **delayed rainy season onset** (WFP 2016). The northern regions have only one wet season and therefore one harvest, while the central highlands and south coast experience two wet seasons, usually allowing the planting of two maize crops per year (Molyneux *et al.* 2012). Therefore, maize production in the northern regions is highly vulnerable if rainfall patterns change and drought risk increases. Generally, the changes in rainfall seasonality will decrease the suitability of traditionally grown crops and limit expansion opportunities for agriculture – especially in the north (WFP 2016). Rainfed rice paddies in the low-lying coastal regions (mainly southern coast) are also vulnerable to rainfall changes – along with salinization from **sea-level rise and coastal flood events** (WFP 2016).

The **increased intensity of cyclones heightens** exposure to high wind speeds, intense rainfall and coastal floods with significant risks of loss of crops.

More intense and frequent **extreme rainfall** will exacerbate land erosion and landslide problems – compounded by deforestation and slash-and-burn practices, with economically important coffee production in the highlands particularly vulnerable (Molyneux *et al.* 2012; WFP 2016). Extreme rainfall can damage plants and cause waterlogging. While a lot of water can benefit rice paddies, it will likely increase the damage risk to maize and cassava – the main subsistence staple crops (WFP 2016; USAID 2017).

The general **increase in temperatures and more frequent hot days** and nights may restrict the germination rates of crops (USAID 2017) and also increase evaporation, thereby intensifying water requirements while reducing water storage. Furthermore, hot conditions may favour the development of pests and diseases for both plants and livestock, and deteriorate water quality. For livestock, heat stress may reduce the animals' reproduction and weight and may increase their vulnerability to disease – especially when coupled with water access restrictions during drought.

The rising sea-surface temperature and ocean acidification will affect the migration of reef fish further away from the shore, with negative implications for artisanal fisherfolk (USAID 2017)[2] who use paddle boats that will not be able to go further out to sea because of the stronger currents.

2 Interestingly, unlike in the Maldives and Fiji, Timor-Leste's coral reefs may be protected from bleaching by cooling from the Indonesia Throughflow ocean current (Rosegrant *et al.* 2016).

ENSO AND AGRICULTURE IN TIMOR-LESTE

Droughts and extremely wet years are largely determined by El Niño (dry) and La Niña (wet) events. The impact of ENSO on agricultural production, rural livelihoods and, by extension, food security is immense. For example, estimates suggest that an extreme drought during the 2015/2016 El Niño affected up to 50 per cent of national maize and rice production, and half of the affected population lost livestock because of heat impacts and water scarcity (SNC 2020). The cumulative effects caused 50 per cent of the population to become food insecure (WFP 2016; FAO 2018). Water access was severely limited, as springs, rivers and lakes dried up (WFP 2016). This underlines the importance of considering ENSO dynamics in disaster planning.

3.3. OIL AND GAS

The main source of income for the national treasury are revenues from the offshore oil and gas industry. While these oil and gas reserves will not directly be affected by climate change, the increased frequency of and exposure to floods, landslides, storms and more intense cyclones may incur damages to the industry's infrastructure and transport (INC 2014). This may have knock-on implications for public spending on, for example, social security and public health services.

3.4 URBAN AND TOURISM LIVELIHOODS

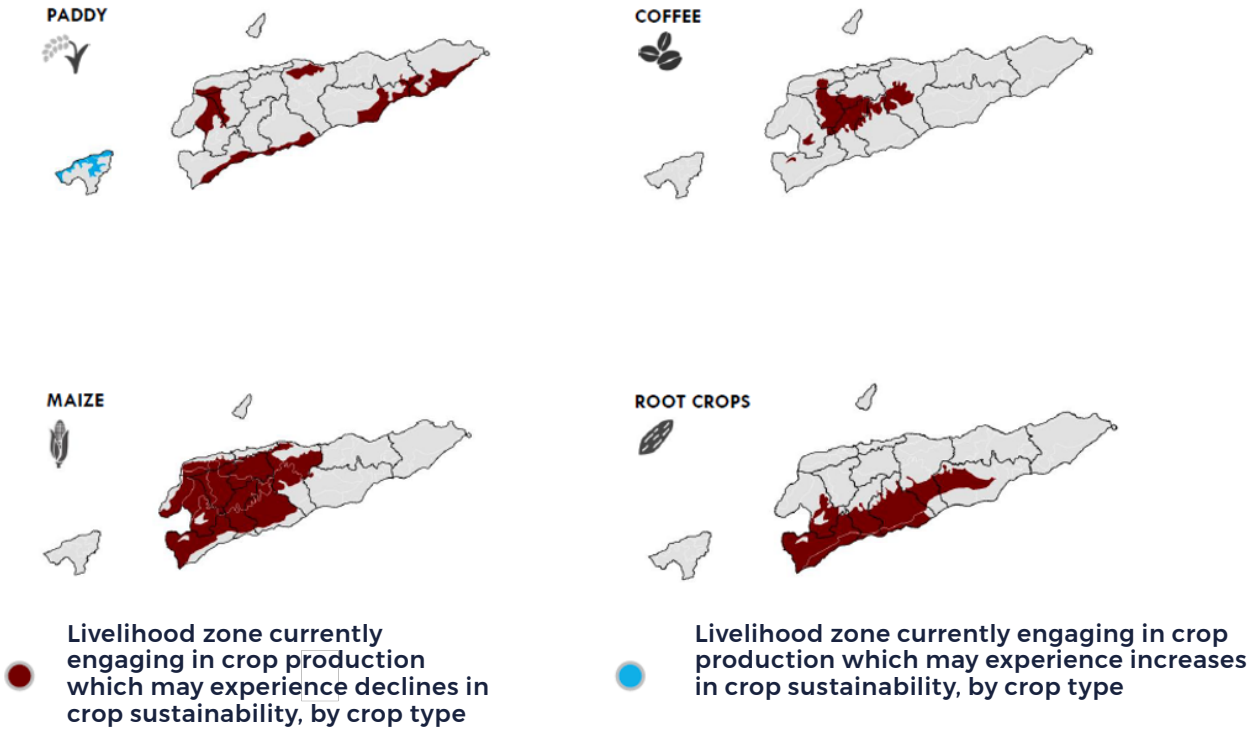
Those living in urban areas and communities involved in tourism in Timor-Leste are generally considered less vulnerable to climate change shocks because of income stability and predictability – poverty rates in urban areas are lower compared to rural areas. However, especially in the capital Dili, there are many settlements suffering from poverty, few employment opportunities and poorly planned infrastructure, where households depend on markets for food. **Food price shocks**, therefore, pose a major risk to these urban households' food security (WFP 2016). **Extreme rainfall-induced flash floods and cyclones** frequently cause extensive damage to urban informal settlements (CEDMHA 2019). Furthermore, **heat stress and rising temperatures** will affect those working outside (e.g., in construction or street vending) as well as people living in crowded, poorly constructed housing (NAPA 2010); although International Labour Organization (ILO) estimates suggest only minor losses in work productivity (ILO 2019).

The tourism industry in Timor-Leste is considered a potential livelihood diversification opportunity. However, the higher risk of extreme weather events – especially floods and cyclones – along with the degradation of the coastal ecosystems (reefs, mangroves) may negatively influence Timor-Leste's attractiveness as a holiday destination, and jeopardize the development plans for this sector (NAPA 2010; Jebson 2014).

3.5. FOOD SECURITY

According to the Committee on World Food Security (CFS) (2012), "food security is a situation that exists when all people, at all times, have physical, social, and economic access to sufficient, safe, and nutritious food that meets their dietary needs and food preferences for an active and healthy life." Whilst food security relates to nutrition, food insecurity is related to malnutrition insofar as poverty is often linked to poor diets.

Figure 3. Crop suitability trends under climate change per livelihood zone. Source: WFP 2016



Food security remains a major challenge in Timor-Leste, with 15 per cent of the population experiencing **severe chronic food insecurity**, and up to 70 per cent of the population experiencing some degree of food insecurity per year (CEDMHA 2016; Hallo 2019). A distinct "hungry season" in Timor-Leste occurs before the harvests in two phases – initially when supplies of maize and rice are nearly finished, and again when all staples are in short supply (Costa *et al.* 2013). For a review of the health implications of these nutritional shortages, see section 4.4 on Malnutrition.

70% of Timorese experience food insecurity annually

The main drivers of this chronic cycle of food insecurity are the low yields and productivity of the subsistence agriculture sector along with post-harvest losses of up to 30 per cent of grains (Molyneux *et al.* 2012; USAID 2017). Market access, the policy environment and the geography of Timor-Leste are the major determinants of low yields. Weather and climate shocks – especially **droughts and extreme rainfall events** – limit productivity as well. The effects of climate change on agricultural productivity outlined in section 3.2 will increase the risk of crop failure, damage, reduced yields and loss of products post-harvest (ACAPS 2012; WHO 2015a).

Vulnerability is determined by the type of crop grown along with rainfall patterns. The "hungry season" affects lowland rice farmers prior to harvest in June/July (in the north) and August/September (in the south), and upland maize farmers are at risk in September–April (Costa *et al.* 2013). The World Food Programme (WFP) identifies the municipalities of Ermera, Manufahi and the Special Administrative Region of Oé-Cusse Ambeno (SAROA) as suffering from severe chronic food insecurity (IPC level 4), along with Ainaro, Covalima, Manatuto and Lautém (WFP 2020).

Table 3. Food insecurity in Timor Leste has two phases (Costa *et al.* 2013):

STAGE 1: '*TEMPU AIHAN MENUS*'	STAGE 2: 'TEMPU RAI HAMLAHA'
Staple supplies of maize and rice are nearly finished but households have access to root crops (cassava, sweet potato, taro and arrowroot) as substitutes - **although the amount of food consumed already markedly decreases.**	**Shortages of all staples.** Coping strategies include foraging for wild foods in forests, taking loans, consuming seed stocks and relying on social networks for emergency food supply. **Severe food insecurity.**

3.6 PHYSICAL ASSETS (HOMES AND WORKPLACES)

The heavily sloping terrain, the short, fast flowing rivers and long coastline of Timor-Leste exposes the population to floods, landslides and strong winds (CEDMHA 2016). **Over 450,000 households are affected annually (almost half the population) by floods and landslides**, with outcomes such as displacement and diminished water quality to injury and mortality from falling structures (USAID 2017). The increased frequency and intensity of extreme rainfall is likely to exacerbate riverine floods, flash floods (especially in urbanized areas) and landslides (mainly in the highlands). Furthermore, sea-level rise may increase the area exposed to coastal floods and may aggravate storm surge intensity – combined with the more intense cyclones projected, this may cause severe damage to the housing of coastal communities.

SUMMARY: HOW WILL LIVELIHOODS BE AFFECTED BY CLIMATE CHANGE?

Most livelihoods in Timor-Leste are climate-sensitive, especially those related to agriculture. Changing rainfall patterns, higher temperatures and drought risks challenge existing knowledge and practices and may reduce agricultural income. The high portion of subsistence agriculture limits investment opportunities elsewhere. Furthermore, climate change puts an additional strain on the already highly food insecure (rural) population, as the onset of the growing season becomes more unpredictable and harvests may be lost due to climatic events. Urban centres are faced with water availability issues, an increased frequency of floods that damage homes and workplaces and, in coastal regions, sea-level rise as well. The impacts of increasing extreme events such as flash floods, landslides, storms and extreme temperatures will affect all economic sectors and those working in them through damages, transport issues and more challenging working conditions.

RECOMMENDATIONS

1. To support food security and livelihood stability, there is a need for the adaptation of agricultural practices, where historical/indigenous knowledge and practices may need to adjust to shifts in the seasonal calendar and characteristics.
2. Livestock, afforestation (for food, wood and ecosystem resilience) and home gardens need to be prioritized to enhance food and water security and safeguard livelihoods.
3. More extreme rainfall and water security risks need attention around stormwater drainage, rainwater harvesting techniques and the integration of local (indigenous) knowledge to prevent water-centred disasters.
4. There may be scope for more Early Warning Early Action activities regarding extreme rainfall, although the changing length of the wet season also requires structural adaptation.

4. HOW WILL HEALTH BE AFFECTED BY CLIMATE CHANGE?

4.1. MORTALITY AND NONCOMMUNICABLE DISEASES

Mortality and injury. Floods are the most frequently occuring and deadly natural hazard in the country, followed by landslides and strong winds (CEDMHA 2016). Floods and landslides cause death from drowning and falling trees and structures (including bridges and houses) as well as injury from uprooted trees, debris and rubble moving in fast-flowing mud or water. They result in the displacement of communities to temporary shelters. The risk of these hazards will escalate with climate change as the intensity and frequency of heavy rainfall events increases; higher intensity cyclones are also predicted.

Heat. Timor-Leste is already a hot country and the number of 'hot' days and nights will show a large increase (as high as 21 days and 43 nights) by 2040, representing extremely uncomfortable conditions, especially for outdoor workers. Under high emissions scenarios (business as usual) the number of heat-related deaths in the elderly is projected to increase from no estimated deaths (at baseline) to 39 deaths per 100,000 (by 2080) (WHO 2015a). A rapid reduction in emissions will still see 5.5 deaths per 100,000 (by 2080) as a result of the temperature increases that are already inevitable (WHO 2015a).

Noncommunicable diseases. Mortality from noncommunicable diseases may also increase from outdoor and indoor air pollution, caused by activities that are contributing to greenhouse gas emissions (e.g. the burning of fossil fuels) and, as such, climate change. Ninety three per cent of the population uses solid fuels for cooking (WHO 2015) and "62 per cent of an estimated 500 child deaths due to acute lower respiratory infections is attributable to household air pollution" (WHO 2015a).

4.2. VECTOR-BORNE DISEASES

Vector-borne diseases pose significant health impacts and are highly sensitive to changing climatic conditions (temperature, rainfall, humidity), which exert a strong influence on the life cycles of the vectors (such as mosquitoes) (WHO 2015b). Vector-borne diseases are also influenced by non-anthropogenic factors – which are not the focus of this report – such as population growth, urbanization, and prevention and control measures.

Dengue Fever is a major public health concern in Timor-Leste, exhibiting a highly seasonal increase in cases. Most cases occur across the wettest and hottest months of the year (December–February, peaking in January), with hotspots around Dili (especially Comoro, Tirilolo, Bairo Pite and Manatuto (Wangdi *et al.* 2018). The mean relative vectorial capacity (the total number of potentially infectious bites that could arise from mosquitoes biting a single human on a single day) is projected to increase under both high and low emissions scenarios, as increases in mean temperature and precipitation create more favourable conditions for the mosquitoes (WHO 2015a; Wangdi *et al.* 2018). Additionally, rising temperatures and water shortages (e.g. during the dry months) will likely result in the increased storage of water in containers, which provide ideal breeding places for mosquitoes, bringing them into contact with people and especially women who are more likely to work in and around the house (Wangdi *et al.* 2018).

4.3. WATER, SANITATION AND HYGIENE

This section covers the main health issues related to Water, Sanitation and Hygiene (WASH) and how they will be impacted by climate change.

Water supply

Changing rainfall patterns, the heightened risk of drought (i.e. water scarcity) and more extreme rainfall events – which are all projected for Timor-Leste – will affect water supplies by damaging water infrastructure and polluting surface-water sources (USAID 2017). Water scarcity, in particular, will increase competition between the different uses of water (domestic, drinking, agriculture). As the seasons are expected to become more pronounced, water sources are more likely to dry up during the dry season. This is already being seen in certain districts, and has especially impacted women who now have to walk further to access water for their families (Oxfam 2012). Due to rapid urbanization, groundwater resources are already over-abstracted (INC 2014). Climate change will complicate matters by changing the recharge potential with a longer dry season and creating more concentrated rainfall and salinization due to sea-level rise in coastal regions (AusAID 2010). The challenge of water scarcity will need to be addressed with integrated multi-use approaches to safeguard food security and WASH. The Red Cross Timor-Leste (CVTL) is one of the main organizations involved

in the construction of improved water and sanitation facilities in rural communities, and is well-placed to contribute significantly to climate change adaptation for WASH as well as climate-proofing infrastructure and systems across the coutry.

78% Improved drinking water

70% Rural

98% Urban

54% Basic sanitation

43% Rural

76% Urban

JMP WASH data

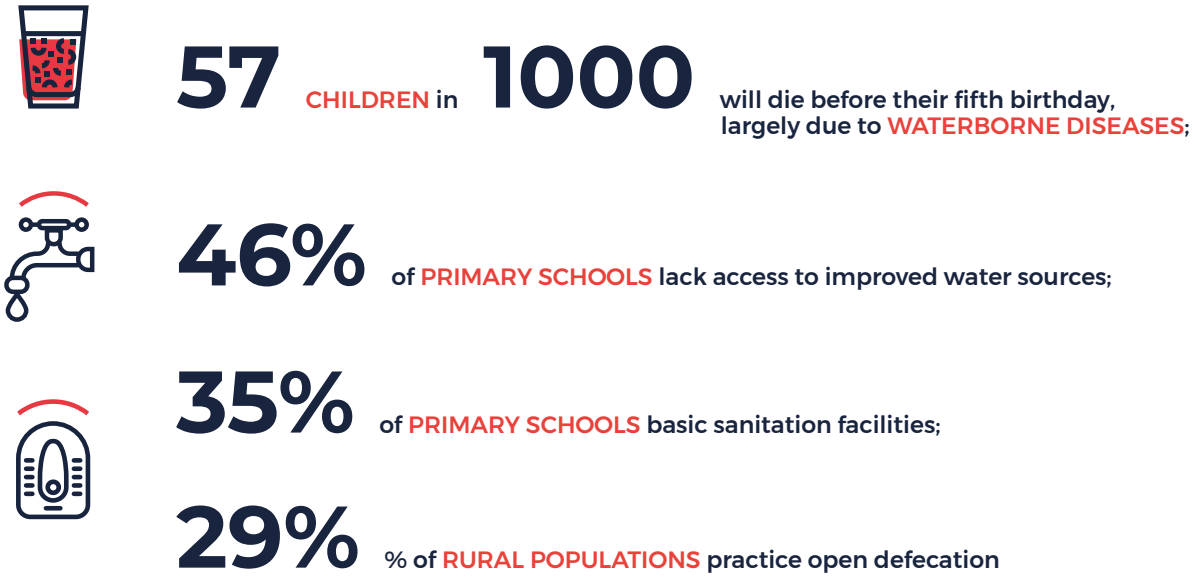
Sanitation

Less than 50 per cent of the overall population have access to basic sanitation. Typically access to improved sanitation systems (e.g. domestic wastewater facilities) is higher in Dili, where more than 70 per cent of the capital's population are linked to a sanitation system (SNC 2020). For the rest of the population, most disposal of sewage (including infant faeces) takes place directly into river systems (CEDMHA 2016). Improved water access and basic sanitation facilities are lacking in primary schools, which adds to the disproportionate risk children face from the impacts of climate change on health (UNICEF 2014). As floods and temperatures are likely to increase, this poses a heightened risk of the transmission of waterborne diseases.

Water-borne diseases

- Waterborne diseases already represent a high burden of mortality, especially amongst children. Changing conditions which favour parasitic and pathogenic growth (e.g. more extreme rainfall, increased temperatures) may increase the burden of Diarrhoeal diseases, Typhoid Fever, and Soil-transmitted Helminths. Dehydration caused by severe Diarrhoea is a major cause of mortality among young children, and may become more challenging to treat as temperatures and water scarcity increase, especially where sanitation remains absent (UNICEF 2014; Vaz Nery *et al.* 2019). These infections are associated with nutritional deficiencies (e.g. iron-deficiency Anaemia), but can be cost-effectively prevented and treated by using soap, hand washing, improved hygiene, and deworming pills (Vaz Nery *et al.* 2019).

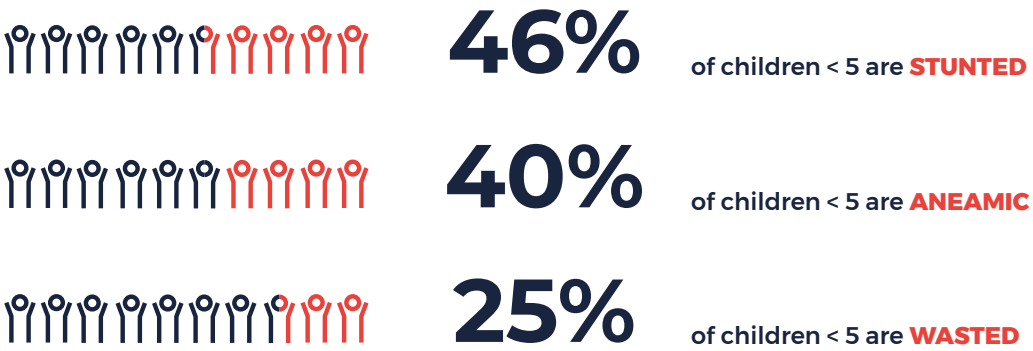
Figure 5: Source: UNICEF 2014.



4.4. MALNUTRITION

Climate change will likely exacerbate the serious public health problems of food and nutritional insecurity facing Timor-Leste. Malnutrition is already the "single greatest contributor to premature death and disability in the country" and Timor-Leste has the highest levels of malnutrition among the countries of the Asia Pacific Region (Provo *et al.* 2017). One in two children under five years old are stunted (a sign of chronic malnutrition); and one in four children under five years old are wasted (a sign of acute malnutrition caused by insufficient food intake, infectious diseases, or a combination of both) (World Bank 2020). The rising temperatures, heatwaves, land and water scarcity and more extreme weather events (resulting in higher flood risk) will negatively impact agricultural productivity by increasing the risk of crop failure and livestock mortality, thereby disrupting the food systems in a country in which there is already an underproduction of staple foods (WHO 2015a; Provo *et al.* 2017; USAID 2017).

Previous studies have shown that stunting is most prevalent in rural areas (especially Ermera) where poverty is most concentrated, compared to urban areas (World Bank 2020). Yet, wasting was higher among urban, wealthier children indicating that "factors related to infant and young child feeding, hygiene, and caregiving (rather than poverty-driven food shortages) may be driving the prevalence of wasting" (Provo *et al.* 2017). Boys in their first two years of life are more likely to be malnourished than girls (World Bank 2020), which may have to do with cultural practices.



Malnutrition in the form of micronutrient deficiencies is common in Timor-Leste. The Timorese diet is low in iron and protein-rich foods; and, as a result, the incidence of anaemia is high: two in five children under 5 years old and women (aged 14–60) are anaemic (Provo *et al.* 2017). Wealthy, urban women show a higher prevalence of anaemia, potentially due to a diet with greater quantities of processed food (Provo *et al.* 2017). Zinc and Vitamin A deficiencies are also high in both women and children (Provo *et al.* 2017), as the diet is based largely on starches (imported cereals as well as corn, rice, cassava, rice porridge, peanuts, mung beans, vegetables and pumpkin leaves (Provo *et al.* 2017). Both macro- and micronutrient deficiencies in women of reproductive age risk perpetuating intergenerational cycles of malnutrition (Provo *et al.* 2017; World Bank 2020).

4.5. DISPLACEMENT AND MIGRATION

There is a high proportion of internal migration (17.7 per cent) as people settle in other districts, often towards Dili, the capital (UNESCO *et al.* 2016). There is limited evidence on environmental migration as a result of climate change. The majority of large-scale internal displacement – in which people were forced to flee to camps – occurred during the violent conflicts in early 2006 (IFRC 2007). Nevertheless, each year, floods and landslides cause the displacement of 450,000 households – "a number which is likely to rise with increased rainfall intensity" (USAID 2017).

4.6. MENTAL HEALTH

Mental health issues (anxiety, stress, depression, post-traumatic stress disorder) as a result of climate change and extreme weather events around the world have been identified in numerous studies. In Timor-Leste, however, there is limited evidence linking mental health issues and climate change, but there is: 1) a high volume of evidence for a significant burden of trauma from decades of conflict; and 2) evidence that cumulative trauma exacerbates symptoms of psychological distress, anxiety and stress (Silove 2014; Hall *et al.* 2019). People with mental health illnesses have been found to face widespread barriers to employment, education, social protection and legal systems as well as stigmatization, bullying, physical and sexual violence, and confinement (Hall *et al.* 2019). Whilst the exact links between climate change and mental health are not explicit for Timor-Leste, there is reason to believe that those already suffering from mental illnesses are likely to face multifaceted challenges as a result of direct and indirect climatic stressors on livelihoods, people and services.

4.7. CRITICAL INFRASTRUCTURE AND HEALTHCARE SYSTEMS

Decades of conflict have destroyed much of the infrastructure, including the health, water and sanitation systems of Timor-Leste, which have since slowly started to be rebuilt (World Bank 2018). Timor-Leste has a tax-based health system, through which healthcare services are provided free at the point of use – i.e. universal healthcare coverage (Guinness *et al.* 2018). The three-tiered healthcare delivery system consists largely of community health centres and health posts delivering primary healthcare services in all 13 districts; five referral hospitals at the district level providing secondary services; and a national hospital in the capital (Dili) providing tertiary care. Though the services are designed so that everyone should be able to access basic healthcare services within an hour's walk (Guinness *et al.* 2018), access – especially road access – remains a challenge during the rainy season. Roads in high elevation areas are routinely washed away by landslides, and those in low elevations are routinely blocked by floods and the debris of landslides (ACAPS 2012). Increased extreme rainfall as a result of climate change may increase the frequency of these events, further hampering the access of those at a distance from the healthcare facilities that they require. Unsurprisingly, rural households have been found to be less likely to go to hospital (secondary services) than urban households (Guinness *et al.* 2018).

4.8. SEXUAL, REPRODUCTIVE, MATERNAL, NEWBORN AND CHILD HEALTH

Climate change already is, and will continue to, affect men and women as well as boys and girls differently. Key areas of concern from global studies have shown how a changing climate is altering the dynamics and risk of negative maternal health outcomes, forced child marriages, human trafficking, sexual exploitation and gender-based violence (Castañeda Carney *et al.* 2020; Women Deliver 2021). However, considerable gaps in research and evidence that link climate change and sexual and reproductive health rights exist both globally (Women Deliver 2021) and in Timor-Leste.

Some key trends bear consideration with regards to sexual, reproductive, maternal, newborn and child health and climate change:

- **Accessing sexual and reproductive healthcare services:** physical remoteness and the poor quality of service delivery have also been found to reduce women's access to family planning services, ante-/post-natal care, and vaccination (Provo *et al.* 2017).
- **Sexual health:** intimate partner violence is extremely high (at least 39 per cent of women have experienced violence) in Timor-Leste, including sexual violence and abuse, which is also directed at minors (Rees *et al.* 2016; The Asia Foundation 2019). Climate change is "recognized as a serious aggravator of gender-based violence" (UNFCCC 2019).

- **Reproductive health:** climate change will impact crop growth, and reduced food intake is particularly concerning for pregnant women and their unborn children. Studies show that a lack of nutritious food has led to Anaemia in 40 per cent of women of reproductive age, pregnancy issues, increased intrauterine growth retardation, low birth weight and perinatal mortality.
- **Maternal health:** half of the women in Timor-Leste do not deliver in a healthcare facility or have access to a skilled birth attendant (UNICEF 2021). Maternal mortality is high and accounts for 42 per cent of deaths in women aged 15–49 years (UNICEF 2021). Access to reproductive healthcare is low in rural areas, with less than half (45 per cent) of births being delivered by a skilled birth attendant (WHO 2018). Urban women have higher access to skilled birth attendance (87 per cent) (WHO 2018). Short timespans between births and insufficient caloric and nutrient intake increase the risk of adverse maternal health (and child) outcomes. The risk of pregnant women experiencing dehydration, micronutrient deficiencies and infections (e.g. with Dengue Fever) is expected to be increased by climate change, heightening the chance of complications (e.g. preterm birth, eclampsia and low-weight births among others) (Women Deliver 2021).
- **Newborn and child health:** the level of malnutrition among children is high (stunting and Anaemia) and may be exacerbated as climate-related food insecurity increases, with lifelong consequences on the children affected.

SUMMARY: HOW WILL HEALTH BE AFFECTED BY CLIMATE CHANGE?

Climate change will have both direct and direct impacts on health. Direct mortality from climate-related hazards, especially floods and landslides, may increase as these hazards become more intense and frequent. The biggest health risk in Timor-Leste is the impact climate change may have on an already dire prevalence of malnutrition. Timor-Leste has the highest levels of malnutrition among the countries of the Asia Pacific region and is already the "single greatest contributor to premature death and disability in the country". Malnutrition in the form of micronutrient deficiencies is common in Timor-Leste, and especially among women of reproductive age, which risks perpetuating intergenerational cycles of malnutrition. Numerous factors influence malnutrition, including cultural practices as well as access to nutrient-rich, healthy food. The linkages between infectious diseases, water security and hygiene, livelihoods and maternal knowledge, in combination with the interaction of climate change, are therefore highly important to understand to combat malnutrition in urban and rural areas. The impacts of climate change on WASH and waterborne diseases, however, represents a significant gap in the literature. There is limited evidence of environmental migration as a result of climate change with the majority of historic displacement linked to conflict. There is reason to believe that those already suffering from mental illness are likely to face multifaceted challenges as a result of direct and indirect climatic stressors on livelihoods, people and services.

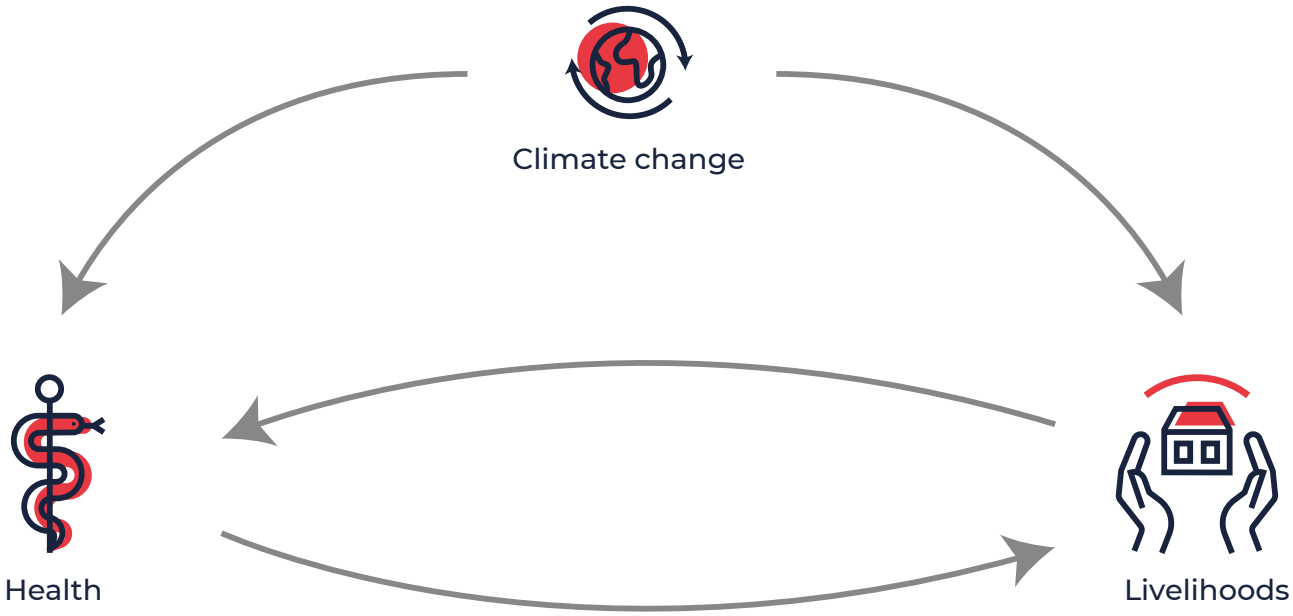
RECOMMENDATIONS

1. Adopt an integrated focus on preventing underlying environmental and climatic drivers of malnutrition.
2. Use forecast-based actions to reduce spikes in food insecurity, which may exacerbate the malnutrition situation.
3. Conduct further research into waterborne diseases.


"Cribas"
CVTL
→Sintina Hotu.
→Atu Han.
→Atu Prepara Hahan.
→Atu Fo Susu Bebe.
→Hamos Hotu Bebe
Nia Foer.
DEPOIS DE KURU
BEE HOTU TENKI TAKA
FALI TORNEIRA.
TAKA BEE NALIHUN
NO HAMOS BEE DALAN
© IFRC

5. LINKAGE BETWEEN CLIMATE IMPACTS ON HEALTH AND LIVELIHOOD

Climate change has the potential to affect health and livelihoods in a negative feedback loop. When climate change negatively affects livelihoods, people do not have sufficient money to ensure good health and pay for healthcare, causing a spiralling of acute or chronic conditions; or, when climate change negatively affects health, people may be unable to work and thereby earn sufficient money to pay for the healthcare they need, further reducing their ability to get better. A popular idiom in South Asia says: *jaan hai to jahan hai* – "the world exists when health exists."



Timor-Leste is experiencing rising air temperatures that are making the already hot country hotter, sea-level rise and changes in sea-surface temperature and acidification as well as changes to the onset of the rainfall season, more erratic rainfall and more intense rainfall events. The ENSO phenomenon has a significant influence on the climate of Timor-Leste. During extreme phases, the dynamics of El Niño bring drought conditions where crops fail, livestock die and families' incomes are reduced, and water and food shortages are widespread. At the other extreme, La Niña typically brings above average rainfall in the dry season and the wet season is elongated, which results in the increased risk of flash floods which also destroy or damage crops, reduce incomes and increase food insecurity. As malnutrition is the single biggest contributor to death in Timor-Leste, the dynamics of food insecurity are extremely important and impact the health status of the Timorese, especially at-risk groups, in turn affecting their ability to put in adequate work to earn a decent income.

There is a substantial amount of uncertainty around rainfall projections and little consensus on how the ENSO phenomenon will change and what this will mean for the intensity and frequency of El Niño or La Niña events. It is likely that there will be more pronounced differences between the seasons, meaning that the wet season will be wetter and the dry season drier. As such, the risks of higher intensity cyclones, floods and droughts are likely to increase, all of which have a major negative impact on the productivity of predominantly rainfed agriculture. The risk of crop failure and damage, livestock mortality, and damage to and the destruction of assets from droughts and floods is likely to increase. Changes in rainfall patterns will affect staples such as maize and root crops, which may become less suited to the environment as rains have an earlier onset. Women, who already have lower agricultural productivity due to barriers to accessing finances as well as knowledge, will have to walk further to gather water in longer dry seasons thereby reducing the time spent on their farms. They already spend, on an average, 2–3 hours a day accessing water (UNDP and GCF 2019). Longer walks to access water and firewood as well as carrying perhaps larger loads for longer distances will further aggravate health impacts, especially in peak temperatures. This may impact their productivity further. Climate change is a major driver of livelihood vulnerability and food insecurity, which can lead to serious negative coping strategies, augmenting the risk of poverty-driven malnutrition directly from insufficient food production and caloric intake, but also through the dynamics of infection from contaminated water, of which there was found to be relatively little information. Climate change impacts on home gardens are seldom addressed as part of relief work or rehabilitation inputs and this will lengthen the time required for families to produce nutritious food after a disaster.

The impacts of floods and landslides are not only limited to agriculture. Flooding in upland rural areas (along with landslides), urban centres and lowland areas frequently destroys or damages infrastructure – washing away bridges, blocking roads, damaging or destroying buildings (such as health facilities), wrecking foundations and breaking electricity poles among others – which disrupts immediate emergency response efforts as well as impedes long-term development goals and connectivity to healthcare facilities and markets.

Temperature increases may also affect people's overall productivity and health outcomes. The number of 'hot' days and nights may increase by up to 21 days and 43 nights by 2040, representing extremely uncomfortable conditions. Hot days cause physical discomfort, dehydration, heat stress/stroke and the increased risk of particular noncommunicable diseases, which may reduce an individual's ability to earn a livelihood. Heat stress also affects crops and domestic animals, which may further reduce households' food sources and livelihoods. Dengue Fever transmission and cases are highest at the wettest and hottest times of the year, with expectations that transmission will increase as conditions become more favourable for mosquitoes. Infection with this disease – once called 'breakbone fever' – can reduce an individual's ability to get out of bed let alone work for several weeks, thereby reducing the household income, and necessitating spending on healthcare. Increased air

temperature also leads to greater evaporation of the already limited surface waters and water sources, which may increase the risk of waterborne diseases – similarly affecting people's ability to work and earn enough to meet their increasing expenditure on healthcare. However, information on this is relatively limited.

The changes in the seas – both sea-level rise and ocean acidification – for the island nation may also lead to damage to infrastructure and agriculture, impacting livelihoods and health. For example, as much as 18cm of coastline may be lost by 2030, 34cm by 2050, 58cm by 2070 and 88 cm by 2090, encroaching on roads and critical infrastructure such as water sanitation systems, electricity, healthcare facilities and agricultural land. Loss of connectivity will lead to loss of markets as well as livelihoods and may deepen malnutrition, resulting in further work loss. As most rice paddy fields are in coastal areas, they are particularly susceptible to salinization and loss of land due to sea-level rise. Interestingly, Timor-Leste has a cooler ocean current passing by it – the Indonesia Throughflow – which may be protecting the coral reefs as well as the marine ecosystems they support. The protection of marine ecosystems along with the health and livelihoods of coastal communities are, therefore, interdependent and critical to building local resilience.

SUMMARY: WHAT ARE THE KEY LINKAGES BETWEEN CLIMATE CHANGE, HEALTH AND LIVELIHOODS?

Climate change impacts both health and livelihoods and also causes one to affect the other. This leads to a downward spiral of impoverishment, especially for at-risk groups. Lower food production due to the late onset of rainfall, higher temperatures, longer droughts and more intense cyclones will worsen malnutrition which, in turn, will affect the work capacity of these people. On the health front, a rise in water- and vector-borne diseases will also affect people's productive capacity, in turn leading to lower incomes to access healthcare facilities and medical attention. Climate shocks damage assets and infrastructure. For instance, heat stress on livestock and the higher salinization of coastal paddy fields affect people's livelihoods. This deepens nutritional deficiencies and makes them less fit to take on laborious field work. Damage to home gardens especially affects households' nutritional 'basket', deepens malnutrition and reduces work capacity.

RECOMMENDATIONS

1. An integrated approach to climate change adaptation interventions on health and livelihoods will yield robust results in local resilience.
2. Protecting infrastructure – like roads and power stations – from storm surges, soil erosion and floods is necessary to maintain and enhance connectivity which, in turn, allows people access to markets and adequate food.
3. There is a need to collect relevant qualitative and quantitative gender-disaggregated data and factor in the linked impacts of climate change on their health and livelihoods in adaptation interventions and when engaging on policy platforms.

6. EXISTING CAPACITIES, STAKEHOLDERS AND PROGRAMMES

6.1. POLICY LANDSCAPE

Figure 6: Institutional framework

THE MINISTRY OF AGRICULTURE AND FISHERIES AND THE MINISTRY OF COMMERCE, INDUSTRY and ENVIRONMENT are primarily responsible for managing and coordinating environmental policies and implementation (e.g. for biodiversity, water, pollution control)

THE MINISTRY OF HEALTH is responsible for healthcare and monitoring, with a special department on Environmental Health

THE MINISTRY OF THE INTERIOR and specifically THE NATIONAL DIRECTORATE FOR DISASTER RISK MANAGEMENT coordinate climate change-related disaster preparedness

Furthermore, the Coral Triangle Initiative for Coral Reefs, Fisheries and Food Security – a multilateral partnership of six countries – is an initiative to address the threats to coastal ecosystems in the Pacific.

Table 4: National policies and plans

POLICY	DESCRIPTION OF CLIMATE–LIVELIHOODS–HEALTH FOCUS

National Adaptation Plan for Action (NAPA) (2010)	The NAPA (2010) is a comprehensive document that addresses several relevant priority areas:
	• **Health:** Aims to enhance the capacity of the health sector and communities to anticipate and respond to changes in the distribution of endemic and epidemic climate-sensitive diseases, and reduce the vulnerability to infection of populations in areas at risk from the expansion of climate-related diseases
	• **Livelihoods: Lists priorities around: i**ntegrated water resource management; forests, coastal and marine ecosystem protection; livestock resilience and food supply; climate-resistant infrastructure; and improving the capacity to adapt offshore oil and gas infrastructure to withstand forecast strong storms and waves
	• **Interlinked climate–health–livelihoods targets:**
	  • Food security: building farmers' resilience to droughts, human health
	  • Natural disasters: improving institutional and community capacity (including vulnerable groups such as women and children) to prepare for and respond to climate change-induced natural disasters
	  • National poverty reduction
	Implemented projects related to NAPA (2010) have primarily focused on rural infrastructure, agricultural practices and water resource management (SNC 2020) and there is scope for further investment in adaptation in the health sector.

Initial National communication (2014)	The health section of the INC (2014) is limited to a discussion of the risks of Dengue Fever and Malaria; for the agriculture sector, yield reductions and seasonal ENSO impacts are the main focus. There is little mention of urban livelihood challenges, but extensive acknowledgement of the challenges for rural livelihoods and agriculture. A gender component and the identification of particularly vulnerable groups is generally lacking.
Intended Nationally Determined Contribution (INDC 2016)	The INDC (2016) outlines key vulnerabilities in Timor-Leste, emphasizing the impacts of more frequent natural disasters as well as the role of ENSO and warmer temperatures. For **health**, the focus lies on changes in the incidence of Dengue Fever and Malaria. Furthermore, the INDC (2016) discusses changes in water availability and coastal damages from sea-level rise, and elaborates on erosion and water management challenges. The assessment does not mention food security, heat-stress and other health risks explicitly. A gender component and the identification of particularly vulnerable groups is generally lacking.

POLICY	DESCRIPTION OF CLIMATE–LIVELIHOODS–HEALTH FOCUS
Second National Communication (2020)	The main vulnerable sectors assessed are: agriculture, coastal and marine resources, health and water resources. • For **livelihoods** the SNC (2020) considers agriculture the most vulnerable and focuses the most attention on losses in this sector. • For **health** the SNC (2020) outlines a broad range of climate-sensitive issues, direct (temperature extremes, damage to infrastructure, risk of injury due to more extreme weather events) and indirect (geographical range and incidence of vector-borne diseases, infectious diseases, malnutrition and hunger which in turn disturb child growth and development). Overall, it provides a comprehensive springboard for work on climate–health–livelihoods linkages. While the SNC (2020) offers a detailed vulnerability assessment on the suco level, disaggregated information on gendered impacts and particularly vulnerable groups is missing. The main areas for climate change adaptation are the agriculture, waste and health sectors. To date, there have been few projects addressing health and a majority focus on agriculture.
National Adaptation Plan (ongoing)	UNDP is supporting the National Directorate of Climate Change of Timor-Leste to formulate the NAP document based on vulnerability assessments and multi-stakeholder meetings.
National Climate Change Policy (NCCP) 2017	This policy was compiled by UNDP to mainstream climate change into development programmes; however, as of April 2021, this had not been approved by the Timor-Leste Government.
National Health Sector Strategic Plan 2011–2030	The plan outlines the main strategic areas for the health sector in Timor-Leste, but does not mention climate change.
The National Strategic Development Plan: 2011–2030	Climate change is a relevant point for Goal 13 of the plan.

6.2. CAPACITIES

GOVERNMENT

STRENGTHS

- Climate change work is developing in the young country, including a National Adaptation Plan (NAP).
- Efforts are under way to integrate climate change and environmental knowledge into primary and secondary education (INC, 2014).

CHALLENGES

- Limited capacity on climate change, health and livelihood intersections and few policies addressing these areas. Disaster preparedness and response capacity is also under development (Cook *et al.* 2019)
- Weather and climate monitoring is limited. Challenges in data management and analysis; forecasting systems and skills also need to be addressed (World Bank 2020)
- There is a need to develop disaster management and risk reduction plans across sectors and communities (WBCCKP 2020).

TIMOR-LESTE RED CROSS SOCIETY (CVTL)

STRENGTHS

- CVTL is a stable auxiliary to the Government in disaster preparedness and response, with projects focusing on early warning strengthening, education and disaster response planning (Cook *et al.* 2019).
- Much of the disaster preparedness and response work has focused on environmental protection and rejuvenation, which forms a strong base for climate change adaptation work to build medium- to long-term local resilience.
- CVTL is expanding and building its volunteer network.

CHALLENGES

- Data integration of stakeholders in disaster response and climate adaptation as well as the accessibility of data on evaluations, needs assessments and funding plans remain inaccessible in Timor-Leste (Cook *et al.* 2019).
- CVTL accesses warning information through common media channels, and may benefit from an integrated warning system.
- Poor road conditions and the inaccessibility of communities make outreach difficult.
- Financial and human resources limit climate responses (source: CVTL)

7. RECOMMENDATIONS AND OPPORTUNITIES

OVERARCHING RECOMMENDATIONS

RECOMMENDATION 1: Continue to increase knowledge and awareness on climate change impacts on ecosystems, health, water and sanitation (WASH), livelihoods and disaster risk reduction (DRR).

Gap: The varied and cross-sectoral impacts climate change will have on health and livelihoods are not always well understood within the National Society and by other practitioners or local government departments. Yet, knowledge on the multi-hazard, multi-dimensional impacts is key to spur the necessary local action by communities and local agencies. Often, the reason for lacking this knowledge is because complex information is not unpacked adequately, or translated in terms of lived experience.

Opportunity for action: There are three key opportunities for action. 1) Undertaking training and campaigns on weather and climate awareness within the National Society, at the community-level and with relevant local stakeholders in rural and urban areas to understand the impacts of weather forecasts and climate projections on the ecosystem and its ramifications on health and livelihoods. Several tools and games developed by the Red Cross Red Crescent Climate Centre may also be used for this purpose. 2) Communicating weather and climate information, in collaboration with the the national meteorological service, local district administration and pilot project(s), to the 'last mile' so that local communities are able to adopt an Early Warning Early Action approach to initiate short-term and then medium- to long-term key early public health and livelihoods protection actions. 3) The systematic collation of local gender-disaggregated and intersectional data, human interest stories and 'best practice' communication strategies on building awareness and knowledge on weather, climate and sectoral impacts to share with Government and non-government actors at local, sub-national and national levels.

RECOMMENDATION 2: Scale-up climate-smart programming and preventative health activities which adopt a multi-hazard Early Warning Early Action approach to preparedness for medium- to long-term local resilience.

Gap: Local climate adaptation programmes are limited by a lack of available expertise, research and financial capacity. There are also silos between climate and health and livelihoods policies and practices which compounds this issue.

Opportunity for action: 1) Climate-smart programmes which protect and nurture the ecosystem – also called nature-based solutions – are well-begun as pilots and then scaled up through Government programmes. Climate-smart programmes adopt a multi-hazard Early Warning Early Action approach including forecast-based Financing (FbF) and may also use social protection platforms to help people take anticipatory action and prepare for climate shocks, especially in high-risk areas. Training materials on climate risk management, including modules on climate change and health and on community resilience are available in the Climate Training Kit. 2) Local risk assessments on vulnerabilities and capacities are best done by continuously identifying specific drivers of vulnerability for health and livelihoods, especially among at-risk communities, because this contributes to developing stronger analytical capability for an integrated health–livelihoods–climate risk assessments approach for multiple hazards. 3) There is an urgent need to integrate public health and livelihoods with DRR to include, in addition to relief and response, three more 'Rs': rehabilitation, reconstruction and medium- to long-term resilience.

RECOMMENDATION 3: Continue to foster cross-sector collaboration across programmes.

Gap: No organization can tackle the increased risks posed by climate change alone, or alleviate the exacerbated risks of vulnerable populations

Opportunity for action: 1) CVTL is well-placed to empower those most at-risk via capacity-building activities which take an inclusive and gender-sensitive approach. 2) CVTL is equipped to continue and enhance the fostering and strengthening of partnerships both within and outside the humanitarian sector to include experts and institutions working on climate and development. There are opportunities to work closely with national agencies and donors to improve finance flows, strengthen community infrastructure, facilitate local access to technology-based solutions and innovations for climate adaptation as well as to support Forecast-based Financing mechanisms and link adaptation interventions with social protection programmes to scale-up anticipatory action on the ground as well as more long-term adaptation measures. More internal integration is also required within the National Society between, for example, disaster management, communication and policy teams. Some of the Government and external agencies to collaborate with include, for instance, the national meteorological service, academia, civil society organisations and also bilateral and multilateral agencies like the UNDP and the World Bank. 3) CVTL is well-positioned to showcase locally led adaptation action on community-based natural resource management and resilience-building across ecosystems, health, WASH, livelihoods and DRR and to leverage this to engage with the Government's adaptation processes, especially with regard to disaster law and the ongoing National Adaptation Plan.

PROGRAMMATIC AND PROJECT RECOMMENDATIONS

- Expand early warning systems and early action, by extending meteorological monitoring capability with data management as well as analysis and forecasting systems and skills, while building capacity within the National Society to interpret, process and communicate meteorological data and warnings. Specifically focus on drought (El Niño).

- Holistic programmes for nutritional security which combine shifting seasonal calendars with nature-based solutions to reduce environmental degradation and improve agroecology to improve the nutritional status of populations and prevent flash floods.

- Integrate community-led natural resource management capacity into community resilience projects to improve food security, protect the environment and strengthen livelihood security.

- Specifically address integrated, sustainable land management by promoting fixed/permanent agriculture, reduced burning, reduced erosion and increased soil fertility (based on existing national action plans on sustainable land management). Also address crop losses in storage, conservation agriculture and water harvesting.

- Gather, share and make readily available existing knowledge on WASH and WBD and fill any knowledge gaps.

- Developing disaster management and risk reduction plans across sectors and communities, addressing the health and livelihood risks of climate change – building on locally sourced knowledge of vulnerabilities. Specifically develop drought (El Niño) response plans.

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ANNEX A
NEAR-TERM CLIMATE PROJECTIONS FOR TIMOR-LESTE (2020–2039)[1]

Basic climatology. For monthly average, minimum and maximum temperature, all models predict a slight increase of monthly temperature by 0.60–0.75°C, with the high global emissions scenario (RCP8.5) resulting in slightly higher monthly changes. For monthly rain and snowfall (precipitation), there is only a very small change projected per month. A minor decrease in precipitation for the wet season (December–May) can be observed, although the range of uncertainty is quite high.

Climatic extremes.[2] Both the RCP2.6 and RCP8.5 show a *slightly increasing trend in the amount of rain falling per rainfall event*, for example, the maximum five-day rainfall is projected to increase by 3.48–16.26mm. The increase in the amount of rainfall during these extreme events (for both the 10- and 25-year return level) is especially pronounced in the west of Timor-Leste. This means that the total amount of rain falling during the most extreme periods will be greater compared to the historical period, and this may translate into the increased risk of events linked to intense rainfall such as landslides, flash floods, erosion etc. *Relatively more rain will fall during 'very wet days'* (increasing by 11.3–30 per cent), although the range of uncertainty is very high due to the diverging general rainfall projections. This increase is expected to occur primarily during the monsoon months. In relation to this shift of a wetter rainy season to slightly drier dry season, *the difference between the driest and the wettest month is projected to increase* by 42.76mm (RCP2.6) to 106.86mm (RCP8.5), although it should be noted that variability between seasons and years is strongly influenced by El Niño/La Niña (ENSO) dynamics and these are not included in the projections. Projections for changes in the frequency and intensity of ENSO extremes in climate projections remains a challenge for the scientific community.

Extreme temperatures (above 35°C) are projected to increase, especially during the monsoon months, and models project an annual increase by 12.86 days (-1.02–200.61 likely range; RCP2.6) to 22.91 days (-1.09–192.22 likely range; RCP8.5). In line with this trend, the warm spell duration and heatwave probability are both expected to increase drastically. Warm spell duration is expected to increase across the year by 55.62 days (16.4–164.19 days likely range) under RCP2.6 and 70.87 days (23.11–180.09 days likely range) under RCP 8.5. Furthermore, the heatwave probability is expected

1 All data in this Annex are sourced from the World Bank Climate Portal, supplied under the Creative Commons 4.0 licence.

2 Please note that wave activity, storm activity, tropical cyclones and sea-level rise are all important climatic factors. These are beyond the scope of the CMIP5 dataset in the WBCCKP but are discussed in the main chapter.

to increase by +10 per cent (4–25 per cent likely range) under RCP2.6 and +12 per cent under RCP8.5 (5–32 per cent likely range). This near-term increase in heat exposure will have far reaching consequences for the health and wellbeing of the Timorese, and requires urgent attention in DRR.

Agricultural conditions. Agriculture in Timor-Leste is primarily dependent on rainfall, and this remains the main determinant of the growing season. For wet spells, both RCP2.6 and RCP8.5 show an increasing trend, in line with the expected slight increase in rainfall. Wet spell days are expected to increase by 2.62 days (RCP 2.6) to 0.50 days (RCP 8.5), especially in the centre and east of the country. While rainfall is important for agriculture in Timor-Leste, wet spells in combination with an increased amount of rainfall may cause issues such as floods and landslides as well as damage to crops if not managed appropriately. Trends in dry spells are difficult to establish, because the projections for the different RCPs are quite far apart. It should be noted that under both RCP2.6 and RCP8.5, the climate is projected to become drier in the long-term.

SUMMARY OF KEY POINTS:

1. **Heatwaves and warm spells will increase drastically already in the next 20 years. Along with global warming, Timor-Leste will experience a shift to a significantly hotter climate with hot days and nights becoming the norm.**
2. **Extreme rainfall events will become slightly more intense and more frequent. More intense rainfall may increase the risk of landslides and flash floods.**
3. **The wet season will become wetter, while the dry season's rainfall remains stable/decreases slightly. This means the difference between seasons will become more pronounced.**

ANNEX B
SUMMARY TABLE OF CLIMATE CHANGE IMPACTS ON LIVELIHOODS

CLIMATE CHANGE TRENDS	PHYSICAL IMPACT	LIVELIHOODS IMPACTS
Sea level is expected to continue to rise	In coastal regions: increased salinity, coastal erosion and more permanent inundation	Increased groundwater contamination by saltwater intrusion affects drinking water and agriculture Agriculture: saltwater intrusion and seawater floods of coastal lands reducing crop yields as well as viable cropping area; rise in food imports to compensate for insufficient domestic production; increased soil erosion, runoff and landslides
	Exacerbated impact of storm surges and coastal floods	Infrastructure and housing damage can disrupt work, damage harvests and stocks and disrupt market access. Losses and damage also pose a financial burden that may push near-poor households into poverty.
Ocean acidification and **rise in sea-surface temperature** will continue	Coral reef damage and bleaching (although the Indonesia Throughflow may provide cooling and therefore protection from bleaching), fish stocks affected (change in distribution, migration and species)	Loss or destruction of coastal vegetation, species and habitats Loss of health, diversity and productivity of inshore marine systems and fisheries along with changing migration patterns reduces catch for subsistence coastal communities, especially affecting artisanal fishing and food security in coastal areas.

CLIMATE CHANGE TRENDS	PHYSICAL IMPACT	LIVELIHOODS IMPACTS
Decrease in dry season rainfall with mild drying effect over June–August period. **Increase in wet season rainfall.** Overall, annual average rainfall will increase.	Longer dry periods with implications for **droughts** (mostly affecting the northern part of the country)	The dependency on a single harvesting season in the north leaves these regions vulnerable to drought impacts. In the central highlands of Timor-Leste, the combination of samtuco trees and coffee plantations ensures lower sensitivity as the tall trees provide shade and protection from intense rainfall, although these crops are very sensitive when flowering (WFP 2016) Longer dry seasons will have implications for water security, which can affect people's ability to work as well as industrial production.
Increase in the intensity of heavy rainfall events	More incidence of flash floods, riverine floods and landslides (east)	Risk of environmental damage and pollution; infrastructure and transport damage; displacement, injury and death; agricultural resources degrading.
	Heavy rainfall events more frequent	Agriculture: increased degradation and loss of agricultural land as well as soil fertility; decreased agricultural productivity caused by storm damages to seeds, changed pattern of crop pests and diseases
Increase in average air temperatures	Increase in the number of hot days and warm nights; increased duration of heatwaves; increased evapotranspiration	Agriculture: reduce crop yields by preventing pollination; potentially positive fertilization effect on some crops (rice and grasses); increased frequency of water shortages for agriculture as well as rising demand through increased evapotranspiration, coupled with rising water needs for livestock; livestock heat-stress reducing productivity and reproduction; pest and disease risk increases; decomposition of products (milk, eggs, etc.) during hot spell Water resources: evaporation increases demands and reduces storage; heat reduces availability of surface water
Decrease in the number of tropical cyclones, but there will be an **increase in the intensity of cyclones** i.e. higher wind speed	Floods from tidal surges and swells (mostly affecting the southern coast) accompanied by strong winds	Salinization impacts on paddy fields; general wind and flood damage to crops grown in coastal regions

ANNEX C
POLICY LIST TIMOR-LESTE

UNFCCC-RELATED COMMUNICATIONS
National Adaptation Plan for Action (NAPA) (2010)
Initial National communication (2014)
Intended Nationally Determined Contribution (INDC 2016)
Second National Communication (2020)
National Adaptation Plan (Unpublished, in progress)
POLICIES, PLANS AND NATIONAL DOCUMENTS
National Climate Change Policy (NCCP) 2017 (not approved by Government yet)
National Health Sector Strategic Plan 2011–2030
The National Strategic Development Plan: 2011–2030
National Biodiversity Strategy and Action Plan 2011–2020 (2011)
Basic Environmental Law, Decree Law No. 26/2012

ANNEX D
ONGOING PROJECTS

The Timor-Leste Red Cross Society (CVTL) is working on climate change through its Integrated Community-Based Risk Reduction Programme (ICBRRP), which is coordinated by the DRM department and primarily entails planting trees (mitigation) and raising awareness of climate change through community activities by local branches. The ICBRRP also provides guidance to rural communities on resilient agricultural practices and the protection of livestock from pests and diseases through nature-based solutions.

IFRC

Climate Centre