BELIZE
Health National Adaptation Plan

CARIFORUM Climate Change and Health Project:
"Strengthening Climate Resilient Health Systems in the Caribbean"

MINISTRY OF HEALTH & WELLNESS
Equal Health for All

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List of Acronyms:

AF:	Adaptation Fund
AIDC:	Spanish Agency for International Development Cooperation
BNCCC:	Belize National Climate Change Committee
BHIS:	Belize Health Information System
CARPHA:	Caribbean Public Health Agency
CCCCC:	Caribbean Community Climate Change Centre
CDEMA:	Caribbean Disaster Emergency Management Agency
CIMH:	Caribbean Institute for Meteorology and Hydrology
CMIP6:	Coupled Model Intercomparison Project Phase 6
DOE:	Department of Environment
FAO:	Food and Agriculture Organization
FOLU:	Forestry and Other Land Use
GCF:	Green Climate Fund
GIZ:	Sociedad Alemana de Cooperación Internacional
GEF:	Global Environment Facility
GSDS:	Growth and Sustainable Development Strategy
HNAP:	Health National Adaptation Plan
HIS:	Hospital Safety Index
HSSP:	National Health Sector Strategic Plan
NCAPI:	Institute of Nutrition of Central America and Panama
IPCC:	Intergovernmental Panel on Climate Change
IPP:	Industrial processes and product use
LEG:	Least Developed Countries Expert Group
LDCF:	Least Developed Countries Fund
LMM:	Liverpool Malaria Model
MOHW:	Ministry of Health and Wellness
MSDCCDRM:	Ministry of Sustainable Development, Climate Change, and Disaster Risk Management
NAP:	National Adaptation Plan
NCCO:	National Climate Change Office
NDC:	Nationally Determined Contribution
PAHO:	Pan American Health Organization
PPP:	Public Private Partnership
PPPMU:	Policy, Planning, and Project Management Unit
rVc:	Relative Vector capacity for dengue
SCCF:	Special Climate Change Fund
SIDs:	Small Island Developing States
SSP585:	Shared Socioeconomic Pathway 5:8.5
TDPs:	Technical and development partners
UWI:	University of the West Indies
UNDP:	United Nations Development Programme
UNEP:	United Nations Environment Programme
UNFCCC:	United Nations Framework Convention on Climate Change
UNICEF:	United Nations Fund for Children
USAID:	United States Agency for International Development
WB:	World Bank
WHO:	World Health Organization

EXECUTIVE SUMMARY

Caribbean countries, including Belize, are particularly vulnerable to the health impacts of climate change, including vector-borne and foodborne diseases, waterborne illnesses, respiratory diseases, extreme heat-related illnesses, food security and nutrition, mental health disorders, and extreme weather events.

In July 2020, the Pan American Health Organization (PAHO) secured a grant from the European Union to implement the "Strengthening Climate-Resilient Health Systems in the Caribbean" project over five years. This initiative aims to establish climate-resilient health services and delivery systems to better prepare for and respond to climate threats, utilizing a unique interdisciplinary "One Health" approach. This approach aligns with the Caribbean Climate Change and Health Action Plan.

PAHO/WHO leads the project in collaboration with regional partners such as the Caribbean Public Health Agency (CARPHA), the Caribbean Community Climate Change Centre (CCCCC), the Caribbean Institute for Meteorology and Hydrology (CIMH), the Caribbean Disaster Emergency Management Agency (CDEMA), and the University of the West Indies (UWI). Other partners include UNEP, FAO, and UNFCCC.

Belize is one of the sixteen Caribbean countries participating in the project, aiming to:

- Strengthen the resilience of health services aiming to reduce mortality and morbidity in Caribbean countries from the expected health consequences of climate change.
- Work collaboratively across organizations and nations to develop innovative products, methods, and actions to prevent negative climate impacts on health.
- Prepare public health plans, programs, and policies within the CARIFORUM community to adapt to unprecedented climate changes.

A key outcome of the project is the development of Belize's Health National Adaptation Plan (HNAP) as part of the National Adaptation Plan (NAP), prioritizing the health sector. The HNAP enhances the healthcare sector's ability to adapt to climate change, focusing on prevention, preparedness, and adaptation measures, especially for vulnerable populations.

The participatory process for HNAP development included stakeholder consultations, identifying and prioritizing health risks related to climate change, constructing impact chains, assessing risks and vulnerabilities, and formulating adaptation strategies. The HNAP methodology adhered to international guidelines and best practices, including those from the Least Developed Countries Expert Group and the World Health Organization (WHO). Quantitative and qualitative studies revealed vulnerabilities and adaptation strategies related to climate-sensitive diseases across Belize.

Vulnerability assessments identified areas with varying degrees of vulnerability, guiding targeted interventions. The HNAP proposes adaptation measures that align with WHO's health system resilience framework to address current and future health risks. These measures

prioritize short and medium-term actions to strengthen Belize's healthcare system. The vision of the HNAP is to ensure a highly resilient healthcare sector capable of anticipating, preventing, and managing climate-related health risks by 2030. It aligns with Belize's National Adaptation Plan and Health Policy.

The Ministry of Health and Wellness (MOHW) will establish and monitor the key performance indicators and oversee the implementation of the HNAP with the support of PAHO. The MOHW will collaborate and partner with stakeholders to implement the multi-year action plan, including activities, budgeting, monitoring, and evaluation. Successful implementation of the health sector, including other sectors, requires financing from different sources for adaptation activities. As a developing country, Belize relies on technical and financial partners to mobilize significant funding, especially internationally, to adapt to complex climate change impacts on health.

The Belize HNAP highlights a series of key findings. Firstly, the studies highlight the significant impact of climate fluctuations on the spread of communicable and non-communicable diseases such as dengue, hypertension, diabetes, and acute respiratory infections, among others. This underscores the importance of integrating climate factors into health prevention and management strategies. The health vulnerability index, incorporating exposure, sensitivity, and adaptive capacity, revealed varying levels of vulnerability across Belize's districts. While some regions demonstrate strong adaptive capacity, others in vulnerable populations including low-income communities, the elderly, and those with preexisting health conditions face significant sensitivity due to exposure to extreme climate events.

Assessing health risks associated with climate change highlights major concerns such as the increased incidence of waterborne and vector-borne diseases, disruption of health services, and destruction of infrastructure. Vulnerability is particularly pronounced among vulnerable groups such as the elderly, children, and people with chronic diseases.

Adaptation measures covering various areas such as leadership and governance, workforce capacity building, education and community engagement, improved surveillance and Early Warning Systems, infrastructure and health system strengthening, emergency preparedness, research and innovations, and financing have been identified to address these challenges. Prioritizing adaptation options based on their coherence with climate policies, urgency, feasibility, and effectiveness is crucial for building a climate-resilient healthcare system in Belize.

The Belize HNAP outlines a vision to strengthen the health sector's resilience to climate change by integrating adaptation into policies, enhancing healthcare system resilience, improving surveillance and response systems, and enhancing resource governance.

Achieving the vision for a climate-resilient healthcare system requires collaboration to develop an integrated and shared approach among various stakeholders. Moreover, coordinated intersectoral planning is imperative to ensure that policies are consistent and promote health,

especially in sectors that have a strong influence on health, such as water and sanitation, agriculture and nutrition, environment, transportation, industry, energy, land use, housing, and habitat (WHO, 2015; WHO, 2021). There are several national institutions and international organizations in Belize whose mandates and activities address climate change issues with considerable synergy between adaptation actions and major health programs already in place to promote and improve the health of the Belizean population. These include the Ministry of Health and Wellness, PAHO, UNICEF, and the National Climate Change Office which will form the basis of the national strategy for adapting the health sector to climate change in Belize.

The HNAP outlines the main adaptation measures that will be implemented over five years (2025 - 2029) consisting of a description of the key performance indicators for each adaptation measure based on short- and medium-term actions. These actions, prioritized based on previously identified options, contribute to the long-term strategic objectives of the HNAP. It includes actions from the National Adaptation Plan (NAP) related to health, aligned with the existing policy and institutional framework to address climate change and health in Belize. The objective of the action plan is to establish a solid foundation for building a climate-resilient health system. Furthermore, the plan designates responsibilities and provides an estimated budget in USD. It details the implementation plan and outlines components and expected outcomes. All activities will be developed to meet the country's needs. Like in any other sector, successful implementation of health sector adaptation activities will require funding from various sources. In addition to their efforts, developing countries like Belize, need technical and financial partners to mobilize significant funding, particularly internationally, to adapt to the complex effects of climate change on health.

Drawing insight from Belize's NAP results, all elements and information identified focus on strengthening the results regarding the climate and health relationship, vulnerability and adaptation assessment, level of risk relative to health impacts, and priority adaptation options.

Given the alignment of health policies with the National Adaptation Plan and numerous financial mechanisms for climate resilience, recommendations include:

- Enhancing institutional capacities to integrate climate change adaptation into emergency health response policies.
- Increase climate and health research investments to generate scientific evidence and fill data gaps.
- Promoting intersectoral collaboration to develop integrated resilience policies and action plans.
- Establishing a strategy for substantial funding mobilization, supported by other ministries and development partners. Creating a technical steering committee under MOHW leadership and implementing a robust communication strategy with intersectoral stakeholders involved in HNAP implementation.

CHAPTER 1: INTRODUCTION TO THE CONTEXT OF THE DEVELOPMENT OF BELIZE'S HEALTH NATIONAL ADAPTATION PLAN (HNAP)

Belize is located on the eastern coast of Central America and shares its borders with Mexico to the north and Guatemala to the west and south. Its geographic location coordinates range from around 15°N to 18°N latitude and 88°W to 89°W longitude (Figure 1). A land of mountains, swamps, tropical jungles, and mangrove forests along the coast, Belize hosts hundreds of low-lying islands called "cayes", which host rich marine life as part of the Mesoamerican Barrier Reef System, boasting the second largest barrier reef in the world. The country's total area is 22,966 km² including 1,540 km² of lagoons and 690 km² of approximately 450 small islands (FAO 2015). According to the Statistical Institute of Belize, in 2022 Belize displayed demographic diversity with an estimated population of 410,990 inhabitants and is the least densely populated country in Latin America. Belize is a melting pot of ethnic groups, and its unique history is expressed in the cultural and linguistic diversity of its population, including Mestizo, Creole (Kriol), Garifuna, East Indians, Maya Kekchi, Maya Mopan, Mennonite, Maya Yucatec, among others. More than half of the country's population is multilingual.

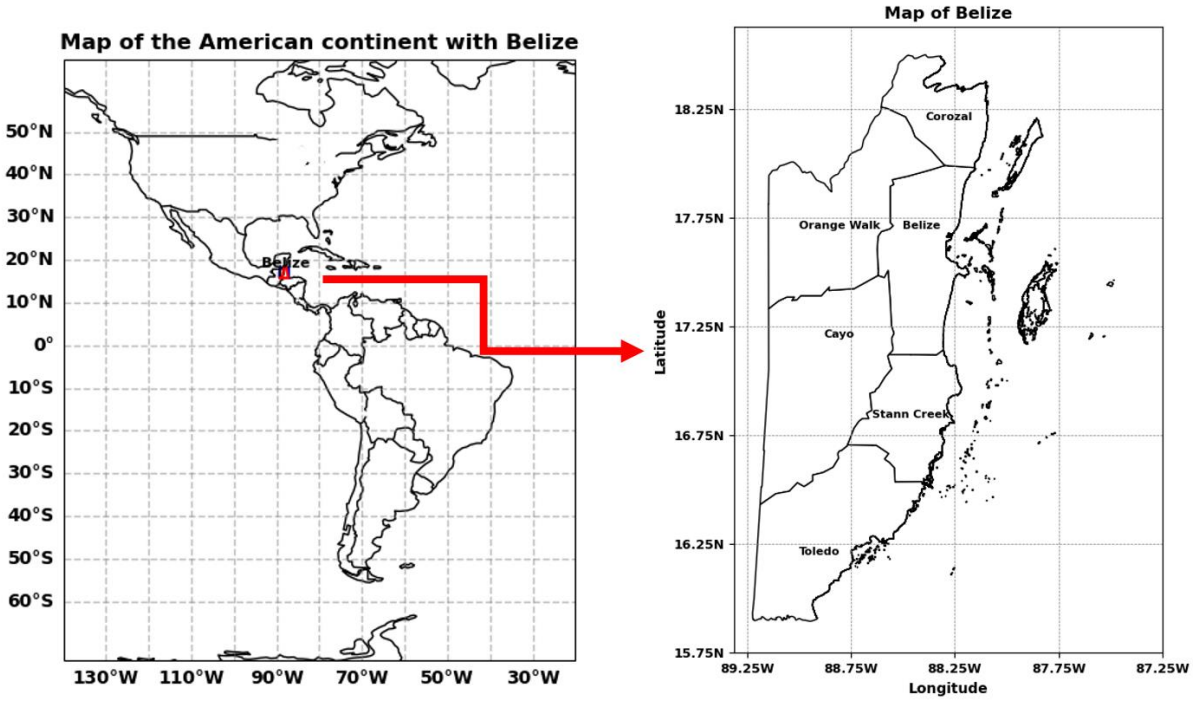

Figure 1: Map of Belize, showing its position (left panel), and its various districts (right panel).

The Belizean economy is mixed, relying on the agriculture and tourism sectors. Despite its GDP of 5.032 billion dollars (PPP) in 2023, the country faces socio-economic challenges such as income inequality, illustrated by a relatively high Gini index of 53.1 in 2013. (Gini index | Data (worldbank.org)).

Climate Change in Belize

Belize's climatic and socio-economic diversity shapes its vulnerability to climate change. The country experiences a tropical climate with distinct dry and rainy seasons, with warm temperatures ranging from 24°C to above 31°C and significant humidity during the rainy months. Additionally, Belize faces the threat of hurricanes between June and November, leading to torrential rains, strong winds, and potential flooding, particularly in Belize City. The nation's low-lying terrain exacerbates the impact of flooding and rising sea levels.

Climate change is already impacting the lives of Belizeans, with the country facing significant challenges despite its minor contributions to global greenhouse gas emissions. While Belize has limited capacity to mitigate global climate change, it remains committed to ambitious targets, including limiting the global temperature increase to 1.5°C. Presently, the nation grapples with droughts, floods, coastal erosion, and changing precipitation patterns, with future projections indicating escalating threats to physical and social infrastructure. Economic sectors such as agriculture and tourism are particularly vulnerable, facing risks from variable climate conditions and environmental degradation. Belize's critical support systems, including water resources and healthcare, are also under strain due to climate variability.

Moreover, the country's rich ecological resources, including rainforests and coral reefs, face existential threats from global warming. In response, Belize prioritizes adaptation efforts, especially in vulnerable sectors like healthcare, contingent upon technical assistance and financial support for vulnerability assessments and research partnerships.

Temperature

Figure 2 presents distinct curves illustrating temperature variations in Belize, each offering a different perspective on time and climatological projection. In Figure 2a, the climatology for 1985-2014 (solid black line) depicts a relatively stable temperature profile with a peak around May reaching approximately 25°C, followed by a slight decline in December. Conversely, the climatology for 2015-2050 (dashed red line) starts with temperatures slightly higher than those of 1985-2014 in January and follows a similar trend but at an overall higher level throughout the year. Similarly, the climatology for 2051-2080 (lighter dashed red line) also begins above the temperatures of 1985-2014 and maintains this elevation throughout the year, with an even higher peak than that observed for 2015-2050.

The curve illustrating the temperature evolution from 1985 to a projected period until 2080 highlights annual fluctuations. Historical data from 1985-2014 (black line) shows significant temperature variations from year to year, with marked peaks and troughs (Figure 2b). Conversely, Projected Data from 2015-2080 (blue line) indicate a trend towards stability or a slight increase in annual mean temperatures, with a reduction in interannual variability. The fluctuations appear less pronounced than in historical data.

In summary, these figures illustrate the projected changes in temperatures in Belize, with higher average temperatures for future periods (2015-2050 and 2051-2080) compared to past climatology (1985-2014). Additionally, interannual variability seems to be increasing over

time. These trends could implicate the local climate and environment, requiring adaptation to changing climatic conditions.

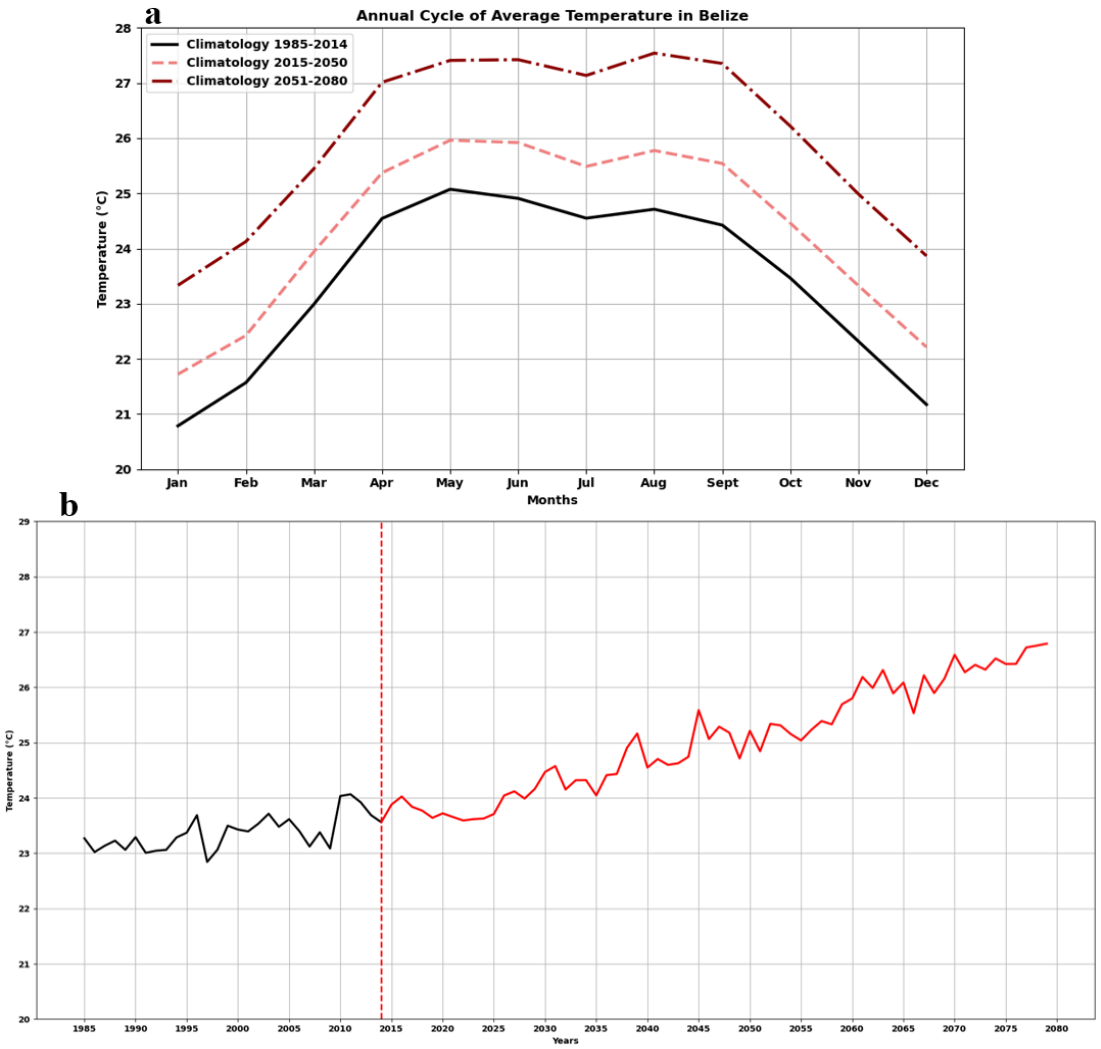

Fig. 2a**:** annual cycle (climatology 1985-2014 versus 2015-1950 and 2051-2080). Fig. 2b: Interannual temperature variability using historical data (1985-2014) and projections (2015-2080) for the SSP585 scenario from the multi-model ensemble mean of the CMIP6 models.

Figure 3 presents Belize's monthly average temperature at different periods, using historical data and projections from the CMIP6 climate model under the SSP585 scenario. In the first panel (Figure 3a), we observe the average temperature in Belize from 1985 to 2014. The colours on the map range from yellow to orange, indicating average temperatures between 24°C and 26°C. The southern districts, such as Toledo and Stann Creek, have slightly lower temperatures, unlike the northern districts of Orange Walk and Corozal.

In the second panel (Figure 3b), the map projects the monthly average temperatures from 2015 to 2050 under the SSP585 scenario. The colours are like those in the first panel, but with a general trend towards higher values, suggesting a slight increase in temperatures between 25°C and 27°C.

The third panel (Figure 3c) represents the projections of annual average temperature for the period from 2051 to 2080 under the same SSP585 scenario. The colours are more intense, ranging from light red to dark red, indicating even higher temperatures. Average temperatures can reach up to approximately 28°C to 29°C, with regional variations. Analysing these maps, a clear upward trend in average annual temperatures in Belize over time is noticeable, with projections indicating significant increases by 2080.

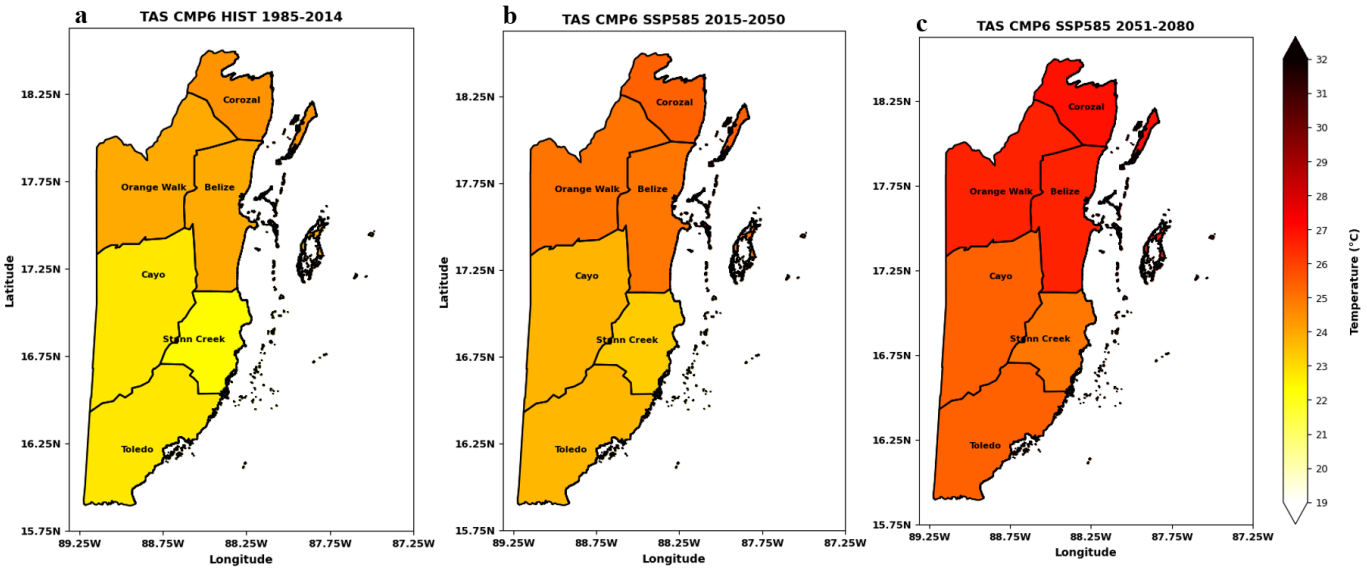

Figure 3: Annual monthly mean temperature in Belize using a) historical data (1985-2014) and projected for b) the near future (2015-2050) and c) for the far future (2051-2080) for the SSP585 scenario from the multi-model ensemble mean of the CMIP6 models.

Figure 4 illustrates two coloured maps projecting changes in average temperature in Belize for two different future periods under the SSP585 scenario. The SSP585 is a climate warming scenario involving substantial increases in greenhouse gas emissions.

Figure 4a - Near-future temperature change (2015-2051): This map shows a relatively modest temperature variation, as indicated by the lightness of the shades used. Colours primarily vary in shades of pale pink which, according to the colour legend on the right, reflects an increase in temperature. Figure 4b - Far-future temperature change (2051-2080): The second map shows much more pronounced temperature increases compared to the first period. According to the legend, a darker red indicates a greater rise in temperatures, approaching, or even reaching increases of 3 to 4°C. This suggests a more significant impact of climate change over time under this specific scenario.

Briefly, these maps highlight a trend toward increasing average temperatures in Belize for both future periods under the SSP585 scenario. The first period shows relatively moderate temperature changes, while the second period indicates more pronounced increases, suggesting an acceleration of climate warming in the region over time.

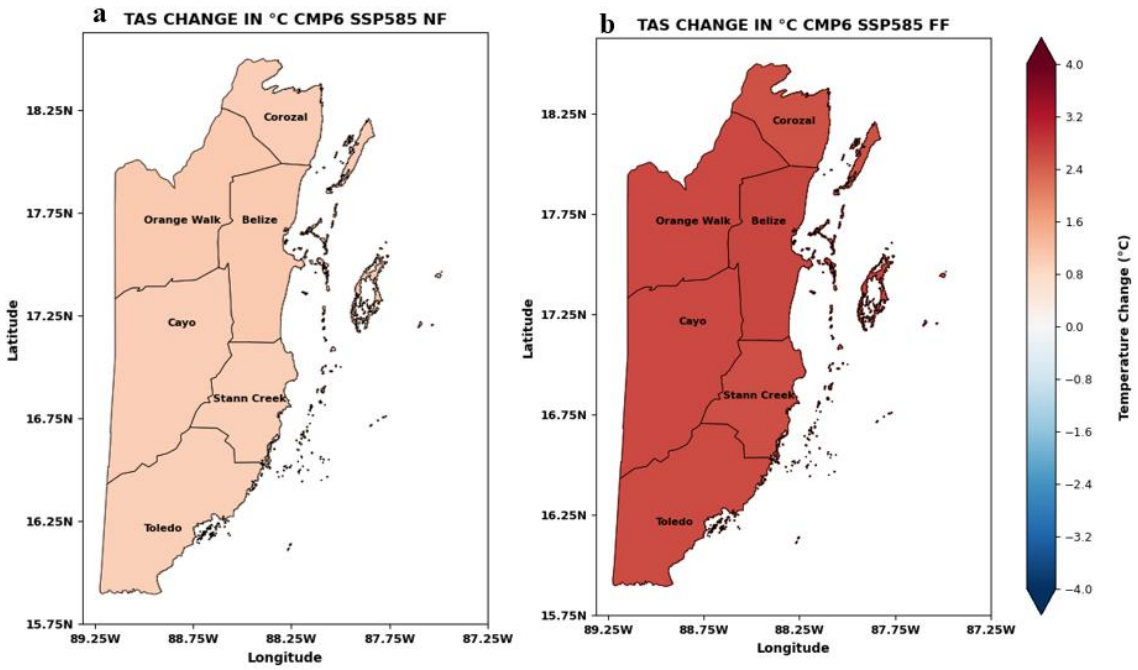

Figure 4: Change (Future minus Present) in Average Temperature in Belize under the SSP585 scenario: (a) for the near future scenario (2015-2051) and (b) for the far future scenario (2051-2080). Variations are expressed in ^{o}C.

Rainfall

Figure 5a, depicts the annual cycle of average precipitation in Belize, comparing three climatological periods: 1985-2014 (solid black line), 2015-2050 (represented by a dashed blue line), and 2051-2080 (dash-dot sky blue line). It highlights a clear seasonal precipitation pattern with peaks between August and October for all considered periods, often exceeding the threshold of 185 mm. The first period (1985-2014) generally shows slightly lower peaks compared to the two future periods. However, the overall pattern remains consistent for all periods, indicating an extended period of heavy rainfall during these months. Figure 5a suggests changes in precipitation amounts over time but maintains a consistent peak seasonality, indicating resilience in the precipitation pattern despite the different climatological periods considered in the SSP585 scenario.

Figure 5b represents the interannual variability of precipitation in Belize from 1950 to a projected period up to 2080. The black line represents historical data from 1950 to 2014, showing significant precipitation fluctuations. The blue line represents projected data from 2015 to 2080 according to the SSP585 scenario. Maximum precipitation occasionally reached up to approximately 600 mm per month. It shows a clear increase in precipitation variability towards the future, with a notable upward trend in rainfall quantities compared to historical data.

Figure 5a highlights a significant excess of precipitation in the projected period, indicating a potential transition to wetter conditions in Belize. Notably, projections according to the extreme SSP585 scenario suggest a more pronounced increase in precipitation variability, with the possibility of rainy periods compared to any recorded historical period in Belize.

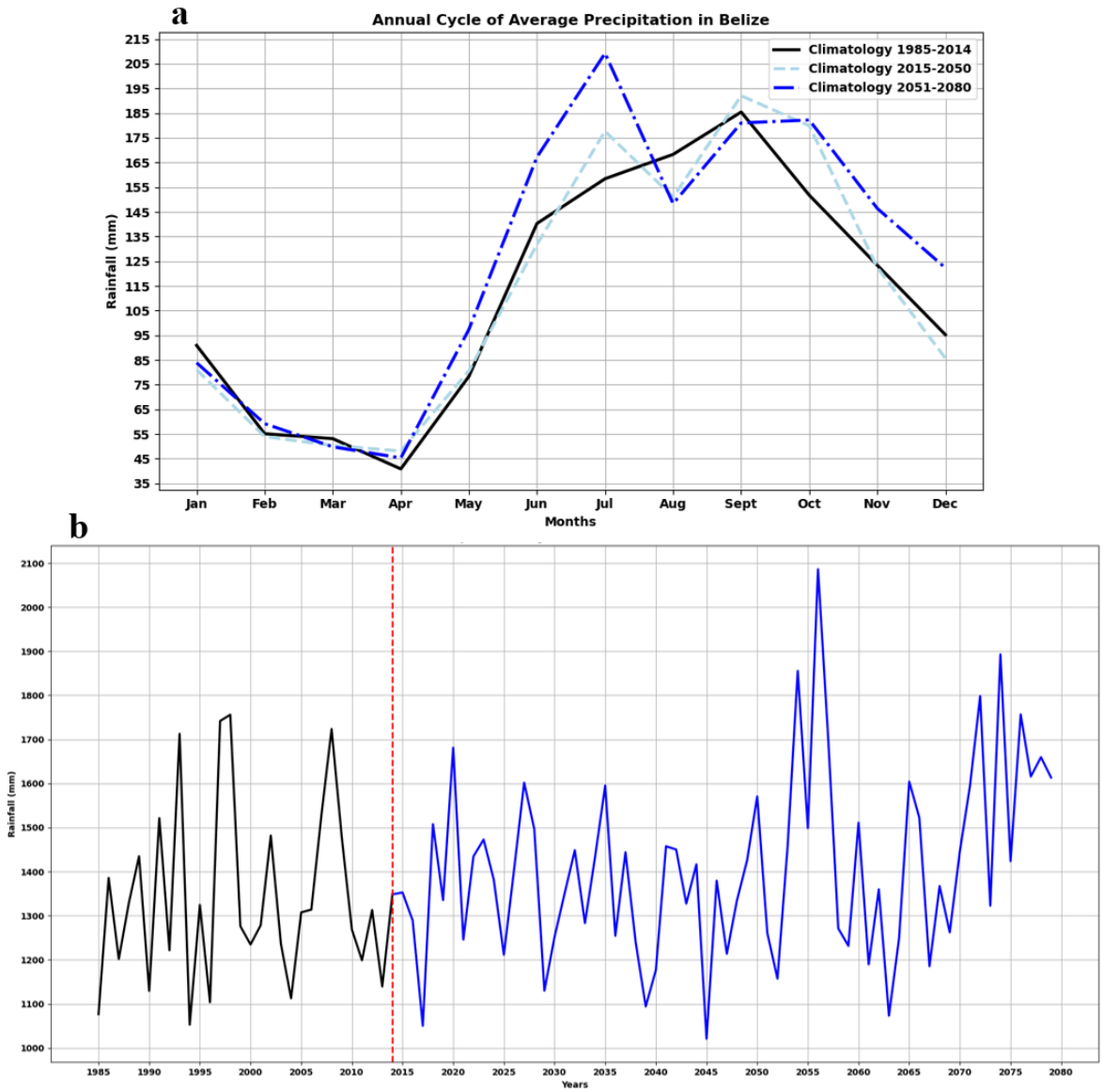

Figure 5**:** a) and b) respectively represent the annual cycle (climatology 1985-2014 versus 2015-1950 and 2051-2080) and interannual precipitation variability in Belize using historical data (1985-2014) and projections (2015-2080) for the SSP585 scenario from the multi-model ensemble mean of the CMIP6 models.

Figure 6 illustrates the annual mean rainfall in Belize over different periods using historical data and future projections based on CMIP6 models. Figure 6a shows historical annual mean precipitation data between 1985 and 2014. The colour range indicates precipitation varying from 110 mm (light blue) to 130 mm (dark blue). It is observed that the highest levels of precipitation (shown in dark blue) are mainly concentrated in the southern regions of Belize, particularly around the Toledo District.

Figure 6b represents a projection from 2015 to 2050 according to the SSP585 scenario. A slight overall change in precipitation is noted throughout the country, with darker shades particularly evident in the Stann Creek and Toledo Districts, compared to the historical period.

Figure 6c shows precipitation projections from 2051 to 2080 according to the SSP585 scenario. The displayed precipitation values range from 110 mm to over 135 mm. There is a trend towards a significant increase in precipitation compared to previous periods. Toledo, Stann Creek, and Cayo Districts show the highest values, exceeding 135 mm, indicating an intensification of rainfall in these districts.

In summary, these maps highlight an upward precipitation trend in Belize, especially in the southern districts, according to CMIP6 model projections for future periods, reflecting a possible climate change scenario with wetter conditions.

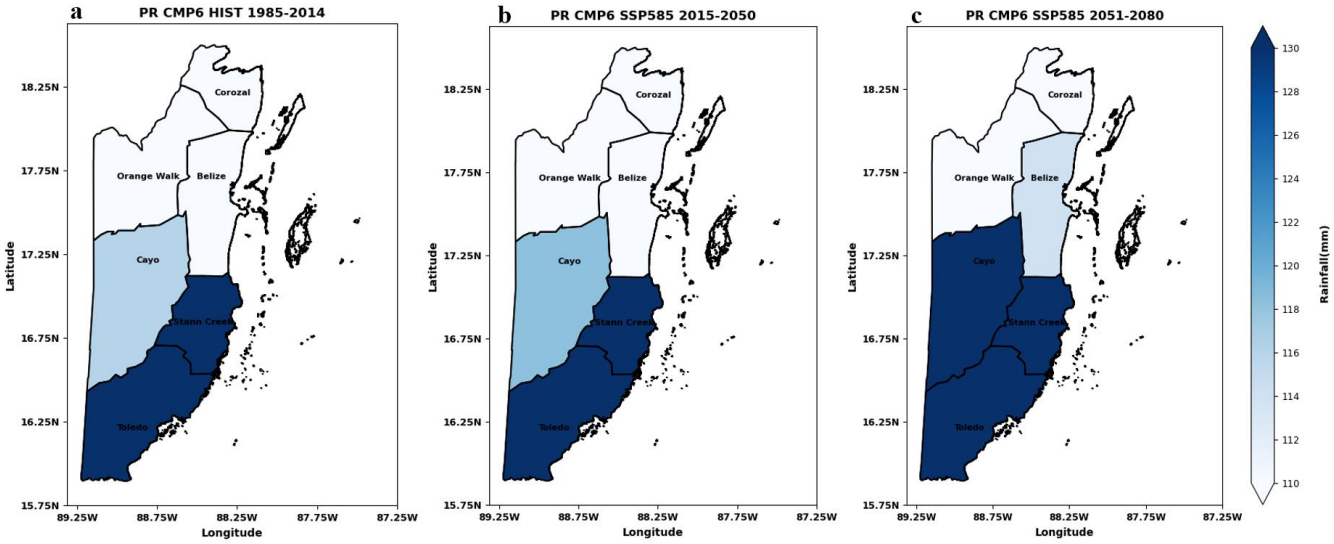

Figure 6**:** Annual monthly mean precipitation in Belize using a) historical data (1985-2014) and projected for b) the near future (2015-2050) and c) for the far future (2051-2080) for the SSP585 scenario from the multi-model ensemble mean of the CMIP6 models.

Figure 7 depicts two projected maps of changes in average precipitation in Belize under a specific climate change scenario (SSP585 from CMIP6). Figure 7a shows the projected changes in the percentage of precipitation for the near future scenario (2015-2051), while Figure 7b presents the changes for the far future scenario (2051-2080). These changes are expressed relative to current levels.

On the maps, different shades of blue indicate an increase in precipitation while shades of red portray a decrease. However, all areas differ in shades of blue, indicating increased rainfall across all regions of Belize. The legend on the right quantifies these changes with values ranging from -60% to +100% precipitation variation.

In summary, these maps project increased precipitation across all regions of Belize for the respective periods under the SSP585 scenario, a highly pessimistic scenario regarding greenhouse gas emissions.

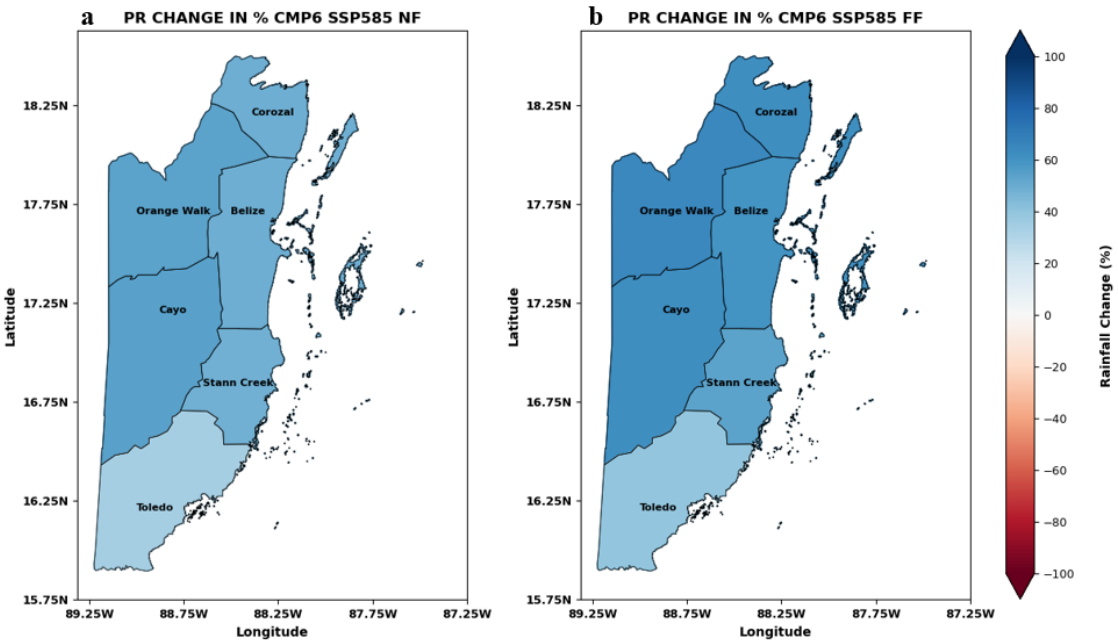

Figure 7: Change (Future minus Present) in Average Rainfall in Belize under the SSP585 scenario: (a) for the near future scenario (2015-2051) and (b) for the far future scenario (2051-2080). Variations are expressed in %.

Overall, Belize will be affected by changes in rainfall, which will intensify from 2030 onwards, especially with the pessimistic scenario SSP585 characterized by very high warming. Monthly rainfall accumulation may decrease by up to 80 mm by 2100 compared to 100 mm for the reference period of 1985-2014. Similarly, changes in rainfall will be affected by greater seasonal or monthly variability compared to the reference period of 1985-2014.

These climate changes will result in significant community vulnerability, driven by many factors: exposure to climate hazards, sensitivity to climate effects, and the adaptive capacity of individuals, populations, and communities. These factors, alone or in combination, can exacerbate the impacts of climate change (IPCC, 2022).

Indeed, Belize is among the most vulnerable countries to climate change among Small Island Developing States and countries in the Hemisphere, where climate risks (floods, droughts, storms, hurricanes, etc.) are significant and recurrent. In addition to these recurrent climate events, meteorological phenomena such as El Niño, resulting in regular rainfall deficits and a much drier climate, and La Niña, responsible for cooler and wetter conditions in the Caribbean, must be considered.

Scientific studies and government reports underscore Belize's susceptibility to extreme weather events and climate change. The country's exposure to hurricanes and tropical storms, compounded by its coastal geography, poses significant risks to infrastructure, agriculture, tourism, and public health. Projections indicate a rise in average temperatures by 2100, accompanied by altered precipitation patterns, including decreased annual rainfall and more intense rainfall events.

The socio-economic implications of climate change in Belize are profound. The agricultural sector faces projected losses in production, while coastal erosion threatens vital ecosystems like the barrier reef. Vector-borne diseases such as Dengue, Chikungunya, and Zika virus pose health risks, impacting tourism and trade. As climate change intensifies, adaptation becomes imperative for Belize's resilience against natural disasters and environmental degradation.

Thus, investments in adaptation strategies are crucial to mitigate the escalating impacts of climate change. While the current generation of Belizeans faces immediate risks, the burden of addressing these challenges falls disproportionately on future generations, underscoring the urgency for action and long-term planning.

Belize considers adaptation a high priority given its vulnerability to natural hazards and climate-related shocks. The impacts of climate change (Figures 8 and 9) will increase over time and Belize's young generation will face the greatest risks but have the least influence on effect change.

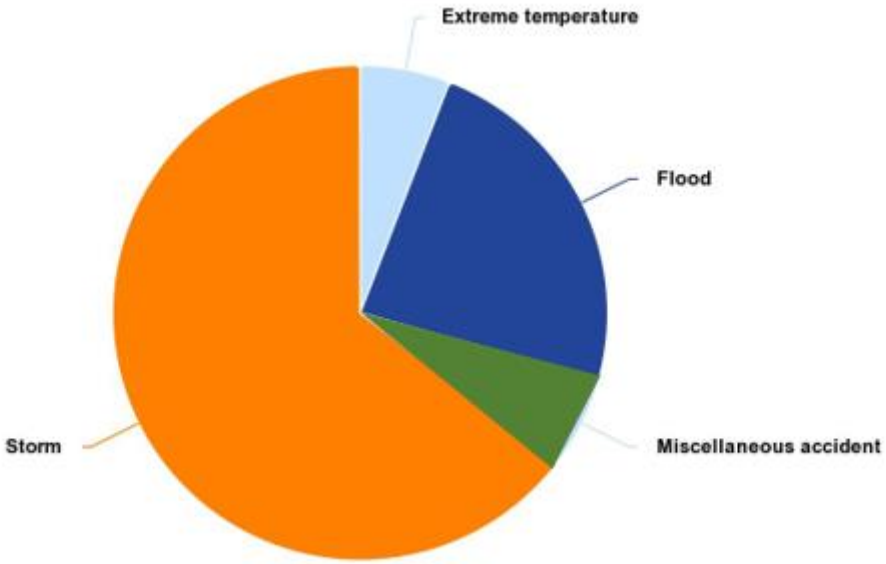

Figure 8**:** Natural hazards annual average occurrence for 1980-2020 (Ministry of Health and Wellness, Epidemiology Unit, 2023).

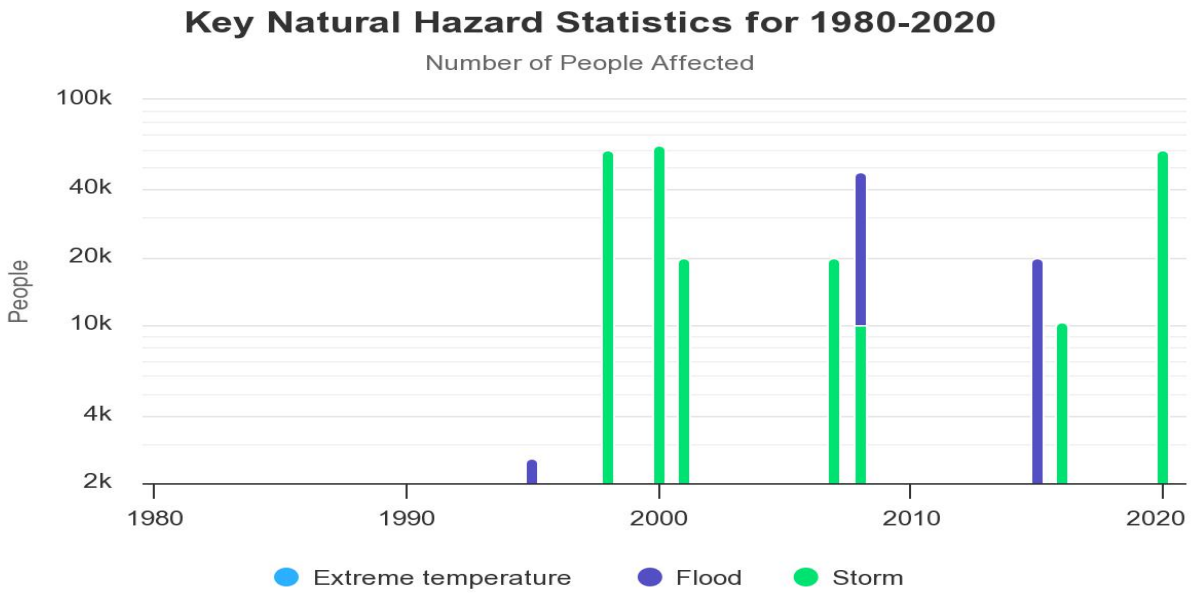

Figure 9: Key natural statistics for 1980-2020 regarding number of people affected (Ministry of Health and Wellness, 2023).

The emergence of certain infectious diseases, increased malnutrition, mental disorders, chronic diseases, etc., can represent a heavy burden for the Belizean population with the increase in morbidity and mortality, especially when extreme weather events threaten health facilities.

Objective of the HNAP

The overall objective of the HNAP is to provide strategic guidance to Belize's health sector in establishing a resilient health system to the adverse impacts of climate change, aiming to contribute to the reduction of vulnerability and the enhancement of adaptive capacities of communities facing climate-related health risks. It specifically aims to:

- Reduce vulnerability to the impacts of climate change by strengthening the adaptation capacity and resilience of the health sector.
- Facilitate the coherent integration of climate change adaptation into new and existing policies, programs, and health sector activities.
- Guide healthcare system personnel in developing and operationalizing a climate-sensitive Early Warning System to prevent and manage climate-sensitive diseases effectively.
- Advocate for the mobilization and allocation of resources for health sector adaptation to the impacts of climate change.
- Facilitate the integration of health priorities into the National Adaptation Plan (NAP) and support the implementation process of the NDC.

Context and process of elaborating on the HNAP

Climate change poses an existential threat to human health and well-being worldwide. Specific global warming risks, such as rising sea levels, deforestation, and increased frequency of extreme weather events, make the Caribbean one of the most vulnerable sub-regions. Caribbean Communities, including Belize, are particularly susceptible to the health effects of climate change, including vector-borne and foodborne illnesses, water-related diseases, respiratory conditions, heat strokes, and mental health disorders.

In July 2020, the Pan American Health Organization (PAHO) secured a grant from the European Union to implement the project "Strengthening Climate-Resilient Health Systems in the Caribbean" over five years. The main objective is to develop climate-resilient health services and delivery systems to better prepare for and respond to climate threats (PAHO, 2014). It employs a unique interdisciplinary approach to health called "One Health" to implement the Caribbean Action Plan on Climate Change and Health as recommended.

PAHO/WHO is the main partner in this project, in collaboration with five sub-regional partners: the Caribbean Public Health Agency (CARPHA), the Caribbean Community Climate Change Centre (CCCCC), the Caribbean Institute for Meteorology and Hydrology (CIMH), the Caribbean Disaster Emergency Management Agency (CDEMA), and the University of the West Indies (UWI). Other partners include UNEP, FAO, and the United Nations Framework Convention on Climate Change (UNFCCC).

Belize, due to its unique geographic location, is one of the sixteen Caribbean countries participating in the project, with the following overall objectives:

1. Strengthen the resilience of public health systems and services to reduce mortality and morbidity related to anticipated health consequences of climate change in the Caribbean.
2. Collaborate with organizations and nations to develop innovative products, methods, and actions to prevent the negative impacts of climate change on health.
3. Develop public health plans, programs, and policies to adapt to unprecedented climate changes more effectively within the CARIFORUM community.

The project’s main outcome will be the development of a HNAP within the framework of Belize's National Adaptation Plan (NAP), where health is one of the priority sectors. This plan aims to enhance the health sector's capacity to adapt to climate change, intensify prevention and preparedness efforts, and prioritize adaptation measures, especially for vulnerable populations.

Moreover, this project aligns with the World Health Organization's (WHO) Climate Change and Health Action Framework for 2017-2021. This framework primarily targets health sector officials, professionals, and regional managers but also mobilizes decision-makers from other sectors crucial to health, such as food, water and sanitation, municipalities, energy, transportation, and emergency management (Figure 10).

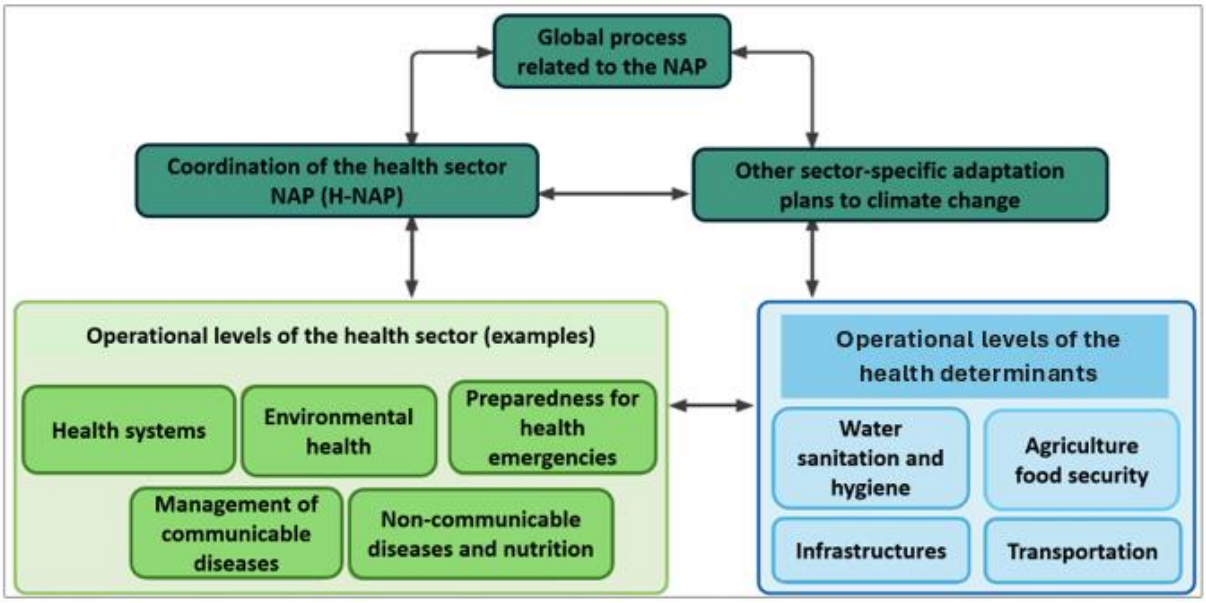

Figure 10: Integration of HNAP Coordination into the Development and Implementation Process of the NAP and Health Planning.

The framework encompasses four key components: 1) establishment of governance policies and leadership responsibilities to protect health from the effects of climate change; 2) strengthening the resilience of health systems to establish surveillance and respond to the effects of climate change on health; 3) enhancing regulatory, monitoring, and management roles of the health sector concerning environmental and social determinants of health; and 4) triggering multisectoral interventions and mobilizing support for health and climate action.

Indeed, Belize's healthcare sector is exposed to high risk from the impacts of climate change, posing challenges that the country must address in collaboration with key health determinants such as food, water and sanitation, municipalities, energy, transportation, emergency management, etc. Thus, strengthening the capacity of Belize's Ministry of Health and Wellness (MOHW) to protect health under changing climatic conditions through prevention, preparedness, and response through the management of climate-related health risks, is critical.

It is in this perspective that the Pan American Health Organization (PAHO)/World Health Organization (WHO) supports the Ministry of Health and Wellness (MOHW) in the development and implementation of its HNAP to strengthen the resilience of the health system against the impacts of climate change, with the following main objectives:

- Assessing the vulnerability and adaptation of health systems and communities to climate change according to the main climate hazards affecting health to health determinants.
- Formulating a health sector adaptation strategy to address health risks associated with climate change and mitigate their impact on the most vulnerable populations.
- Develop a two-year operational plan with a budget and key performance indicators to assess the progress made by various MOHW programs serving the most vulnerable populations.

- Supporting the MOHW in developing a resource mobilization proposal by implementing the health sector's climate change adaptation plan.

The HNAP for Belize was developed through a highly participatory process, which included stakeholder consultations, identification, and prioritization of the main health risks for the Belizean population related to climate change. It also consisted of developing impact chains and relevant indicators, risk, and vulnerability assessments to climate change in Belize, along with risk and vulnerability mapping, and formulation of the Belize HNAP.

From an institutional perspective, the HNAP development process relied on the climate governance framework established to coordinate the integration of climate change adaptation into planning and budgeting in Belize. The Ministry of Health and Wellness (MOHW), the coordinator in the HNAP development process, benefited from collaboration with the Department of Environment (DOE) and the active involvement of all relevant stakeholders (ministries, programs, international organizations, civil society, community organizations).

The HNAP development methodology was based on the latest and most relevant regional and international guidelines, best practices, examples, and experiences, including the Technical Guidelines for the National Adaptation Plan process developed by the Least Developed Countries Expert Group (LEG) in 2012, WHO guides for "Health Sector Adaptation Planning" and "Strengthening Health System Resilience" to climate change (WHO, 2015).

The HNAP presents:

- National strategic objectives for health sector climate change adaptation.
- Adaptation options and resilience-building strategies for health systems against climate change.
- Action plan for health system resilience.
- Cost estimates for priority options in a five-year action plan and beyond.
- Draft financial resource mobilization strategy.
- Draft coordination framework for implementation.
- Draft monitoring and evaluation system to adjust actions for greater success.

This HNAP formulation exercise highlighted the strong commitment of the Ministry of Health and Wellness to supporting climate change efforts in Belize while leveraging the National Adaptation Plan (NAP). It adds a new dimension to the country's assets to facilitate the health sector’s access to adaptation funds nationally and to various international financial mechanisms such as the Adaptation Fund (AF) and the Green Climate Fund (GCF).

CHAPTER 2: NATIONAL FRAMEWORK OF CLIMATE AND HEALTH POLICIES IN BELIZE

2.1 National Framework for Climate Change Policy

The Government of Belize's 2021 Nationally Determined Contribution (NDC) outlines the country's commitments under the Paris Agreement to reduce greenhouse gas emissions and enhance climate resilience. Key targets include increasing renewable energy capacity, improving energy efficiency, and promoting sustainable land management. The NDC also focuses on protecting biodiversity, enhancing water security, and building resilient infrastructure. It emphasizes the need for financial and technical support to achieve these goals and highlights Belize's dedication to contributing to global climate action while addressing its vulnerabilities.
The updated NDC version (2021) benefits from the availability of more robust data on land use trends and emission factors over the previous version submitted in 2016, including the availability of Belize's first Forestry and Other Land Use (FOLU) sector and Greenhouse Gas Inventory showing long-term trends in emissions and removals since 2001. It also carefully considers national capacity and conditions as well as the availability of technological advancements. It therefore represents an ambitious improvement in the planning and projections of national commitments which largely underpinned generalized assumptions and deficiencies in data needed for accurate estimates in the FOLU sector.

As a result, a direct comparison between the first NDC and this updated version, in terms of the magnitude of CO2e commitments in the FOLU sector, cannot be made without considering the increase in the accuracy of projections. Belize considers the improvements made to develop more realistic, transparent, and achievable NDCs in all sectors to demonstrate its high-ambition goals.

Climate change is already affecting the livelihoods of Belizeans. Belize, as a small country with relatively minor contributions to global greenhouse gas emissions, has limited capacity to contribute to the mitigation of global climate change. However, the government is committed to achieving the Convention’s ultimate objective to support more ambitious targets and limit the increase in global average temperature to 1.5°C, compared to pre-industrial levels. As a member of the High Ambition Coalition, Belize has committed to increasing emissions reduction ambition in this updated NDC, including using nature-based solutions in the FOLU sector intended to increase removals, while underpinning the NDC development process with more robust and realistic data and projections (UNDP, 2021).

Additionally, Belize is committed to developing a long-term strategy to achieve net zero global emissions by 2050. The report by Singh, Obretin, and Savoie (2014) titled "Enhancing Belize’s Resilience to Adapt to the Effects of Climate Change" provides an in-depth study of strategies to bolster Belize's capacity to withstand climate change impacts. It outlines key interventions, policy recommendations, and practical measures to improve the country's environmental and infrastructural resilience.

Belize's Nationally Determined Contribution (NDC) aligns with the overarching objectives of the Growth and Sustainable Development Strategy (GSDS), encompassing various facets such as medium-term economic development, poverty alleviation, and long-term sustainable growth. This commitment builds upon previous frameworks, notably the Horizon 2030: National Development Framework for Belize 2010-2030. By integrating the NDC within this strategic framework, Belize aims to address climate change and advance its broader socio-economic goals cohesively and sustainably. The GSDS is the nation's primary planning document outlining four critical success factors for the country's development to ensure a better quality of life for all Belizeans, living now and in the future. The development of the updated NDC has included broad stakeholder engagement including participation of vulnerable populations in an inception workshop for the NDC update process. Throughout the development of the updated NDC, progress was validated through engagement with a technical committee of sector leads, including the representation of indigenous peoples. Broader engagement of civil society and project owners was facilitated during an engagement phase. The actions and targets included in this updated NDC have undergone a gender and vulnerable group scoring analysis, which produced recommendations for increasing the gender sensitivity of both the medium-term implementation of the NDC and the long-term low emissions development strategy under development.

The primary GHG emitters are the energy, agriculture, waste, and industrial processes and product use (IPPU) sectors. The FOLU sector is a net sink of GHG emissions due to GHG removals from forest growth that occurred in the country, which is the main driver of Belize's historical GHG emission profile. The Belize First Biennial Update Report (2020) by the National Climate Change Office outlines Belize's climate action progress, detailing its greenhouse gas emissions inventory and key mitigation and adaptation strategies. The report highlights efforts to boost renewable energy, enhance energy efficiency, and promote sustainable land use. It emphasizes the importance of building resilience in vulnerable communities, particularly those reliant on agriculture and coastal resources. Challenges identified include the need for better data collection, increased financial and technical support, and strengthened institutional capacities. This report aims to inform and engage stakeholders in enhancing Belize's climate resilience and sustainability efforts.

As a Small Island Developing State (SIDs), Belize recognizes that the health and integrity of coastal ecosystems are vital for the health of people and the planet. "Blue carbon", e.g., basin, fringe, and island mangrove and seagrass ecosystems, play important roles as a nature-based solution to climate change with mitigation, adaptation, and resilience co-benefits. These ecosystems sequester and store significant amounts of carbon, help to reduce flooding of low-lying areas on the mainland, safeguard frontline communities and infrastructure from climate impacts, and build greater resilience, making their healthy function a triple-win for Belize by contributing to the national carbon sink, offsetting sea level rise and coastal erosion while expanding habitat for biodiverse resources, and supporting a more resilient tourism and aquaculture industry.

Climate change significantly impacts Belize's territory, population, and key economic sectors. Impacts experienced in the country to date include sustained droughts, floods, increased coastal erosion, and changing precipitation patterns. In the future, these effects are expected to increase, thereby threatening Belize's physical and social infrastructure. Agricultural yields are sensitive to precipitation, temperature, and extreme weather changes. Tourism, which accounts for the most income of any sector is impacted by sea level rise, coral bleaching, and impacts on biodiversity. Critical support systems including water resources, health, and energy are likewise affected by the increasingly variable climate in the region. Belize also hosts significant global ecological resources including rainforest, mangrove forests, wetlands, and coral reefs under global warming threats. Belize considers adaptation a high priority given its vulnerability to natural hazards and climate-related shocks.

This updated NDC (2021) reflects Belize's commitment to enhancing its climate ambition by integrating it through the following enhancements:

- Improvements in the data availability and analysis of projections underpinning commitments, especially in the FOLU (Food and Land Use Coalition) sector.
- Realistic and achievable commitments.
- Increased ambition through expanded sectoral targets.
- Expanded coverage of gases covered in targets to include N2O and Methane in AFOLU interventions.
- Further specification of targets including the addition of time frames, quantified emissions reductions, and other outcomes.
- Increased transparency in the development of targets.
- Detailed financing, monitoring, and implementation of actions included in the NDC.

The targets and actions set out in this document highlight Belize's commitment to supporting the implementation of the Paris Agreement including:

- A set of mitigation targets in line with the international climate policy goal of limiting global goal to keep global warming to below 2° C by 2100.
- Considering the costs of delivering actions identified and the level of climate finance resources to support the delivery of these actions.

The Government of Belize has also taken several steps towards mobilizing finance for climate change activities from domestic and international sources. Recognizing the importance of climate finance aspects, the Climate Finance Working Group has been established under the Belize National Climate Change Committee (BNCCC) to guide the national efforts to access, manage, and effectively use climate finance. Moreover, the Government of Belize has increased public capital investment in climate change, especially in resilience-building aspects. The mitigation targets and actions outlined above are projected to require nearly USD 1.39 billion between 2021 and 2030. After accounting for existing commitments, the funding gap is estimated at USD 1.24 billion. However, recoverable costs in the energy and waste sectors could reduce this gap to USD 607 million.

Similarly, the adaptation measures in Belize's NDC are estimated to cost USD 318 million over the same period. With committed funding considered, the remaining gap stands at USD 146 million.

The implementation of these NDC targets and actions will be led by the Belize National Climate Change Office (NCCO), with strategic guidance from the Belize National Climate Change Committee (BNCCC), comprising representatives from key ministries and stakeholders.

An NDC Implementation Plan will be developed to set out annual targets, funding conditionalities and requirements, and responsible parties for activities required to deliver the actions and targets included in the NDC. The delivery of the NDC Implementation Plan will consider how to incorporate stakeholder engagement in actions to promote a fair transition in Belize. In coordination with the NDC implementation plan, evaluation systems will be established to monitor annual progress toward targets and actions for mitigation and adaptation.

2.2 National Health Policy

The Government of Belize is committed to the health and well-being of all Belizeans. The 2014-2024 National Health Sector Strategic Plan (HSSP)[1] reflects an innovative approach to the organization and delivery of health and wellness services to the population. It is framed in the realization that health interventions geared at achieving wellness are usually the purview of other important sectors/organizations. The WHO Health Determinants Framework is an important tool used to define which areas need to be addressed, what risk factors need to be looked at, and which stakeholders need to be brought to the table in the spirit of cooperation and coordination. The HSSP uses a new approach in developing the strategic objectives for the Ministry of Health and Wellness and identifies six key pillars in the health system: Governance and Leadership; Service Delivery; Financing; Human Resources in Health; Health Information Systems; and Medicines and Technology.

The Ministry of Health and Wellness leadership seeks to develop and strengthen Belize's Health Care System to meet the population's needs and contribute to sustainable development. It will pursue the laudable goal of Universal Health Coverage in which equity of access to quality health care without the creation of financial barriers, and extension of coverage to the citizens in a sustainable, effective, and efficient manner, will be two guiding principles in the engineering process: a people-centered health system.

National and regional political challenges affect healthcare services and will be addressed by the Government of Belize. Hence, it is necessary to be proactive and consider those challenges in planning health care delivery by all partners. One challenge is climate change which impacts many spheres of social welfare such as agriculture and the overall environment. Respective participating actors must know the efforts must be strategic and aligned toward national goals. Partners included are Community-Based Groups, Non-Governmental Organizations, Civil

[1]- https://extranet.who.int/countryplanningcycles/planning-cycle-files/belize-belize-health-sector-strategic-plan-2014-2024

Society, Business Sector, Government Sectors, and the United Nations Organizations in Belize, to name a few.

Concerning climate change, the United Nations Framework Convention on Climate Change (UNFCCC) specifies that Belize is among those countries most vulnerable to the negative effects of climate change due to its long, low-lying coastline, its over 450 small islands, its extensive barrier reef, and its wide forest cover. Belize is ranked 8th of 167 countries for climate risks (World Bank). Since half of Belize's population lives in coastal areas, the vulnerability to natural disasters is extremely high. While hurricanes have affected Belize periodically, a major threat continues to be flooding due to heavy rainfall, which increases the risk for infectious diseases, thus impacting negatively on social life and affecting the country's productive sector (Ministry of Health, 2014).

In addition, the 2021 WHO Health and Climate Change Global Survey Report reveals the global landscape concerning health and climate change in Belize. It highlights the advancements and ongoing challenges the countries face in integrating health considerations into their climate policies. The report reveals that while many nations have acknowledged the critical health risks due to climate change, significant obstacles hinder efforts to implement adaptive measures. These include inadequate funding, which limits the ability to execute and sustain necessary interventions, and a lack of technical capacity within health systems to manage climate-related health risks effectively. Furthermore, the report underscores the importance of intersectoral collaboration, emphasizing that health adaptation requires coordinated efforts across various sectors such as the environment, agriculture, and infrastructure to address the multifaceted impacts of climate change on health. To build resilient health systems, the report advocates for establishing robust health surveillance and early warning systems to detect and promptly respond to climate-related health threats.

Additionally, there is a call for increased investment in research to address gaps in the health impacts of climate change, which is crucial for developing evidence-based policies and interventions. The report also stresses the need to enhance international cooperation to share resources, knowledge, and best practices highlighting the pivotal role of strong leadership within the health sector to spearhead initiatives aimed at mitigating the adverse health effects of climate change.

Strategic Goals for the Health Sector are highlighted below:

- Strengthen inter-sectorial participation to effectively and efficiently deliver preventative, promotive, curative, and rehabilitative services to communities taking into consideration their cultural and social characteristics.
- Ensure strong leadership and governance at all levels.
- Development of innovative strategies to promote inter-sectoral partnerships to improve the population's wellness.
- Advocacy for universal health coverage as a guiding principle for socio-economic development.
- Adapting appropriate technology to increase efficiency and effectiveness in health care delivery.

• Public sector, private sector, civil society, and communities working together to protect and improve the health and well-being of Belize's population.
• Build strong partnerships with communities and involve them in planning, implementing, and evaluating plans and programs geared toward social development.
• Human Resources for national development to ensure well-trained, customer-friendly, and committed individuals meet the health and wellness needs of the communities.

CHAPTER 3: VULNERABILITIES AND PRESENT AND FUTURE RISKS RELATED TO CLIMATE-SENSITIVE DISEASES

3.1 Current and Future Health Risks of Climate-Sensitive Diseases

Spatial-Temporal Variation of Observed Climate-Sensitive Diseases: The spatial distribution of various diseases recorded between 2014 and 2023 in Belize highlights a variability of pathologies such as Dengue (Figure 11a), Zika (Figure 11b), Diarrhea (Figure 11c), Diabetes (Figure 11d), Respiratory Infections (Figure 11e), Hypertension (Figure 11f), Asthma (Figure 11g), and Mental Health Disorders (Figure 11h).

The spatial distribution of dengue in Belize from 2013 to 2023 indicates that the Cayo and Belize Districts have the highest number of cases, marked in dark red, signifying a high prevalence in these regions (Figure 11a). In contrast, Orange Walk and Corozal Districts show a moderate incidence, marked in dark orange, while Stann Creek and Toledo Districts have a low incidence, marked in pale yellow. For Zika in Belize between 2014 and 2023, the Corozal District has the highest number of cases, marked in dark red (Figure 11b) followed by the Belize District with a moderate incidence, shown in dark orange compared to the other districts shown in pale yellow with a low incidence.

Regarding diarrhea from 2014 to 2023, the Cayo District reflects the highest incidence, marked in dark red (Figure 11c), followed by Belize District with a moderate incidence, marked in dark orange, and Corozal, Orange Walk, Stann Creek, and Toledo Districts with a low incidence, marked in pale yellow.

For diabetes, between 2014 and 2023, the Belize and Cayo Districts have the highest number of cases, marked in dark red (Figure 11d), while Stann Creek, Toledo, and Orange Walk Districts show a moderate incidence, marked in dark orange; the rest show a low incidence, marked in pale yellow.

Concerning respiratory infections in Belize between 2014 and 2023, Belize and Cayo Districts yielded the highest number of cases, marked in dark red (Figure 11e), while the other districts show a moderate to low incidence, marked in dark orange to pale yellow.

On the other hand, for hypertension, the Belize District has the highest number of cases, marked in dark red (Figure 11f). Cayo and Stann Creek Districts show a moderate incidence, marked in dark orange, while the other districts show a low incidence, marked in pale yellow.

Regarding asthma, between 2014 and 2023, the Belize District reflects the highest incidence, marked in dark red (Figure 11g), followed by Cayo and Stann Creek Districts with a moderate incidence, marked in dark orange, and the rest showing a low incidence, marked in pale yellow.

Lastly, mental health disorders (2014 and 2023) cases are more evenly distributed across the country, with a slight concentration in Belize, Cayo, and Stann Creek Districts (Figure 11h). In

conclusion, interpreting the spatial distribution of climate-sensitive diseases in Belize highlights variations in the incidence of each disease across the districts, underscoring the importance of targeted public health programs to prevent and manage these conditions, effectively.

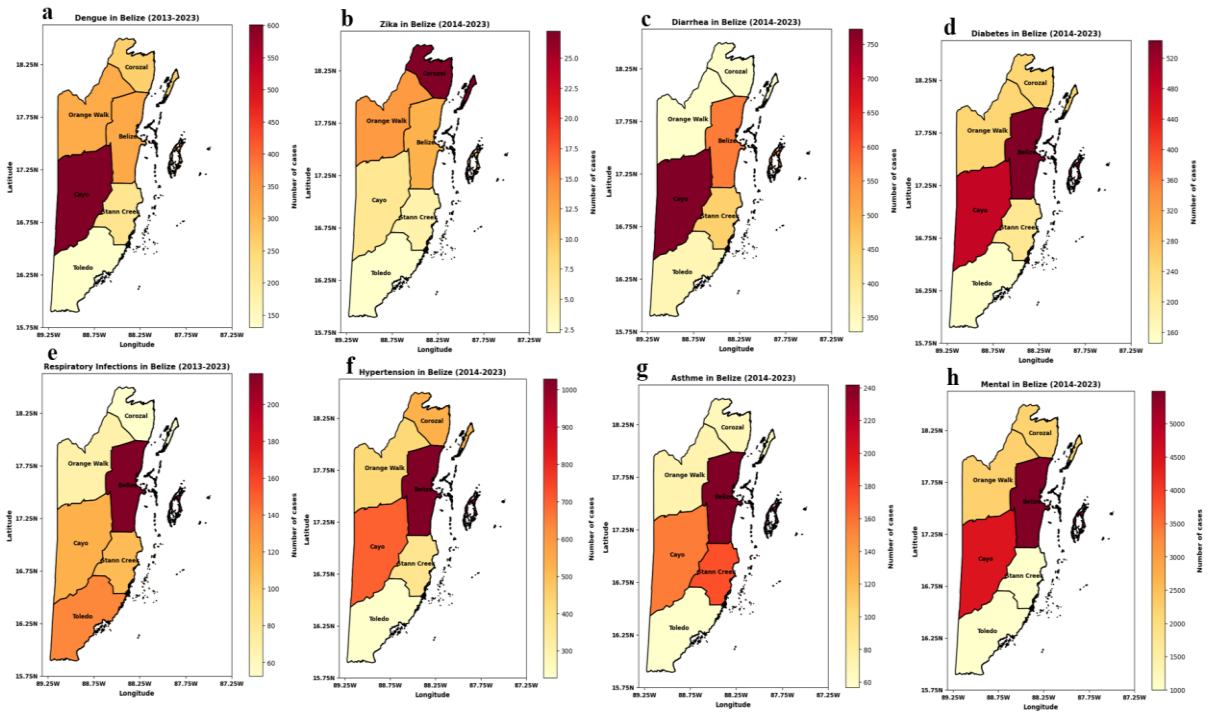

Figure 11: Spatial-Temporal Distribution of Climate-Sensitive Diseases in Belize between 2014-2023: a) Dengue in Belize b) Zika in Belize c) Diarrhea in Belize d) Diabetes in Belize e) Respiratory Infections in Belize f) Hypertension in Belize g) Asthma in Belize h) Mental Health Disorders in Belize

Table 1: Diseases, implicated climatic parameters, and more affected or exposed regions.

Disease	**Climate Parameters**	**Most Affected Districts**
Dengue	Rainfall, Temperature	Cayo, Belize; Orange Walk, Corozal (moderate); Stann Creek, Toledo (low)
Zika	Rainfall, Temperature	Corozal; Belize (moderate); Other districts (low)
Diarrhea	Rainfall, Temperature	Cayo; Belize (moderate); Corozal, Orange Walk, Stann Creek, Toledo (low)
Diabetes	Rainfall, Temperature	Belize, Cayo; Stann Creek, Toledo, Orange Walk (moderate); Other districts (low)
Respiratory Infections	Rainfall, Temperature	Belize, Cayo; Other districts (moderate to low)
Hypertension	Temperature, Humidity	Belize; Cayo, Stann Creek (moderate); Other districts (low)
Asthma	Temperature, Humidity	Belize; Cayo, Stann Creek (moderate); Other districts (low)
Mental Health Disorders	-	Evenly distributed with slight concentration in Belize, Cayo, Stann Creek

Many statistical treatments, including intersections between climatic parameters (temperature and rainfall), and about six climate-sensitive diseases were conducted for each district for 2014-2023. However, it was decided to present only a few results to illustrate the types of analyses. Vector and water-borne diseases are more sensitive to changes in climatic parameters and, thus, were studied in various regions of the country in addition to respiratory and chronic diseases often linked to air quality.

3.2 Variability of climatic parameters and current health impacts

In this section, we examine the variability of climatic parameters and their current repercussions on health, focusing particularly on climate-sensitive diseases, whether Communicable or Non-Communicable Diseases. The goal is to understand present and future spatiotemporal variability in the studied regions, drawing on research, observational data, and existing impact models.

3.2.1 Climate-sensitive communicable diseases

In this section, we examine the effects of precipitation and temperature on confirmed cases of Communicable diseases, such as dengue and diarrhea, in the districts considered in this study (2013-2023).

- **Dengue**

Figure 12 depicts a series of graphs (a-f) illustrating the cross-analysis of precipitation, temperature, and confirmed dengue case anomalies in various health districts of Belize between 2013 and 2023. Each subplot corresponds to a specific district. The curves represent the dengue case anomalies (in red), precipitation in mm (in blue), and temperature in °C (in black). Each graph displays a time series ranging from 2013 to 2023.

The analysis of the graphs reveals several interesting relationships. Firstly, peaks in the precipitation curve often precede or coincide with peaks in dengue anomalies. This observation suggests a possible correlation between precipitation and dengue incidence, due to the propensity of disease-carrying mosquitoes to breed in humid environments.

Furthermore, temperature variations follow seasonal patterns, with temperature peaks sometimes corresponding to peaks in dengue cases. This correlation between temperature variations and disease incidence indicates the influence of temperature on the spread of the dengue virus. These observations suggest that meteorological conditions, particularly precipitation and temperature, play a significant role in the spread of dengue and other vector-borne diseases across Belize.

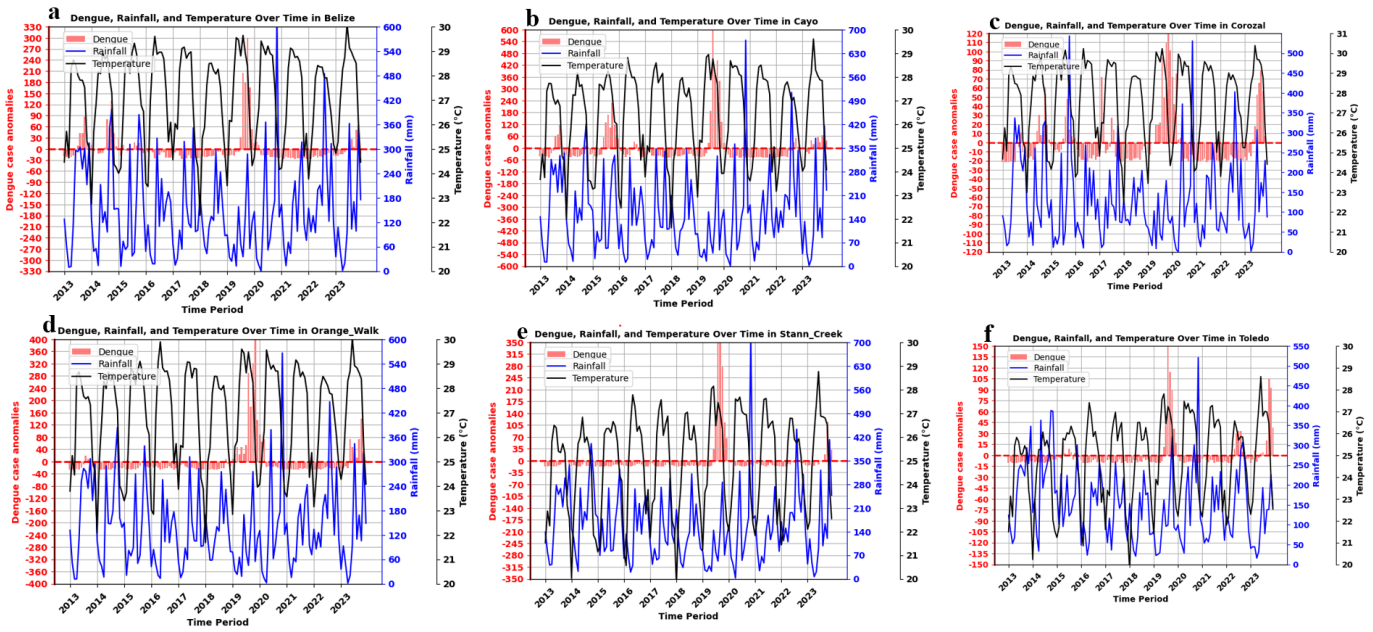

Figure 12: Cross-analysis of precipitation, temperatures, and confirmed dengue case anomalies in the various health districts of Belize: a) Belize, b) Cayo, c) Corozal, d) Orange Walk, e) Stann Creek, and f) Toledo.

- **Diarrhea**

Figure 13 presents a cross-analysis of precipitation, temperature, and confirmed diarrhea case anomalies in various health districts of Belize: Belize (Figure 13a), Cayo (Figure 13b), Corozal (Figure 13c), Orange Walk (Figure 13d), Stann Creek (Figure 13e), and Toledo (Figure 13f). The comparative study of these three variables can help understand the interactions between climatic factors and the incidence of diarrhea. Diarrheal cases (red curve) exhibit temporal fluctuations, with peaks and troughs reflecting variations in disease incidence. A correlation between precipitation peaks (blue curve) and diarrhea case peaks in certain areas may indicate that periods of heavy rainfall increase the risk of water contamination, preferring diarrhea spread.

Temperature variations (red curve) are also crucial, as higher temperatures can promote the growth of diarrhea-causing pathogens. Thus, temperature peaks could be associated with further diarrhea cases in the studied regions.

Hence, observing all three curves together allows the identification of patterns and correlations between precipitation, temperature, and diarrhea cases. For instance, a surge in diarrhea cases following heavy rainfall and high temperatures could indicate increased water contamination and pathogen growth. Negative anomalies in diarrhea case curves could signal periods where environmental conditions are less favorable for disease transmission. This could be due to lower temperatures or less conducive precipitation levels for water contamination.
In summary, the analysis of Figure 13 highlights the impact of climatic factors, such as precipitation and temperature, on the incidence of diarrhea in different regions of Belize.

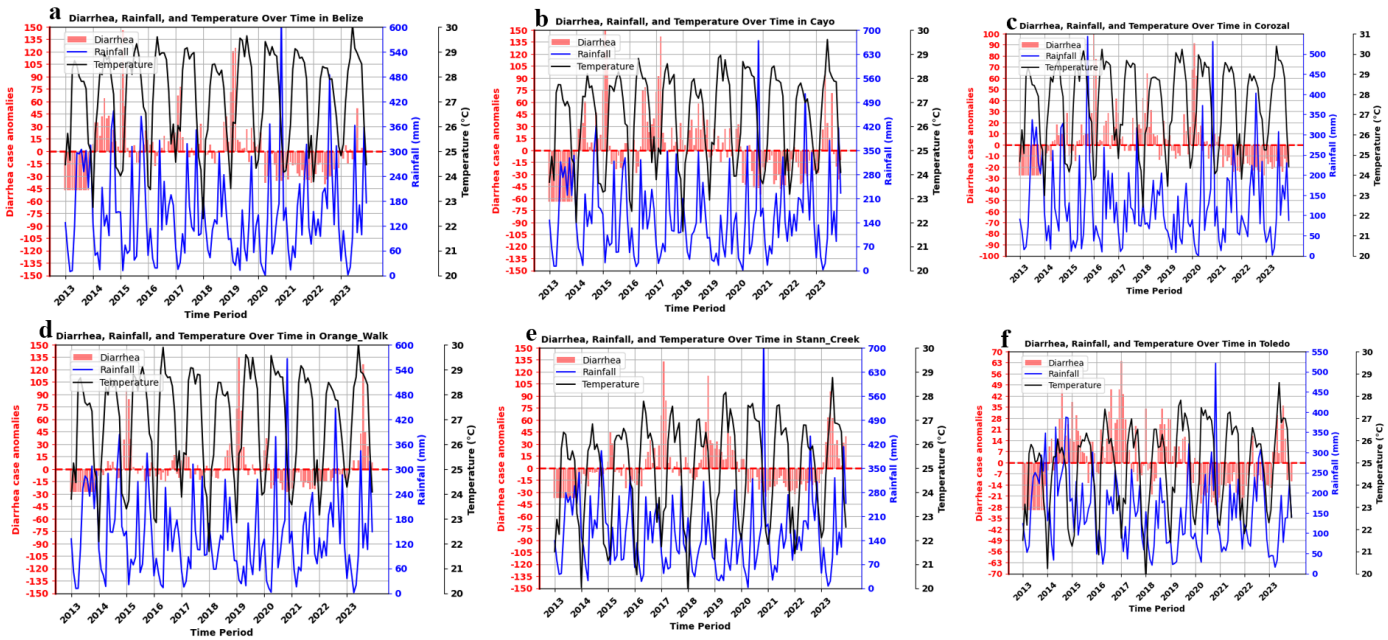

Figure 13: Cross-analysis of precipitation, temperatures, and confirmed diarrhea case anomalies in the various health districts of Belize: a) Belize, b) Cayo, c) Corozal, d) Orange Walk, e) Stann Creek, and f) Toledo.

3.2.2 Climate-sensitive non-communicable diseases

In this section, we examine the effects of daylight and nighttime heat extremes on confirmed cases of Non-Communicable Diseases (NCDs)in the districts considered in this study for 2013-2023. Non-communicable diseases include cardiovascular diseases, chronic respiratory diseases, cancer, and diabetes, not caused by infectious agents such as bacteria, viruses, or parasites.

- **Respiratory diseases: Asthma**

Asthma, a chronic respiratory disease characterized by airway inflammation, is subject to seasonal and meteorological fluctuations. Figure 14 presents a cross-analysis aiming to examine temperature extremes (minimums and maximums) and their association with confirmed asthma case anomalies in various health districts of Belize. The graphs are divided into segments, each representing a different district and covering a period from 2014 to 2023.

Three main elements are depicted in each subplot: asthma case anomalies, minimum temperatures, and maximum temperatures. Asthma case anomalies are indicated by a red line, expressing deviations from the average. Minimum and maximum temperatures are represented by darker and lighter gray lines, with temperature scales in degrees Celsius on the right side of each graph.

By analyzing these graphs, one can observe the variations of minimum and maximum temperatures in each district over time and the fluctuations in asthma cases compared to the average. This analysis allows for exploring trends or correlations between temperatures and asthma cases in each district, thus aiding in better understanding the potential impact of meteorological conditions on respiratory health in the population.

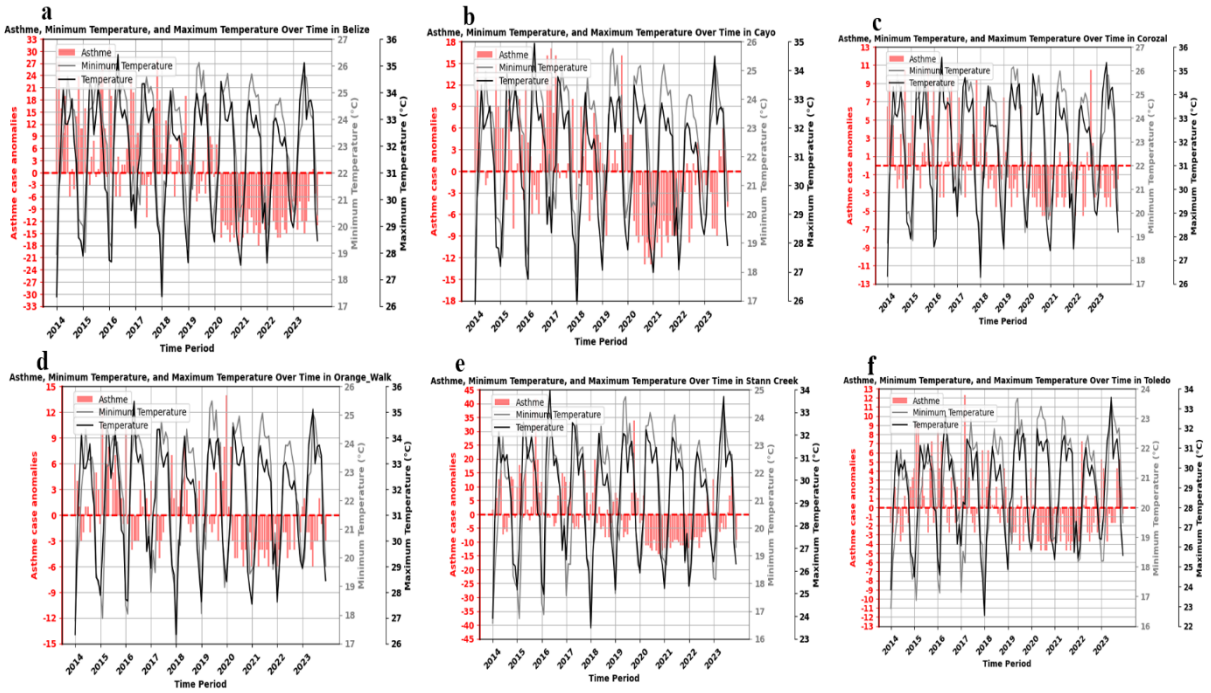

Figure 14: Cross-analysis of heat extremes associated with minimum (Tmin) and maximum (Tmax) temperatures, as well as confirmed asthma case anomalies in the various health districts of Belize: a) Belize, b) Cayo, c) Corozal, d) Orange Walk, e) Stann Creek, and f) Toledo.

- **Hypertension**

Figure 15 presents a cross-analysis of the association between temperature extremes (minimum and maximum temperatures) and confirmed hypertension case anomalies in various health districts of Belize. The graphs are organized for the following districts: Belize, Cayo, Corozal, Orange Walk, Stann Creek, and Toledo.

Each graph displays three types of data over the period from 2014 to 2023:
Hypertension case anomalies (red line): represent deviations in the number of hypertension cases from an average or reference value, with positive values indicating more cases than usual and negative values indicating fewer cases than usual.
Minimum temperature (black line): shows fluctuations in minimum temperature in degrees Celsius.
Maximum temperature (gray line): illustrates variations in maximum temperature in degrees Celsius.
This analysis aims to understand how temperature variations may influence the incidence of hypertension in these regions. In some cases, there seems to be a relationship between temperatures and hypertension case anomalies, with peaks or troughs in hypertension cases corresponding to temperature variations.

This cross-analysis enables the exploration of trends and potential correlations between extreme temperatures and hypertension cases in the various health districts of Belize. It can help identify specific periods or weather conditions associated with increased hypertension cases, which could be useful for public health planning and preventive interventions.

By closely examining the data and conducting in-depth statistical analyses, it would be possible to quantify the degree of the relationship between temperatures and hypertension to identify other potential factors that could influence this association.

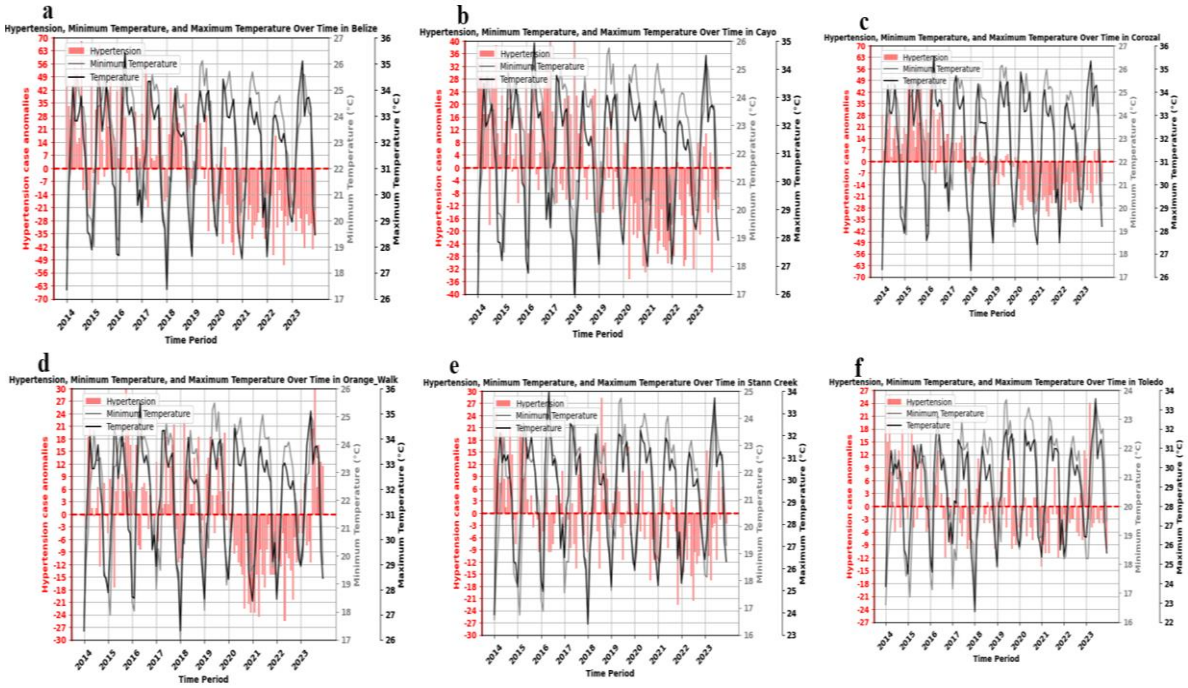

Figure 15: Cross-analysis of heat extremes associated with minimum (Tmin) and maximum (Tmax) temperatures, as well as confirmed hypertension case anomalies in the various health districts of Belize: a) Belize, b) Cayo, c) Corozal, d) Orange Walk, e) Stann Creek, and f) Toledo.

3.3 Modeling the health impacts of climate change.

3.3.1 Vector-borne climate-sensitive diseases

This section addresses the modelling of health impacts induced by climate change. We focus specifically on climate-sensitive vector-borne diseases, aiming to better understand their evolution and their consequences to public health.

Spatial variability of seasonal malaria incidence and validation with observed cases.

Figure 16 illustrates two aspects of malaria incidence in Belize, based on data simulated by the LMM. Regarding the annual cycle of average malaria incidence in Belize, Figure 16a shows the monthly evolution of malaria incidence for three different periods. The lines denote:

- Climatology 1985-2014 (solid black line): shows the annual cycle of malaria incidence in Belize based on historical data from 1985 to 2014.
- Climatology 2015-2050 (dotted red line): represents predictions for the period from 2015 to 2050.
- Climatology 2051-2080 (dashed red line): presents predictions for the period from 2051 to 2080.

The overlay of these lines illustrates how the simulated malaria incidence changes or remains constant over time. The three lines follow distinct profiles, suggesting variations in malaria incidence in Belize over the years. For example, there may be an increase in malaria incidence risk at certain periods, which may be related to environmental, climatic, or public health factors.

Figure 16b shows the interannual variability of malaria incidence from 1985 to 2080. The portion from 1985 to 2015 displays simulated historical malaria incidence, with some variability over the years. Post-2015, Figure 18b shows projected data in red, suggesting trends under one of the SSP (Shared Socioeconomic Pathways) scenarios, specifically SSP585, which typically assumes high future socio-economic challenges for mitigation and adaptation. The projection indicates a very slight increase in incidence around the mid-2020s, followed by what appears to be fluctuations before stabilizing to some extent toward 2080.

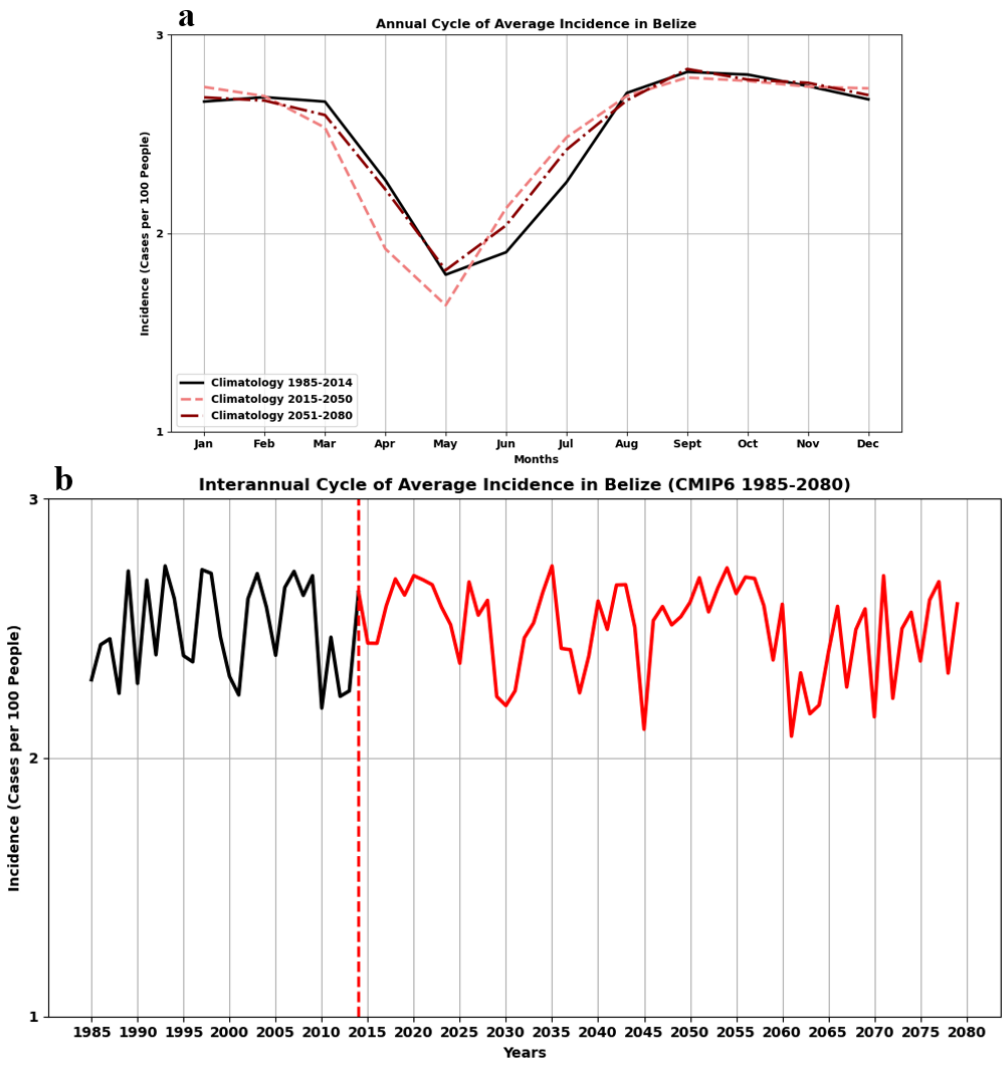

Figure 16**:** a) and b) represent the annual cycle and interannual variability of malaria incidence simulated by the LMM in Belize using historical rainfall and temperature data (1985-2014) and projections (2015-2080) for the SSP585 scenario from the multi-model ensemble mean of the CMIP6 models.

Figure 17 depicts three maps presenting data on the projected annual mean malaria incidence in Belize for different periods, based on simulations using historical and projected climate data.

Figure 17a: Historical data (1985-2014) - This map depicts the annual mean malaria incidence during the past decades, specifically from 1985 to 2014. The data reflects the historically simulated incidence. The colour gradient (from yellow to dark red) shows lower to higher incidence rates, respectively.

Figure 17b: Near future projections (2015-2050) - This map shows malaria incidence projections for the near future, utilizing the SSP585 scenario, a climate pathway assuming significantly high greenhouse gas emissions. The colour scale remains consistent, indicating that trends in malaria incidence could remain similar or slightly increase in specific areas.

Figure 17c: Far future projections (2051-2080) - This map extends the projection further into the future, under the SSP585 scenario. Again, the colour shading indicates projected incidence rates, suggesting either stable or somewhat varied incidence rates from the near to the far future.

Each map has a colour spectrum legend to help interpret the data. The legend typically indicates the range of malaria incidence rates corresponding to the colours used in the maps, providing a visual reference for understanding the severity of malaria risk in different regions of Belize.

Overall, these maps serve as valuable tools for understanding the potential impact of climate change on malaria transmission in Belize. By comparing historical data with future projections under different climate scenarios, researchers and policymakers can better anticipate and prepare for potential changes in malaria incidence rates, enabling more effective disease prevention and control strategies.

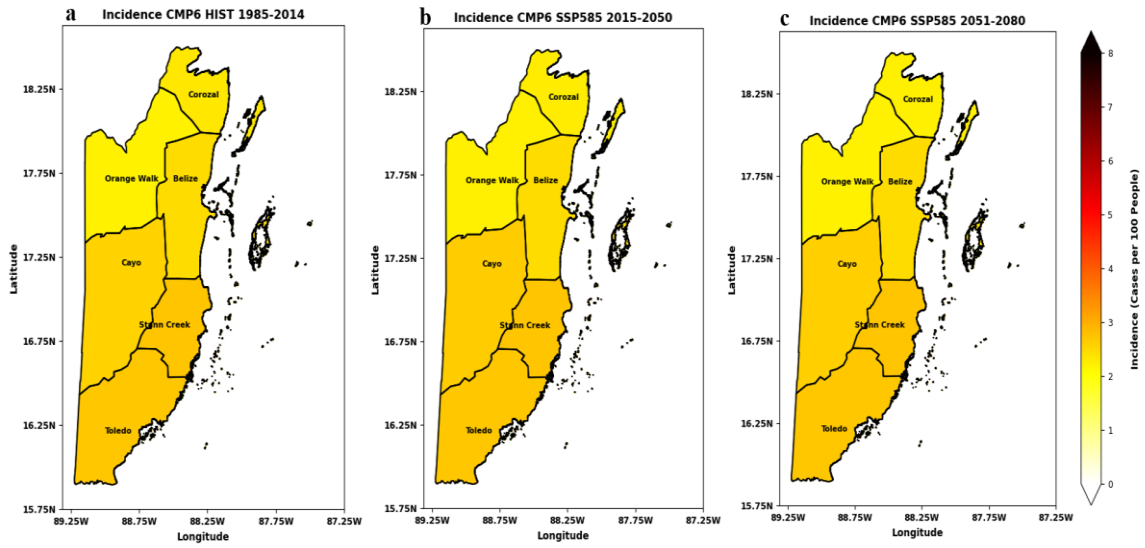

Figure 17: Annual mean malaria incidence simulated by the LMM in Belize using rainfall and temperature data in Belize for a) historical data (1985-2014) and projected for b) the near future (2015-2050) and c) for the far future (2051-2080) for the SSP585 scenario from the multi-model ensemble mean of the CMIP6 models.

Modelling Aedes Aegypti vector capacity: effects of temperature on dengue.

These maps in Figure 18 illustrate the relative vector capacity (rVc), which indicates the Aedes Aegypti mosquito's ability to transmit dengue fever based on temperature, across various time frames and climate scenarios for Belize. Aedes Aegypti is the primary dengue vector, a significant viral disease in numerous tropical and subtropical regions.
Figure 18a displays rVc for the historical period from 1985 to 2014. Shades vary across the country. Belize (dark red) exhibit higher rVc values compared to southern areas like Toledo (in light yellow), suggesting greater mosquito capacity for dengue transmission. In Figure 18b, this near-term projection (2015-2051), under the SSP585 scenario, indicates specific increases in vector capacities, particularly in areas like Orange Walk and Belize Districts, with relatively stable or slightly increasing trends elsewhere. This implies potentially heightened dengue transmission in these areas due to projected climate changes.

Figure 18c (2051-2080) shows that under the SSP585 scenario, the situation differs slightly. Most regions show relatively stable rVc values, with minor fluctuations. However, regions like Corozal and Orange Walk Districts exhibit an upward trend compared to SSP585, suggesting less favourable climate conditions for dengue transmission in these areas.

In summary, these maps of relative vector capacity for the dengue vector, Aedes Aegypti, in Belize reveal potential variations in dengue transmission capacity across different regions of the country based on projected climate scenarios. Monitoring these trends is crucial for understanding and preventing the spread of dengue in the region.

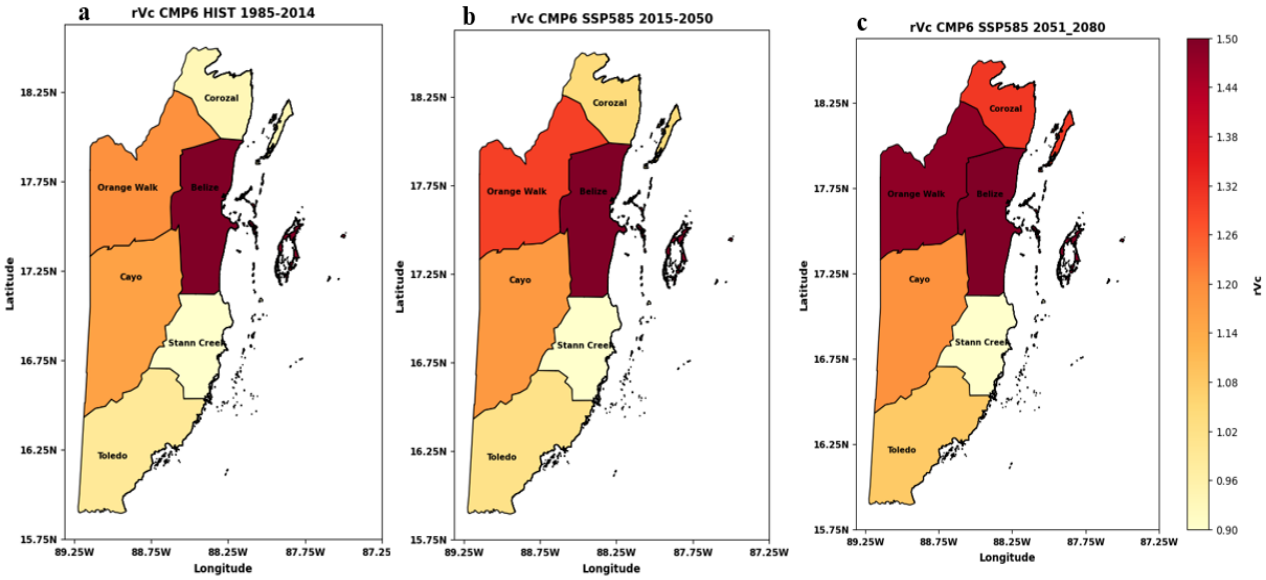

Figure 18: Annual mean of relative vector capacity for dengue (rVc) simulated in Belize using historical temperature data in Belize for a) historical data (1985-2014) and projected for b) the near future (2015-2050) and c) for the far future (2051-2080) for the SSP585 scenario from the multi-model ensemble mean of the CMIP6 models.

3.3.2 Chronic diseases related to heat waves and other risk factors.

Figures 19a, 19b, and 19c each depict a map of Belize, illustrating the number of consecutive days exceeding the 95th percentile in temperature for different periods and scenarios.

Figure 19a represents actual historical data from 1985 to 2015. It shows the distribution of the number of days where temperatures exceeded the 95th percentile. The colour gradient, from yellow to dark red, indicates fewer to more consecutive hot days, respectively. Cayo and Toledo Districts show more days in darker shades, suggesting a higher frequency of extreme temperatures during this period.

Figure 19b predicts the future occurrence of days exceeding the 95th percentile. There's a notable increase in the southern parts of the country, particularly in Toledo and Stann creek, which exhibits darker shades indicating more consecutive hot days compared to the historical data in Figure 19a.

Figure 19c is for the projected for the future temperatures. This highlights a potential substantial increase in the frequency and intensity of hot days in the future, with Belize notably shown in darker red, indicating a particularly high number of consecutive days exceeding the 95th percentile the frequency and intensity of hot days in the future, with Belize notably shown in darker red, indicating a particularly high number of consecutive days exceeded 95 percentiles.

These figures are useful for understanding and predicting the impacts of climate change on temperature extremes in Belize, aiding in the planning and adaptation efforts to mitigate heat-related issues.

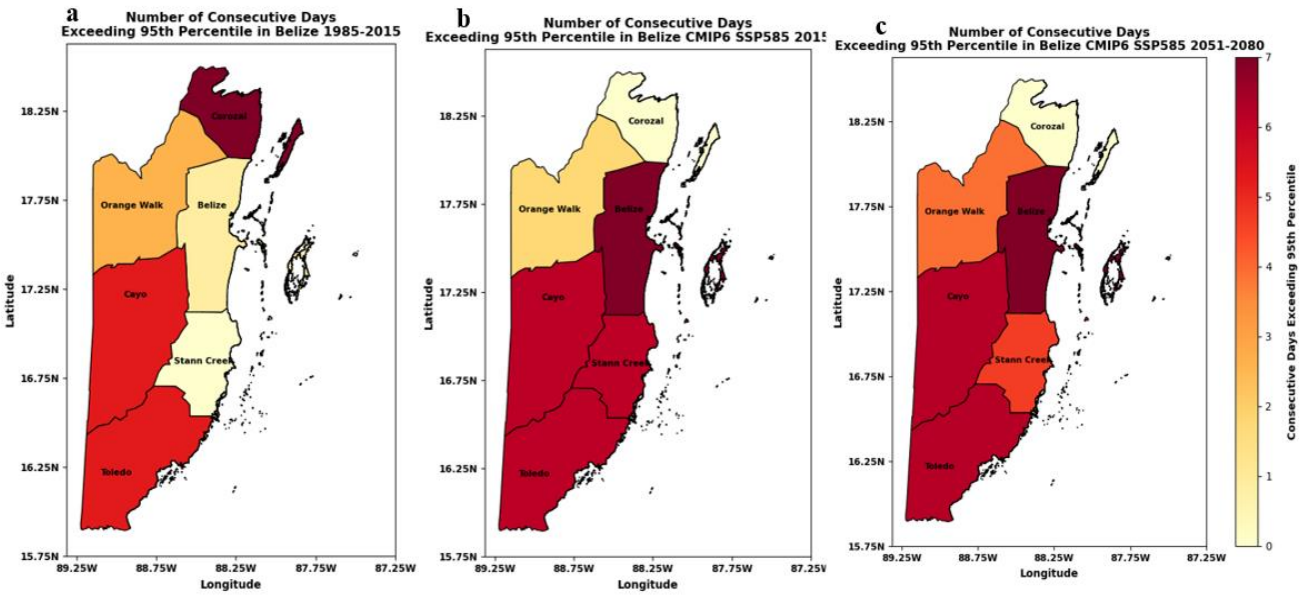

Figure 19: Projected Increase in Consecutive Hot Days in Belize: Historical Trends (1985-2015) and Projected Near (2015-2051) and Far Future (2051-2080) in the SSP585 Scenario.

In summary, the findings show a correlation between precipitation, temperature, and the incidence of diseases such as dengue, diarrhea, asthma, and hypertension highlighting

important climate factors in disease prevention and management. These studies underscore the crucial importance of understanding and predicting the impacts of climate change on human health in Belize. The findings can guide public health policies and adaptation strategies to mitigate the adverse health effects caused by climate change in the region.

To date, there is no proven model for simulating the occurrence of health risks related to heatwave events but studying the spatiotemporal variability of the number of consecutive days exceeding the 95th percentile in temperature. It enabled the identification of hot spots where monitoring chronic diseases and respiratory pathologies is crucial in future climate evolution, especially temperature. These diseases, sensitive to temperature variability, especially maximum temperatures, which currently affect a significant portion of the Belizean population, include hypertension, diabetes, and acute respiratory infections (ARIs), marked by uneven evolution across Belize from 2014 to 2023.

In many geographical regions, heatwave events have been associated with excess mortality and morbidity, often affecting infants, individuals with pre-existing health conditions, and the aging population (Qiang Zeng et al., 2016; Chen, 2016). These findings highlight a global trend of heatwave occurrences, leading to international mobilization on issues related to rising temperatures, a priority health concern. Scientific studies focusing on heatwave events in America and Europe have demonstrated the real impact of extreme temperatures on human health, evident by the recorded excess mortality and morbidity.

3.4 Vulnerabilities to Climate-Sensitive Diseases and Adaptive Capacities of the Health System and Communities

3.4.1 Health Vulnerability Index by District

Developing a health vulnerability index based on the cumulative scores from coefficients assigned to various health determinant indicators allowed the classification of departments from the lowest sensitivity level to the highest.

Figure 20 represents the vulnerability index, encompassing climate hazards, environmental nuisances, health risks, social determinants, the healthcare system, and access to information. The overall vulnerability index for the districts is calculated by combining three essential components: exposure, sensitivity, and adaptive capacity. The index values range between -1 and +1, with lower values indicating lower vulnerability. Consequently, sensitivity acts as a multiplier, so that high sensitivity in a district where exposure exceeds adaptive capacity will result in a high and thus positive score, meaning high vulnerability.

The results suggest that the Cayo District appears to have a low health vulnerability index in the face of climate hazards (Figure 20). The Cayo District stands out for its strong adaptive capacity, the highest in the country, which mitigates its health sensitivity and, consequently, reduces its overall vulnerability to the health impacts of climate change (Figure 20).

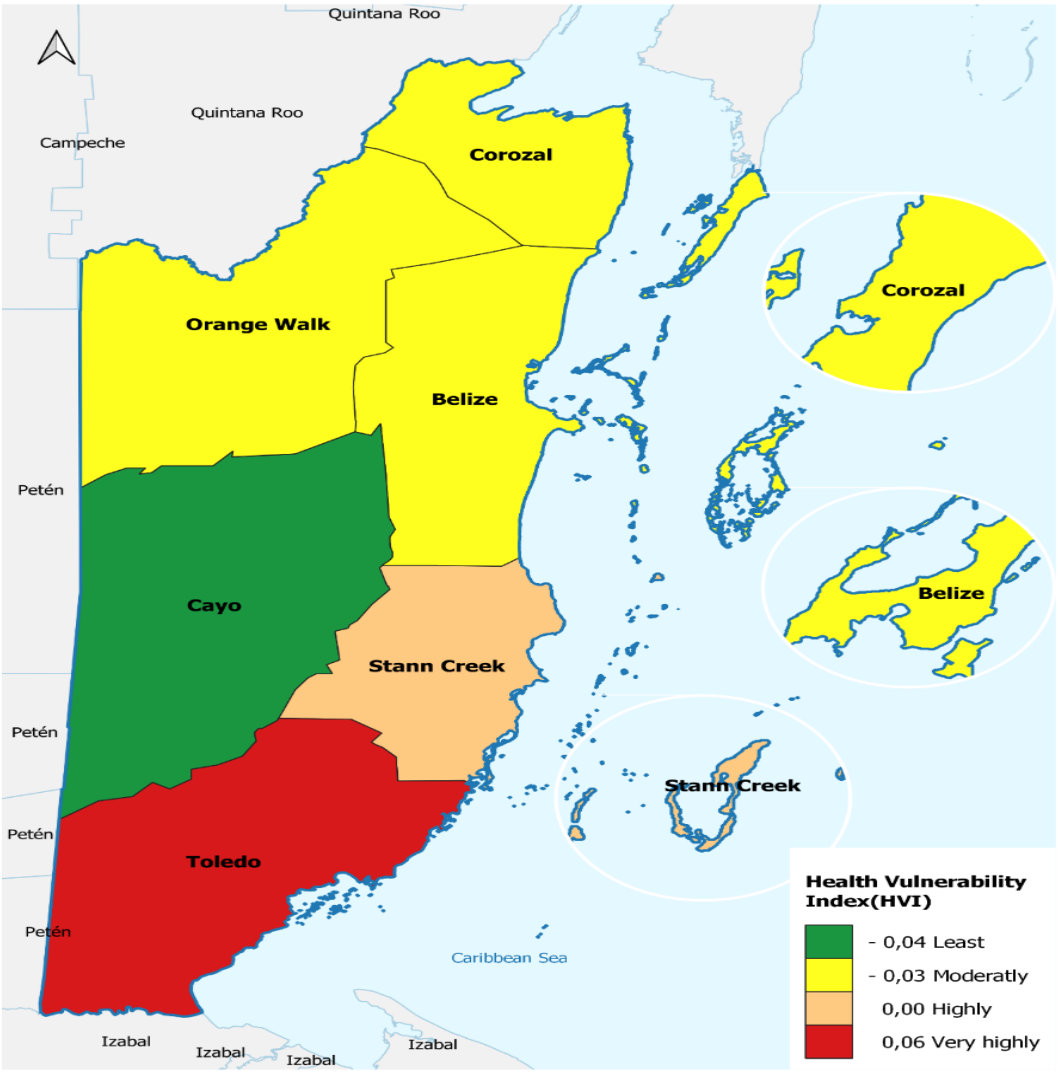

Figure 20: Distribution of the Health Vulnerability Index by regions

Belize, Corozal, and Orange Walk Districts are characterized by an adaptive capacity that exceeds their health sensitivity and exposure (Figure 21), thus showing a relatively moderate vulnerability index. In contrast, the Toledo District appears to have a very high overall vulnerability index, the highest in the country (Figure 21). This district is marked by high exposure to extreme climate events, resulting in significant health sensitivity and limited adaptive capacity, which leads to high vulnerability (Figure 21). Similarly, the Stann Creek District shows a relatively high vulnerability index (Figure 20), marked by pronounced health sensitivity (Figure 21).

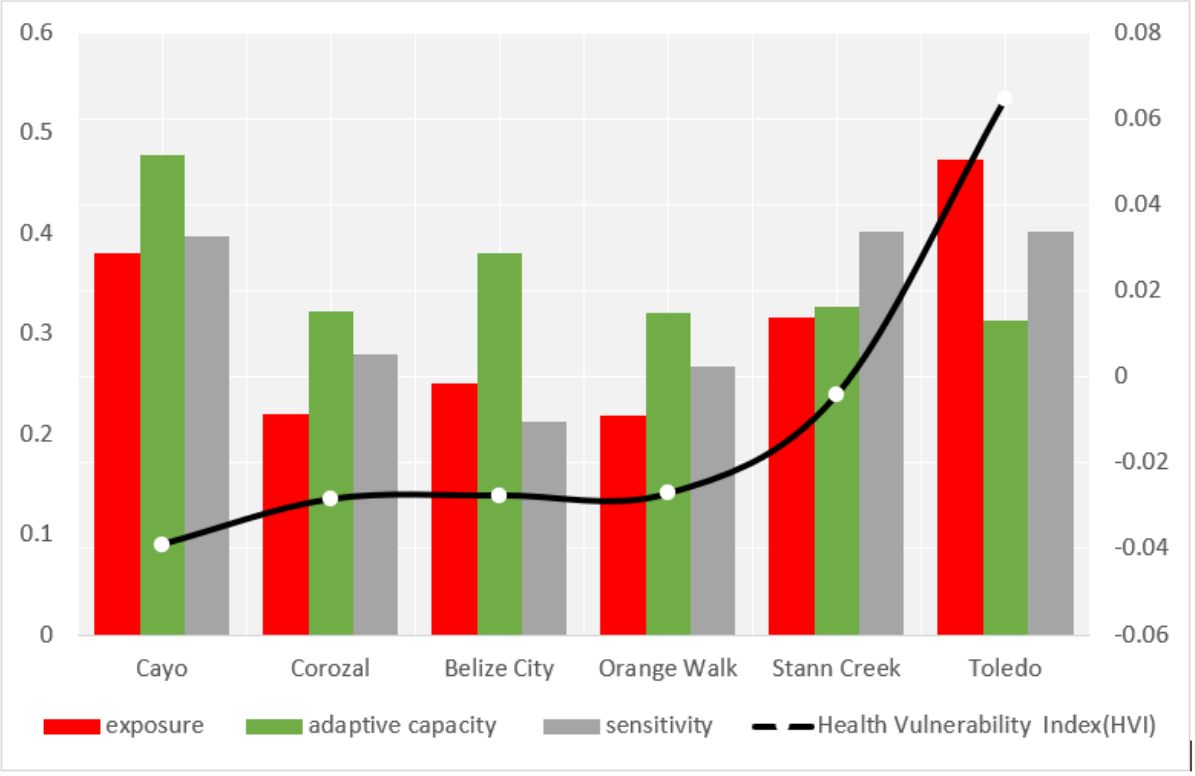

Figure 21: Health Vulnerability Index Based on Extreme Climate Hazards

After developing a health vulnerability index, the vulnerability assessment and adaptation of the health system and communities involved identified the most relevant health impacts through exposure, sensitivity, and adaptive capacity, each time mentioning the level or degree.

3.4.2 Vulnerability and Adaptive Capacity of Communities to Climate-Related Health Impacts

Temperature changes (increase in temperature, heat waves, heat spikes) lead to various health impacts such as water stress, land degradation, low food production, depletion of water services, malnutrition, waterborne diseases, heat-related illnesses, cardiovascular disease, respiratory diseases, and mental health issues. The exposure level ranges from moderate to high in the agricultural blocks of Corozal and Orange Walk District, .

Sensitivity is high among older persons, children, pregnant women, farmers, disabled individuals, low-income individuals, and those with chronic diseases. Adaptation capacity includes access to water systems, solar systems, water harvesting, increased health services, free health care services (National Health Insurance), visiting medical teams, training in managing extreme temperatures, and access to climate services, all categorized at a high level.

Changes in precipitations (heavy rainfall, floods, decreased rainfall, rain breaks, droughts) cause water stress, flash floods, erosion, increase in vector breeding sites, soil contamination, water pollution, depletion of water services, decreased water quality services, degraded sanitation services, decrease in food availability, waterborne diseases, vector-borne diseases, and malnutrition. Exposure is high in low-lying, waterlogged areas, cities, and towns.

Sensitivity is high among older persons, children, pregnant women, farmers, disabled individuals, and low-income individuals. Adaptation capacity includes irrigation systems, solar water systems, water harvesting, increased health services, free health care services (National Health Insurance), visiting medical teams, access to climate services, and water and sanitation services, all categorized at a high level.

Climate Extreme Events (earthquakes, storms, hurricanes, cyclones, bushfires, wildfires, etc.) result in deforestation, loss of biodiversity, increase in vector habitats, soil contamination, water pollution, soil degradation, and flash floods. Health impacts include waterborne diseases, vector-borne diseases, stress and mental health issues, respiratory and dermatological diseases, and accidents. Exposure is very high in coastal areas like San Pedro, Caye Caulker, and the Western Corridor. Sensitivity is very high among older persons, children, pregnant women, farmers, disabled individuals, low-income individuals, and individuals with chronic diseases. Adaptation capacity involves early warning systems, increased emergency health services, improved health facilities, visiting medical teams, access to climate services, water and sanitation services, access to hurricane shelters, and trained emergency responders, all categorized at a high level.

Changes in sea and river levels lead to saltwater intrusion, increased vector habitats, heavy metals, coastal erosion, eutrophication, and biodiversity/habitat loss, resulting in health impacts like waterborne diseases, vector-borne diseases, malnutrition, stress, and mental health issues. Exposure is moderate to high in coastal areas like Baranco, Dangriga, Punta Gorda, Corozal Bay, and water sheds like Jordan, Mopan, Macal, New River, Rio Hondo, and Belize Rivers, as well as Maskal Village where water harvesting is not practiced. Sensitivity is low among older persons, children, pregnant women, farmers, disabled individuals, low-income individuals, individuals with chronic diseases, fishermen, and in the marine environment. Adaptation capacity involves early warning systems, increased emergency health services, improved health facilities, visiting medical teams, access to climate services, water and sanitation services, marine protected areas, and fishing seasons (Blue Economy), carbon rights legislation, and protection status (Belize Barrier Reef), all categorized at a high level.

Table 2: Summary of the assessment of community vulnerability to health impacts related to climate change.

Climatic variables	**Health impacts on individuals and communities**		**Vulnerabilities: Exposure, Sensitivity, Adaptive capacity (Vulnerability factors) Assess and evaluate the degree of exposure, sensitivity, and adaptive capacity: very low, low, moderate, high, and very high.**	
	Climate-related health hazards	**Health impacts (Gender approach)**		
Changes in Temperature (increase in temperature, heat waves, heat spikes	o Water stress o Land degradation o Low water table o Low food production o Depletion of water services	o Malnutrition o Water borne diseases o Heat-related illnesses o Cardiovascular disease o Respiratory diseases o Mental Health	**Exposition:** The most exposed geographical areas are those vulnerable to phenomena such as heat waves, droughts, floods, storms, and cyclones, characterized by a prevalence of precarious habitats and housing, high population density, and intense socio-economic activities	**Degree/Level** **Low**
			Sensibility: The most sensitive categories include newborns, infants, pregnant and lactating women, persons with reduced mobility, those with medical histories, the elderly, immunocompromised individuals, farmers, and livestock breeders, etc. characterized by limited access to basic social services, low resilience of healthcare services to the increasing burden of diseases, and high workload and treatment costs for patients.	**Degree/Level** **Very High**
			Adaptative Capacity: Adaptive capacities involve actions such as awareness campaigns, alternative water supply strategies, health education, distribution of mosquito nets, reliance on community solidarity, aid organizations, health programs and projects aimed at improving access to healthcare, expanding healthcare infrastructure to enhance medical services, as well as access to health insurance and social coverage.	**Degree/Level** **Low**
Changes in Precipitation (heavy rainfall, floods, decreased rainfall,	o Water stress o Flash floods o Erosion o Increase vector breeding sites o Soil contamination	o Water-borne disease (Diarrheal, Gastroenteritis, Leptospirosis, dermatitis, etc.)	**Exposition:** The most exposed geographical areas are those vulnerable to heat waves, droughts, floods, storms, and cyclones, characterized by a prevalence of precarious habitats and housing, high population density, and intense socio-economic activities.	**Degree/Level** **High**

rain, breaks, droughts)	○ Water pollution ○ Depletion of water services ○ Decrease water quality services ○ Degraded sanitation services ○ Decrease food availability	○ Vector-borne diseases (Dengue, Malaria) ○ Malnutrition.	**Sensibility:** The most sensitive categories include newborns, infants, pregnant and lactating women, persons with reduced mobility, those with medical histories, the elderly, immunocompromised individuals, farmers, and livestock breeders, etc. characterized by limited access to basic social services, low resilience of healthcare services to the increasing burden of diseases, and high workload and treatment costs for patients.	**Degree/Level** **Very High**
			Adaptative Capacity: Adaptive capacities involve actions such as awareness campaigns, alternative water supply strategies, health education, distribution of mosquito nets, reliance on community solidarity, aid organizations, health programs and projects aimed at improving access to healthcare, expanding healthcare infrastructure to enhance medical services, as well as access to health insurance and social coverage.	**Degree/Level** **Low**
Change in sea level and river level	○ Saltwater intrusion ○ Increase in Vector habitats ○ Biodiversity/Habitat lost ○ Increase Mercury and other heavy metals ○ Coastal erosion ○ Eutrophication	○ Waterborne disease ○ Vector-borne disease ○ Malnutrition ○ Stress and Mental Health	**Exposition**: The most exposed geographical areas are those vulnerable to heat waves, droughts, floods, storms, and cyclones, characterized by a prevalence of precarious habitats and housing, high population density, and intense socio-economic activities.	**Degree/Level** **High**
			Sensibility: The most sensitive categories include newborns, infants, pregnant and lactating women, persons with reduced mobility, those with medical histories, the elderly, immunocompromised individuals, farmers, and livestock breeders, etc. characterized by limited access to basic social services, low resilience of healthcare services to the increasing burden of diseases, and high workload and treatment costs for patients.	**Degree/Level** **Very High**
			Adaptative Capacity: Adaptive capacities involve actions such as awareness campaigns, alternative water supply strategies, health education, distribution of mosquito nets, reliance on community solidarity, aid organizations, health programs and projects aimed at improving access to healthcare, expanding healthcare infrastructure to enhance medical services, as well as access to health insurance and social coverage.	**Degree/Level** **Low**

Extreme Climate events (Earthquakes, storms, hurricanes, cyclones, bushfires, wildfires, etc.)	o Deforestation o Loss of biodiversity o Increase vector habitats o Soil contamination o Water pollution o Soil degradation o Flash floods.	o Waterborne disease o Vector-borne disease o Stress and Mental Health o Respiratory and Dermatological Diseases o Accidents	**Exposition:** The most exposed geographical areas are those vulnerable to heat waves, droughts, floods, storms, and cyclones, characterized by a prevalence of precarious habitats and housing, high population density, and intense socio-economic activities.	**Degree/Level** **High**
			Sensibility: The most sensitive categories include newborns, infants, pregnant and lactating women, persons with reduced mobility, those with medical histories, the elderly, immunocompromised individuals, farmers, and livestock breeders, etc. characterized by limited access to basic social services, low resilience of healthcare services to the increasing burden of diseases, and high workload and treatment costs for patients.	**Degree/Level** **Very High**
			Adaptative Capacity: Adaptive capacities involve actions such as awareness campaigns, alternative water supply strategies, health education, distribution of mosquito nets, reliance on community solidarity, aid organizations, health programs and projects aimed at improving access to healthcare, expanding healthcare infrastructure to enhance medical services, as well as access to health insurance and social coverage.	**Degree/Level** **Low**

3.4.3 Vulnerability and adaptive capacity of the healthcare system to health impacts related to climate change.

Changes in Temperature (increase in temperature, heat waves, heat spikes) bring various health impacts including water stress, land degradation, low food production, depletion of water services, higher demand for energy services, increased morbidity of water- and food-borne diseases, respiratory illnesses, chronic and cardiovascular diseases. Consequently, this leads to increased demand for healthcare services, overburdening of healthcare workers, healthcare services interruption, and increased threat to the cold chain and preservation of drugs and medical supplies.

Exposure is noted in the Northern Health Region (Corozal Community Hospital, Northern Regional Hospital) and Western Health Region (San Ignacio Community Hospital, Western Regional Hospital). Sensitivity is observed in health facilities with intermittent energy supply shortages based on demand (Polyclinics) and water availability for Polyclinics. Adaptation capacity involves SMART Facilities including emergency power supply, water storage, AC, solar panels, and energy-efficient windows and doors for these facilities along with others like Regional Hospitals, Community Hospitals, Polyclinics, and Health Centers.

Changes in Precipitation (heavy rainfall, floods, decreased rainfall, rain breaks, droughts) result in water stress, flash floods, soil erosion, increased vector breeding sites, soil contamination, water pollution, depletion of water services, decreased food availability, decreased water quality services, degraded sanitation services, and increased morbidity of water, vector, and foodborne diseases, respiratory illnesses. This leads to increased demand for healthcare services, pressure on healthcare workers, risk of interruption of healthcare services, and risk of destruction of buildings, infrastructure, equipment, and supply services.

Exposure is observed in the Toledo District (Jordan River, Santa Teresa, Aguacate, Jacintoville Junction, Blue Creek, Graham Creek), Orange Walk District (Albion Islands), Cayo District (Benque, Viejo, San Jose Succotz), and Belize District (Belize River Valley, Belize City). Sensitivity factors include duration of rain, geographic location, built environment, and long-term environmental health concerns. Adaptation capacity involves early warning systems, national response systems, and SMART Facilities.

Extreme Climate Events (earthquakes, storms, hurricanes, cyclones, bushfires, wildfires, etc.) lead to deforestation, loss of biodiversity, increased vector habitats, soil contamination and degradation, water pollution, flash floods, increased respiratory illnesses, decreased food production, and increased morbidity of emerging/re-emerging diseases. This results in increased demand for healthcare services, overburdening of healthcare workers, risk of perturbation of healthcare services, and risk of destruction of buildings, infrastructure, equipment, and supply services.
Exposure is noted in coastal communities, communities along river systems, islands, and inland areas. Sensitivity includes the disabled, elderly, women, children, individuals with chronic

conditions, and low-income families. Adaptation capacity involves shelter management systems, warning systems, response systems, relief programs, and external support.

Changes in sea and river levels bring about saltwater intrusion, increase in vector habitats, biodiversity/habitat loss, increase in heavy metals, coastal erosion, eutrophication, decrease in food supply, emerging diseases, decrease in potable water, and increased morbidity of water, vector, and foodborne diseases. This leads to increased demand for healthcare services, overburdening healthcare workers, increased disruption of healthcare services, and risk of destruction of buildings, infrastructure, equipment, and supply services.

Exposure is noted in coastal areas, islands, low-lying areas, and inland areas like communities along rivers. Sensitivity factors include a rise in sea and water levels. Adaptation capacity involves SMART Facilities standards such as drainage, elevation, shutters, self-contained utilities (water and energy), energy-efficient equipment, hydrants, and fire suppression systems.

Table 3: Summary of the assessment of the vulnerability of the healthcare system to health impacts related to climate change.

Climatic variables	**Health impacts on individuals and communities**		**Vulnerabilities: Exposure, Sensitivity, Adaptive capacity (Vulnerability factors)** **Assess and evaluate the degree of exposure, sensitivity, and adaptive capacity: very low, low, moderate, high, and very high.**	
	Climate-related health hazards	**Health impacts (Gender approach)**		
Changes in Temperature (increase in temperature, heat waves, heat spikes	○ Water stress ○ Land degradation ○ Low water table ○ Low food production ○ Depletion of water services ○ Higher demand for energy service ○ Increase of the morbidity of water- and foodborne diseases, respiratory illnesses, chronic and cardiovascular diseases	○ Increase the demand for healthcare services ○ Increase of pressure on healthcare workers ○ Risk of disruption to health care service ○ Increased threat to the cold chain and the preservation of drugs and medical supplies.	**Exposition:** The most exposed healthcare facilities are those located in geographical areas vulnerable to phenomena such as heat waves, droughts, floods, storms, and cyclones, characterized by a prevalence of precarious habitats and housing, high population density, and intense socio-economic activities.	**Degree/Level** **Low**
			Sensibility: The most sensitive healthcare facilities are those poorly prepared for health emergencies related to climate risks, lacking qualified or sufficient personnel and resources, equipment, and services capable of dealing with health emergencies, including water supply, sanitation, energy, and transportation services, insufficient financial resources, and those in advanced decay or without maintenance and upkeep mechanisms.	**Degree/Level** **Very High**
			Adaptative Capacity: Existing adaptive actions involve raising awareness and training healthcare personnel, maintaining and servicing buildings, equipment, infrastructure, and services, utilizing renewable energy sources, investing in the modernization and sustainability of healthcare facilities, carrying out rehabilitation work on damaged buildings, implementing stormwater drainage systems, and developing health contingency plans.	**Degree/Level** **Low**
Changes in Precipitation (heavy rainfall, floods, decreased rainfall,	○ Water stress ○ Flash floods ○ Soil erosion Increase vector breeding sites Soil contamination	○ Increase in health care service demand ○ Increase of pressure on healthcare workers	**Exposition:** The most exposed healthcare facilities are those located in geographical areas vulnerable to phenomena such as heat waves, droughts, floods, storms, and cyclones, characterized by a prevalence of precarious	**Degree/Level** **High**

rain, breaks, droughts)	Water pollution Depletion of water services Decrease food availability Decrease water quality services Degraded sanitation services Increase of the morbidity of water, vector, and food-borne diseases, respiratory	○ Risk of interruption of health care services ○ Risk of destruction of buildings, infrastructure, equipment, and supply services; disruption of roads	habitats and housing, high population density, and intense socio-economic activities.	
			Sensibility: The most sensitive healthcare facilities are those poorly prepared for health emergencies related to climate risks, lacking qualified or sufficient personnel and resources, equipment, and services capable of dealing with health emergencies, including water supply, sanitation, energy, and transportation services, insufficient financial resources, and those in advanced decay or without maintenance and upkeep mechanisms.	**Degree/Level** **Very High**
			Adaptative Capacity: Existing adaptive actions involve raising awareness and training healthcare personnel, maintaining and servicing buildings, equipment, infrastructure, and services, utilizing renewable energy sources, investing in the modernization and sustainability of healthcare facilities, carrying out rehabilitation work on damaged buildings, implementing stormwater drainage systems, and developing health contingency plans.	**Degree/Level** **Low**
Change in sea and river levels	○ Increase Mercury and other heavy metals ○ Coastal erosion ○ Eutrophication ○ Decrease food supply ○ Emerging diseases ○ Decrease potable water ○ Increase of the morbidity of water, vector, and food borne diseases	○ Increase in disruption of health care services ○ Risk of destruction of buildings, infrastructure, equipment, and supply services.	**Exposition**: The most exposed healthcare facilities are those located in geographical areas vulnerable to phenomena such as heat waves, droughts, floods, storms, and cyclones, characterized by a prevalence of precarious habitats and housing, high population density, and intense socio-economic activities.	**Degree/Level** **High**
			Sensibility: The most sensitive healthcare facilities are those poorly prepared for health emergencies related to climate risks, lacking qualified or sufficient personnel and resources, equipment, and services capable of dealing with health emergencies, including water supply, sanitation, energy, and transportation services, insufficient financial resources, and those in advanced decay or without maintenance and upkeep mechanisms.	**Degree/Level** **Very High**

			Adaptative Capacity: Existing adaptive actions involve raising awareness and training healthcare personnel, maintaining and servicing buildings, equipment, infrastructure, and services, utilizing renewable energy sources, investing in the modernization and sustainability of healthcare facilities, carrying out rehabilitation work on damaged buildings, implementing stormwater drainage systems, and developing health contingency plans.	**Degree/Level** **Low**
Extreme Climate Events (Earthquakes, storms, hurricanes, cyclones, bushfires, Wildfires, etc.)	○ Deforestation ○ Loss of biodiversity ○ Increase vector habitats ○ Soil contamination ○ Water pollution ○ Soil degradation ○ Flash floods ○ Increase respiratory illnesses ○ Decrease food productions ○ Increase of the morbidity of emerging/ re-emerging of diseases	○ Increase in healthcare service demand ○ Increase demand for health care services ○ Risk of perturbation of health care services ○ Risk of destruction of buildings, infrastructure, equipment, and supply services.	**Exposition:** The most exposed geographical areas are those vulnerable to heat waves, droughts, floods, storms, and cyclones, characterized by a prevalence of precarious habitats and housing, high population density, and intense socio-economic activities.	**Degree/Level** **High**
			Sensibility: The most sensitive categories include newborns, infants, pregnant and lactating women, persons with reduced mobility, those with medical histories, the elderly, immunocompromised individuals, farmers, and livestock breeders, etc. characterized by limited access to basic social services, low resilience of healthcare services to the increasing burden of diseases, and high workload and treatment costs for patients.	**Degree/Level** **Very High**
			Adaptative Capacity: Adaptive capacities involve actions such as awareness campaigns, alternative water supply strategies, health education, distribution of mosquito nets, reliance on community solidarity, aid organizations, health programs and projects aimed at improving access to healthcare, expanding healthcare infrastructure to enhance medical services, as well as access to health insurance and social coverage.	**Degree/Level** **Low**

3.4.4 Evaluation of risk levels according to types of health impacts

An assessment of the level of risk associated with potential health impacts considers the magnitude, the severity of the health impact, the number of people affected, the duration, and the socio-economic implications. Thus, the levels of health risk priority (ratio between consequence and probability for each assessed health impact) are entered into the risk assessment matrix as seen in the table below. The resulting risk levels range from very low to extreme.

The assessment of health risks is determined by examining the consequences and probability of the main effects of climate change on health, identified from the vulnerability and adaptation assessment. Potential climate change effects on health at the departmental level include vector-borne diseases, chronic diseases, water, and foodborne diseases, as well as the collapse of healthcare facilities materialized through the risk of disruption to the organization and functioning of healthcare, increased threats to the conservation chain of inputs, medicines, and other means of patient treatment, and the risk of destruction of buildings, infrastructure, equipment, and supply services.

Indeed, current data suggest that interannual and inter-decadal climate variability directly influences the epidemiology of vector-borne diseases. The impact of climate change on the incidence, duration of the transmission season, and spread of vector-borne diseases represent a major threat. Outbreaks of waterborne diseases have been associated with heavy rainfall and dry periods. Increased risks of water and foodborne diseases can be expected "if climate change continues as projected in representative concentration pathway (RCP) scenarios until mid-century".

Furthermore, extreme weather events are followed by the destruction of healthcare infrastructure and services, low numbers of healthcare and social personnel, and difficulties in resource mobilization, significantly impacting the capacity of health services to provide curative and preventive services. Many health systems operate with low surge capacity, and departments in Belize are already working with suboptimal staffing levels, which is problematic in the context of increasing risks of climate change-related shocks and stresses.

The synthesis of potential health impacts highlights a series of major risks associated with climate change. Firstly, there is an increase in waterborne diseases such as diarrhea, typhoid, gastroenteritis, leptospirosis, dermatitis, etc., presenting a very high risk with a high probability, resulting in a very high level of risk.

The increase in vector-borne diseases such as dengue and malaria represents an extreme risk, with a very high probability, resulting in a very high level of risk. Likewise, the increase in foodborne diseases, including pathologies such as E. coli, rotavirus, campylobacter, salmonellosis, giardiasis, norovirus, shigellosis, as well as malnutrition and growth retardation, constitutes a high risk with a high probability, resulting in a high level of risk. Additionally, the increased demand for healthcare services and the increased pressure on healthcare workers pose high risks with high probabilities, resulting in high and extreme risk levels respectively.

There is also a moderate risk of disruption to healthcare services, with a possible probability, resulting in a low level of risk. Similarly, an increased threat to the cold chain and the conservation of pharmaceuticals and medical supplies is identified as a moderate risk, with an unlikely probability, resulting in a low level of risk. Finally, the risk of destruction of buildings, infrastructure, equipment, and supply services is very high, with a very high probability, resulting in a very high level of risk.

Table 4: Summary of the final ranking of risk levels for potential health impacts.

Potential Health Impact	**Consequence**	**Probability**	**Risk**
Increase of waterborne diseases (diarrhea, typhoid, gastroenteritis, leptospirosis, dermatitis, etc.)	Very High	Likely	Very High
Increase of vector-borne diseases (dengue, malaria)	Very High	Very Likely	Extreme
Increase of food-borne disease (E. coli, rotavirus, campylobacter, salmonellosis, giardiasis, norovirus, shigellosis, malnutrition, stunting)	High	Likely	High
Increase in chronic, cardiovascular, and respiratory diseases	Very High	Very Likely	Extreme
Increase of health care service demand;	High	Likely	High
Increase pressure on healthcare workers;	Very High	Very Likely	Extreme
Risk of disruption of health care services;	Moderate	Possible	Low
Increased threat to the cold chain and the conservation of drugs and medical supplies	Moderate	Unlikely	Low
Risk of destruction of buildings, infrastructure, equipment, and supply services	Very High	Very Likely	Extreme

Based on the risk assessment conducted for the identified types of health impact within the healthcare system, the increased demand for healthcare services due to rising morbidity, as well as the threat of disruption to the organization and functioning of healthcare services, are at a very high level of risk across all departments. The increase in pressure on healthcare personnel and work-related stress is at an extreme level of increase. The threat to the conservation chain of inputs, medicines, and other means of patient treatment is at a high level, as is the risk of destruction of buildings, infrastructure, equipment, and supply services, across all vulnerable departments considered. However, presenting the overall view of the increasing risk levels of various health impacts for the healthcare system shows that the Northern, Central, and Western districts will be the most affected, as was the case with the communities, highlighting the necessity to implement actions to enhance the resilience of healthcare facilities.

3.5 Priority adaptation options and actions according to various components of WHO as a framework for the NAP

Reducing current and future risks to human health requires implementing adaptation measures linked to policies and programs preventing avoidable effects and reducing the burden of morbidity and mortality attributable to climate change impacts. A resilient healthcare system integrating community needs is capable of i) anticipating, ii) countering, iii) managing, iv)

withstanding, and v) adapting to climate shocks and stressors, while substantially improving population health despite climate instability.

Climate resilience thus requires: i) reducing vulnerability through universal access to basic services, ii) strengthening capacities to understand and manage the effects of climate change on health, iii) considering short-, medium-, and long-term perspectives on climate and development, iv) implementing adaptive management approaches, a structured and iterative decision-making process, and information systems to understand and manage health-related risks, and v) creating community partnerships and engaging communities.

3.5.1 Adaptation options and actions identified within the framework of the ten (10) components of the WHO.

Options and adaptation measures have been developed within the framework of eight components corresponding to the various priority action areas defined by the WHO for the resilience of the healthcare system and communities:

• Component 1: Leadership and governance of health sector adaptation

Two adaptation options were recommended within the framework of the leadership and governance component defined by the WHO: the development of a public health policy integrating climate adaptation needs and the revision of the legislative and regulatory framework to address climate change. Regarding legislation and policy, Belize already has a comprehensive policy framework covering climate change, which recognizes the cross-cutting nature of climate risk.

However, legislation and policies covering the health sector do not optimally integrate climate risk. The National Public Health Policy needs to be updated to address climate risks or be accompanied by a specific adaptation policy. Since the main environmental determinants of health may be influenced by a changing climate, quality standards, and regulations need revising to reflect this broader range of climatic conditions.

• Component 2: Health workforce with capacity building needs on climate risk management

Two adaptation options were also recommended within this component on the health workforce: the development of a capacity-building training plan on climate risk management and the integration of climate change into the curricula of healthcare professionals. This will upgrade healthcare professionals in data collection and management for surveillance and monitoring systems for better preparedness for health risk management related to climate change.

A better understanding of the precise nature of the links between climate variables and morbidity burden, as well as between climate and environmental determinants of health, will enable better linkage of climate data to early warning systems. Health sector personnel need training on preventive measures and prioritization, keeping in mind the social differentiation of risk and the need to target vulnerable groups such as the elderly, pregnant and lactating women, and children.

• Component 3: Education, communication, and public information on climate risks for health

Developing a national strategy for education, communication, and information on health impacts related to climate risks was the main adaptation option recommended for this component. Indeed, public education and communication are key elements of effective adaptation that have universal relevance, although the specific nature of messages may be adapted to the local nature of the risk. Adaptation to climate risks can only occur if there is awareness of the nature of these risks, hence the need for health education and promotion at various levels of intervention. Various communication mechanisms and media can be used for health education, including health facilities and personnel, community centers, radio stations, and television to integrate climate risks into existing public health campaigns.

• Component 4: Integrated surveillance of health risks (diseases) and early warnings

Establishing a community-based integrated climate and epidemiological surveillance system for climate-sensitive diseases was also the only adaptation measure identified for this component. Thus, establishing evidence-based links between climate variables and climate-sensitive diseases is a prerequisite for obtaining effective early warning information. This requires monitoring climate parameters, including the effects of disasters related to extreme events such as floods, droughts, heat waves, and storms, with evolving mortality and morbidity to inform the decision-making process of health sector stakeholders.

Implementing this adaptation option also requires certain modifications to notification criteria for the Belize Health Information System (BHIS) or for disaster notification. It is also possible to deploy community members to monitor environmental determinants of health. Effective surveillance and early warning are essential to enable the implementation of appropriate risk reduction measures.

• Component 5: Sustainable, resilient, and adaptable technologies and infrastructures to climate effects

Establishing a national investment program on technologies, infrastructure, and equipment to upgrade medical technical platforms concerning climate health risks was the only adaptation option specified for this component. Healthcare and public infrastructure must be able to offer appropriate treatment options for climate health risks. This is particularly important as many departments already lack technologies, infrastructure, and equipment allowing better preparedness of healthcare facilities.

• Component 6: Preparedness for emergencies and management of health emergencies related to climate change

Developing national and local contingency plans to enhance preparedness for health emergencies related to climate risks was also the only adaptation option recommended for this component. This includes developing early detection laboratory infrastructures and improving medical equipment to support emergency preparedness plans for epidemic diseases. Preparedness for climate-related health emergencies, which allows for anticipating climate risks, also requires relying on health programs focusing on vulnerable population groups such

as the elderly, pregnant and lactating women, and children. The goal is to strengthen the healthcare system's capacity to manage risks by reducing overall vulnerability and exposure to hazards and effectively managing residual risks and uncertainties.

• Component 7: Research and training on climate and health

For this component, the only adaption option stakeholders identified was the need to develop a national policy on research and training on climate and health. This option requires precise identification of research diagnosis and training needs on climate and health from competent national institutions. This needs assessment is considered a prerequisite for developing new programs, laboratories, and research units on climate and health. This will ultimately establish a national observatory on climate and health. Improving research and training on climate change and health helps inform national public health policies by integrating the dimension of climate resilience.

• Component 8: Health Financing and Climate Change Adaptation:

Two adaptation options were recommended within the component on health financing and adaptation to climate change: developing a strategy for mobilizing climate finance for the healthcare system, and planning and submitting projects for climate-resilient health to climate risks. These two options will be implemented through the establishment of a mechanism to prepare for mobilizing climate finance, capacity building on climate finance mechanisms (GCF, FA, and GEF), the establishment of a team of experts responsible for mobilizing climate finance at both international and national levels, and the mobilization of technical and financial partners to support the strategy. Improving climate finance mechanisms is an essential pillar in the healthcare system's resilience process in the context of climate change.

3.5.2 Prioritization of Recommended Adaptation Options

After carefully examining the various proposed options for adapting the health sector to climate change, these measures were prioritized based on several criteria: coherence with climate policies, urgency of the option, feasibility, social and ecological acceptability, implementation cost, effectiveness, equity, sustainability, and potential impact. The prioritization of adaptation options facilitates the development of a multi-year action plan for implementing a climate resilience policy for the health sector. This prioritization in the target regions varies according to the adaptation options and climate urgencies.

Firstly, with a score of 42, the most prioritized adaptation measure is the creation of a Climate Risk and Disaster Management Unit at the Ministry of Health and Wellness. This initiative centralizes and coordinates efforts to manage climate risks and health disasters, ensuring a rapid and effective response to climate crises with the crucial role of protecting public health against growing climate impacts.

The review of health regulations to support climate actions in the health sector ranks second with a score of 41. This measure aims to update health regulations to incorporate climate actions, ensuring that health standards consider the impacts of climate change, and that health practices and infrastructure are prepared to face new environmental challenges.

Thirdly, with a score of 39, is the assessment of the Health Sector Index Assessment (Green and Safe Health Facilities), which includes green and safe health facilities. This initiative allows for measuring and promoting the sustainability and safety of health facilities, considering climate challenges. It helps identify needs and guides investments for more resilient health infrastructures.

Developing a national capacity-building program in climate risk management and health ranks fourth with 37. This program aims to train health personnel and strengthen their skills, ensuring that health professionals are well-prepared to manage climate risks and respond effectively to climate-related health crises.

Three measures share the fifth position with a score of 36. Firstly, developing a national communication plan is crucial to raise awareness among the public and health professionals about climate risks and adaptation measures. Secondly, integrating climate change into the new Health Sector Strategic Plan (2025-2034) while ensuring long-term health strategies consider climate challenges. Thirdly, developing an investment plan to build climate-resilient health facilities to improve health infrastructure climate impacts.

Ranking #8, with a score of 35, identified two measures. The development of a national program for integrating climate change and health training into university curricula will aid in preparing future health professionals to understand and manage the impacts of climate change in their practice. Additionally, establishing a national budgetary framework for climate change is crucial to allocating financial resources dedicated to climate actions in the health sector.

Finally, in ninth place, with a score of 33, the expansion of Early Warning Systems for surveillance of priority diseases associated with climate change is essential for rapid detection and response to diseases exacerbated by climate change. These systems allow for a proactive response, minimizing impacts on public health.

Table 5: Prioritization Matrix for Adaptation Measures in the Health Sector

Proposed Adaptation Measures	**Score**	**Rank**
Establishment of Climate Change and Disaster Risk Management Unit at the Ministry of Health and Wellness	42	1
Review of Health Regulations to Support Climate Change Actions in the Health Sector	41	2
Health Sector Index Assessment (Green and Safe Health Facilities)	39	3
Develop a National Program in Capacity Building in Health and Climate Risk Management	37	4
Develop a National Communication Plan	36	5
Integration of Climate Change in National Health Sector Strategic Plan 2025-2030	36	5
Develop an Investment Plan for Health Facilities to build Climate Resiliency	36	5
Develop a National Program for the Integration of Climate Change and Health Training into the Universities Curriculum	35	8
Establishment of a National Climate Change Budgetary Framework	35	8
Expansion of Early Warning Systems for Surveillance of Priority Diseases associated with Climate Change	33	9

CHAPTER 4: BUILDING A CLIMATE-RESILIENT HEALTHCARE SYSTEM IN BELIZE.

Vision of the Health National Adaptation Plan (HNAP)

"The health sector has a high level of resilience, guaranteeing its ability to anticipate, prevent, and manage climate-related health risks, by providing a relevant global response in the short, medium, and long term to protect human health by 2030".

The HNAP refers to the objectives of Belize's National Adaptation Plan (NAP) and National Health Policy (NHP) to strengthen the health system's resilience to climate change.

Mission of the Health National Adaptation Plan (HNAP)

"To create a national framework engaging the public and private sector, civil society organizations, technical and financial development partners, and communities in a participatory and inclusive process to address the adverse health effects of climate change and reduce the vulnerability of the health system and communities to the impacts of climate change."

Strategic Goals of the Health National Adaptation Plan (HNAP)

The overall objective of the HNAP is to increase the resilience and adaptive capacity of the health sector to the impacts of climate change and variability. Specifically, the HNAP aims to facilitate the coherent integration of adaptation to climate change impacts into new and existing policies and programs and develop planning and budgeting processes and strategies in the health sector at different levels.

Results of the various vulnerability and adaptation studies of the health system and communities conducted in the target departments yielded four priority strategic objectives.

***Strategic Objective 1*:** Integrate climate change adaptation into the health sector policies, planning, projects, and programs by developing a framework for coherence with climate policies (NDC and NAP).

***Strategic Objective 2*:** Strengthen the resilience of the healthcare system and the capacity of healthcare stakeholders and communities to address health risks related to climate change.

***Strategic Objective 3*:** Strengthen surveillance, early warning, and response systems for climate-sensitive diseases with high epidemic potential.

Strategic objective 4: Improve fund allocation and resource governance capacities for climate change adaptation in the health sector.

CHAPTER 5: HNAP IMPLEMENTATION STRATEGY

5.1 Coordination and Governance Mechanism of the NAP

The NAP requires a strong entity within Belize's Ministry of Health and Wellness to ensure prioritization of climate change challenges like the World Health Organization (WHO). Establishing a coordination and governance mechanism is crucial, especially as the national public health policy must integrate climate change into national and local health planning and foster collaboration with other sectors, notably the Department of Environment.

The coordination mechanism for implementing the NAP will be based on existing structures within Belize's health sector. However, a multisectoral collaborative approach is necessary, given the interconnection of health and climate change across various sectors. Establishing a multisectoral technical group to bolster adaptation options within the health system, comprising representatives from the health sector, related sectors, and climate change stakeholders is pivotal. All health sector stakeholders will be involved in implementing the national health action plan. Coordination for the overall implementation of the national health action plan will build upon existing mechanisms within the health sector. However, improved coordination will be ensured by establishing a health and climate change working group consisting of members from all health sector stakeholders.

The Ministry of Health and Wellness will oversee the coordination and governance of NAP implementation, supported by the World Health Organization (WHO), by establishing monitoring and key performance indicators. Working closely with various stakeholders involved in the NAP, the Ministry of Health and Wellness will implement the multi-year action plan, including activities, budgeting, and monitoring and evaluation indicators.

Achieving the vision of a climate-resilient health system requires collaboration to develop an integrated and shared approach among diverse stakeholders. It also requires coordinated intersectoral planning to ensure consistent policies and promote health, especially in sectors that strongly influence health, such as water and sanitation, agriculture and nutrition, environment, transportation, industry, energy, land use, housing, and accommodation. There are several national institutions and international organizations in Belize whose mandates and activities address climate change issues, showing significant synergy between adaptation actions and major health programs already in place to promote and improve the health of the Belizean population. These include governmental bodies, the private sector, the research community, civil society, and bilateral and multilateral donor partners. These synergies will form the basis of Belize's national strategy for adapting the health sector to climate change.
Thus, governance of the climate change and health process will be organized and managed by the following institutions and organizations, forming the multisectoral steering committee:

- Director of Public Health and Wellness, Ministry of Health and Wellness, with the leadership of several programs and units like the Environmental Health Program, Public Health Program, Epidemiology Surveillance Unit, etc.

- Pan-American Health Organization/World Health Organization (PAHO/WHO) leading Caribbean climate change and health (VAA and HNAP) initiatives.

- the Belize National Climate Change Office (BNCCO), Ministry of Sustainable Development, Climate Change and Disaster Risk Management (MSDCCDRM), to provide guidance to the national efforts to develop, manage, and effectively use climate actions and strategies in the field of public health.

- Belize National Climate Change Committee (BNCCC), advice and guide in climate action and governance for effective implementation of NDC adaptation options.

- All relevant ministries and stakeholders represented on the BNCCC as the directions, departments, and agencies working on sectors considered as health determinants like the Department of Environment, Agriculture, Livestock, Forestry, Fishery, the Direction of Water and Sanitation, Transport, Energy, Food Security, Migration, etc.

- Community organizations working in health surveillance in education, communication, and capacity building to manage health risks linked to climate change impacts.

- Belize technical and financial partners like the United Nations Fund for Children (UNICEF), United Nations Environment Programme (UNEP), United Nations Development Programme (UNDP), Institute of Nutrition of Central America and Panama (INCAP), Caribbean Public Health Agency (CARPHA), Spanish Agency for International Development Cooperation (AIDC), Gesellschaft für Internationale Zusammenarbeit (GIZ), Green Climate Fund (GCF), Adaptation Funds (AF), etc.

- Private sector with Corporate Social Responsibility to support the mobilization of domestic funds and the implementation of HNAP adaptation strategies.

- Municipalities, districts, and territories as stakeholders in the HNAP implementation process focusing on vulnerable communities.

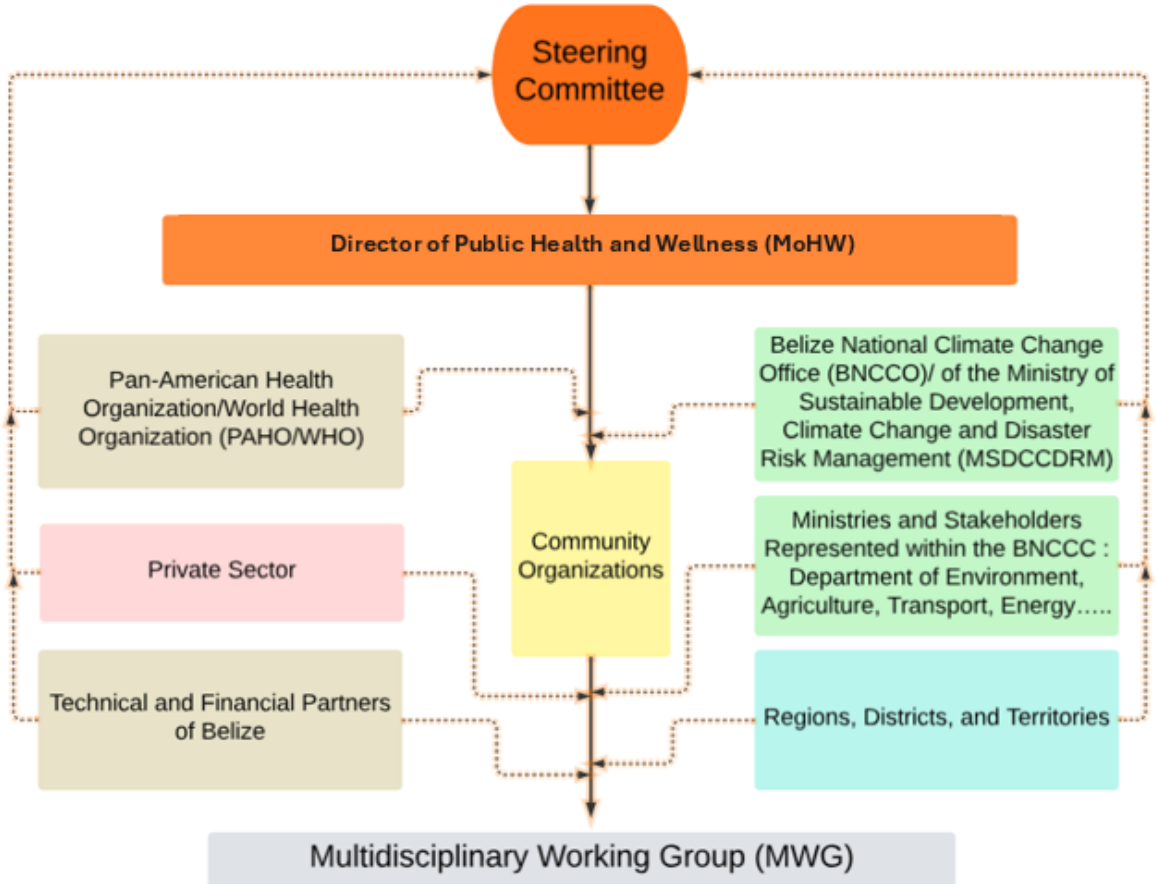

Figure 22: Coordination and Governance of Belize's HNAP

5.2 Action Plan 2025-2029 of the HNAP

The HNAP's action plan outlines the main adaptation measures to be implemented over five years, consisting of short to medium-term actions. These previously prioritized actions contribute to the HNAP's long-term strategic objectives. The action plan goal is to establish a solid foundation for building a climate-resilient healthcare system. It also describes key performance indicators for each adaptation measure, which will be evaluated and revised after five years of implementation. Additionally, the plan assigns responsibilities and provides a budget estimate in USD.

The HNAP includes actions from the National Adaptation Plan (NAP) related to health and is aligned with the existing policy and institutional framework to address climate change and health in Belize. The national health action plan will span five years from 2025 to 2029. A detailed implementation plan outlining component, expected outcomes, and activities will be developed to meet the country's needs.

5.3 Cost Estimation of HNAP Actions

Implementing the HNAP requires human, financial, and other resources, thus, estimating these resources is crucial for effective planning and implementation. Cost assessment of the action

plan helps improve planning and inclusion in the healthcare sector budget. Budget and human resource estimates are needed for the adaptation measures outlined in the HNAP, which are then used to allocate or mobilize necessary resources. Additionally, it is essential to consider national capacities in climate change and health, and opportunities for capacity building at national, regional, and international levels.

The estimated budget for implementing the HNAP over the next five years is approximately USD 3.2 million to cover intervention-related expenses. These costs were developed based on a review of current expenditures by the Ministry of Health and Wellness related to environmental health. The expenditures described here are estimates for each action. As implementation begins, the Ministry of Health and Wellness, through the responsible department or unit, will adjust to reflect the required funding more accurately. Furthermore, this budget is part of the USD 500 million allocated to the healthcare sector in the adaptation options of Belize's Nationally Determined Contributors (NDC) for conditional and unconditional commitments.

Table 6: Action plan for the implementation of the HNAP

Strategic Objective 1: Integrate climate change adaptation into the planning of health sector policies, projects, and programs by developing a framework consistent with climate policies (NDC and NAP).						
Expected Outcome 1: Climate change adaptation is effectively integrated into the planning of health policies, programs, and projects in alignment with national climate policies (NDC and NAP)						
Components	**Adaptation options**	**Actions**	**Performance Indicators**	**Partner Institutions**	**Period**	**Estimated Cost USD**
Component 1: Leadership and Governance of Health Sector Adaptation	Development of a national public health policy integrating climate adaptation needs	Studying the gaps and deficiencies in the integration of climate change in public health policy planning documents	The number of health policy documents studied to identify gaps. Number of analysis reports produced	Ministry of Health and Wellness. PAHO, UNICEF, National Climate Change Office, Caribbean Community Climate Change Centre, National Emergency Management Organization, Department of Environment, Hydrology Unit, National Meteorological Office, Ministry of Agriculture, Belize Agricultural Health Authority	2025-2026	100,000
		Developing a guide for integrating climate change adaptation into health policy planning documents	Number of institutions using the integration guide for adaptation in planning documents			
		Revising public health policy documents to integrate climate adaptation needs	Number of public health policy documents revised			
		Proposing a new public health policy integrating climate change adaptation	Number of institutions using the new public health policy integrating adaptation			
	Revision of the legislative and regulatory framework to account for climate change	Studying the gaps in regulatory and legislative texts regarding the consideration of climate effects on health	Number of regulatory and legislative texts studied to identify gaps		2025-2026	100,000
		Revising regulatory and legislative texts for better consideration of climate effects on health	Number of regulatory and legislative texts revised to account for climate effects			
Strategic Objective 2: Strengthening the resilience of the healthcare system and the capacity of healthcare actors and communities to address health risks associated with climate change.						
Expected Outcome 2: The resilience of the healthcare system and the capacity of healthcare actors and communities to address health risks associated with climate change are strengthened.						
Components	**Adaptation options**	**Actions**	**Performance Indicators**	**Partner Institutions**	**Period**	**Estimated Cost USD**
Component 2: Health personnel with capacity-building needs in climate risk management	Development of a training plan for capacity building in climate risk management	Identify the capacity-building needs of healthcare actors and communities.	Number of meetings or gatherings for needs identification conducted. Number of needs identification documents produced.	Ministry of Health and Wellness. University, PAHO, National Climate Change Office, Caribbean Community Climate Change Centre Ministry of Agriculture, Belize Agricultural Health Authority.	2025-2027	100,000
		Developing capacity-building training modules for target actors	Number of capacity-building training modules developed			
		Organizing capacity-building sessions for actors on climate risk management for health	The number of capacity-building sessions for actors organized. Number of participants in the capacity-building sessions			

	Integration of climate change into the curricula for healthcare professionals	Assessing the needs for climate data and information in the curricula for healthcare professionals	Number of meetings or gatherings for needs identification conducted. Number of needs identification documents produced		2025-2027	300,000
		Revising the curricula for healthcare professionals to integrate climate change.	The number of healthcare professionals' training curricula revised. Number of training programs utilizing the revised curricula			
Component 3: Education, communication, and public information on climate health risks	Development of a national strategy for education, information, and communication on health impacts related to climate risks	Identifying the public education, information, and communication needs on health impacts related to climate risks	Number of meetings or gatherings for needs identification conducted. Number of needs identification documents produced.	Ministry of Health and Wellness. University, PAHO, National Climate Change Office, Caribbean Community Climate Change Centre Ministry of Agriculture, Belize Agricultural Health Authority. National Emergency Management Organization.	2026-2027	300,000
		Developing communication materials and identifying appropriate channels for disseminating key messages on health impacts related to climate risks	The number of communication materials developed. The number of appropriate dissemination channels identified			
		Disseminating key messages aimed at changing behaviors in response to health impacts related to climate risks	Number of key messages disseminated to the general public. Number of users of the developed key messages			
Strategic Objective 3: Strengthening the surveillance, early warning, and response systems for climate-sensitive and highly epidemic-prone diseases.						
Expected Outcome 3: The surveillance, early warning, and response systems for climate-sensitive and highly epidemic-prone diseases are strengthened.						
Components	**Adaptation options**	**Actions**	**Performance Indicators**	**Partner Institutions**	**Period**	**Estimated Cost USD**
Component 4: Integrated surveillance of health risks (diseases) and early warnings	Establishment of a combined community-based climate and epidemiological surveillance system for climate-sensitive diseases.	Conducting a comprehensive diagnosis of existing environmental and health surveillance systems to draw lessons learned and best practices.	Number of comprehensive diagnostic meetings or gatherings conducted. Number of diagnostic documents developed	Ministry of Health and Wellness. University, PAHO, National Climate Change Office, Caribbean Community Climate Change Centre Ministry of Agriculture, Belize Agricultural Health Authority. National Emergency Management Organization, National Meteorological Services of Belize.	2026-2028	450,000
		Mobilizing relevant data and information for the establishment of a combined community-based climate and epidemiological surveillance system.	Number of databases mobilized and structured. Number of users of the mobilized databases.			
		Developing the community-based early warning system for monitoring climate-sensitive diseases.	Number of sharing meetings on the system development framework. Number of reports documenting the system development pro			

		Implementing the community-based early warning system for monitoring climate-sensitive diseases.	Number of users of the early warning system device. Number of institutions that have improved surveillance of climate-sensitive diseases			
		Strengthening the functioning of existing environmental and health surveillance platforms.	Number of existing environmental and health surveillance platforms strengthened			
		Signing partnership agreements between the Ministry of Health and Population and the sectoral ministries involved in the surveillance systems to be established.	Number of partnership agreements signed between the Ministry of Health and sectoral ministries. Number of institutions using the signed partnership agreements.			
Component 5: Sustainable, resilient, and adaptable technologies and infrastructures to climate effects	Establishment of a national investment program on technologies, infrastructure, equipment, and materials for upgrading the medical technical platform related to climate-related	Conducting a comprehensive diagnosis of the level of preparedness and resilience of existing technological, infrastructural, and material devices.	Number of comprehensive diagnostic meetings or gatherings conducted. Number of diagnostic documents developed.	Ministry of Health and Wellness. PAHO, National Climate Change Office, Caribbean Community Climate Change Centre, Ministry of Agriculture, Belize Agricultural Health Authority. National Emergency Management Organization. Ministry of Finance, Ministry of Economic Development, Central Building Authority, Ministry of Infrastructure Development and Housing	2027-2029	650,000
		Identifying the needs for technologies, infrastructures, materials, and equipment for upgrading the medical technical platform.	Number of meetings or needs assessment sessions conducted. Number of needs assessment documents developed			
		Conducting a review of existing standards in the construction and renovation of healthcare infrastructure to integrate construction standards that consider resilient infrastructure to extreme weather events.	Number of existing construction standards studied. Number of study reports on existing construction standards			
		Mobilizing the necessary resources for acquiring the technological, infrastructural, material, and equipment needed for upgrading the medical technical platform.	Number of funding mobilization requests or proposals submitted. Number of funding requests or proposals financed			
		Implementing the necessary investments in technologies, infrastructures, materials, and equipment for upgrading the medical technical platform.	Number of healthcare facilities benefiting from investments in upgrading medical technical platforms. Number of healthcare facilities that have improved response to climate-related health risks			

Component 6: Emergency preparedness and management of health emergencies related to climate change.	Elaboration of contingency plans at the national and local levels to strengthen preparedness for health emergencies related to climate risks.	Conducting a comprehensive diagnosis of the various existing contingency plans for managing health emergencies to draw lessons learned and best practices	Number of comprehensive diagnostic meetings or gatherings conducted. Number of diagnostic documents developed.	Ministry of Health and Wellness. PAHO, UNICEF, National Climate Change Office, Caribbean Community Climate Change Centre, National Emergency Management Organization, Department of Environment, Hydrology Unit, National Meteorological Office, Ministry of Finance, Ministry of Public Service, National Emergency Management Organization, Ministry of Public Utilities, Energy, logistics and E Governance	2027-2029	450,000
		Mobilizing relevant data and information for the establishment of contingency plans to strengthen the level of preparedness for health emergencies related to climate risks	Number of databases mobilized and structured. Number of users of the mobilized databases.			
		Developing contingency plans to enhance preparedness for health emergencies related to climate risks.	Number of sharing meetings on contingency plans to be developed. Number of documentation reports on the process of developing contingency plan			
		Implementing contingency plans to strengthen preparedness for health emergencies related to climate risks.	Number of healthcare facilities benefiting from emergency preparedness contingency plans. Number of healthcare facilities using emergency preparedness contingency plans. Number of healthcare facilities that have improved response to health emergencies.			
Component 7: Research and training on climate and health	Development of a national policy on research and education on climate and health	Identifying research and training needs on climate and health with national priorities.	Number of meetings or needs assessment sessions conducted. Number of needs assessment documents developed.	Ministry of Education, PAHO, National Climate Change Office, Caribbean Community Climate Change Centre, Department of Environment, Hydrology Unit, National Meteorological Office, Technical and Financial Partners (PTF), Local Authorities, etc.	2026-2029	350,000
		Defining the national policy on climate and health research and training aligned with the country's priorities.	Number of meetings for sharing the results of the national research and training policy definition process. Number of documentation reports on the process of defining the national policy.			
		Implementing the national policy on climate and health research and training aligned with the country's priorities.	Number of users of the national research and training policy. Number of institutions that have made progress in research and training on climate and health.			
		Developing collaborations with research and training structures or programs to initiate and support projects/programs on climate and health aspects.	Number of collaborations signed between research and training structures or programs. Number of institutions using the signed collaboration agreements.			

		Implementing a communication and dissemination strategy for research results targeting decision-makers and communities.	Number of communication and dissemination channels for research results created; Number of users of climate and health research results.			
Strategic Objective 4: Improving fundraising and resource governance capacities for climate change adaptation in the health sector.						
Expected Outcome 4: Fundraising and resource governance capacities for climate change adaptation in the health sector are strengthened.						
Components	**Adaptation options**	**Actions**	**Performance Indicators**	**Partner Institutions**	**Period**	**Estimated Cost USD**
Component 8: Health financing and climate change adaptation	Development of a climate financing mobilization strategy for the healthcare system.	Identify the financing needs for climate resilience in the healthcare system and communities.	Number of meetings or gatherings to identify needs conducted. Number of documents for identifying needs	Ministry of Health and Wellness, PAHO, Ministry of Finance, Caribbean Community Climate Change Centre, Ministry of Sustainable Development, Climate Change and Disaster Risk Management, National Climate Change Office, Protective Areas Conservation Trust, Social Investment Fund	2027-2029	150,000
		Define the strategy for mobilizing climate financing for the resilience of the healthcare system and communities.	Number of meetings to share the results of the process of defining the strategy for mobilizing climate financing. Number of reports documenting the process of defining the strategy for mobilizing climate financing.			
		Strengthen institutional and technical capacities in climate financing mobilization.	Number of capacity-building modules developed. Number of capacity-building sessions organized.			
	Development and submission of projects for climate health resilience to climate risks.	Identify capacity and skill needs for mobilizing funding for the health sector.	Number of meetings or gatherings held to identify needs. Number of documents produced to identify needs.		2027-2029	250,000
		Establish a unit or team for mobilizing climate financing for the resilience of the healthcare system and communities.	Number of experts and skills mobilized by the climate funding mobilization unit. Number of initiatives organized on funding mobilization.			
		Develop proposals for mobilizing funding for resilience to health impacts related to climate risks.	Number of meetings or gatherings for proposal development organized. Number of funding mobilization proposals developed.			
		Submit proposals for mobilizing funding for resilience to health impacts related to climate risks.	Number of funding mobilization proposals developed. Number of targets benefiting from mobilized climate funding.			

5.4 HNAP financing and resources mobilization strategy

Like in other sectors, successful implementation of adaptation activities in the health sector requires funding from various sources. In addition to their efforts, developing countries like Belize need technical and financial partners to mobilize substantial financing, particularly from international sources, to adapt to the complex effects of climate change on health. Countries' National Adaptation Plans (NAPs), and sectoral NAPs, are important instruments for identifying priority activities to meet urgent and immediate needs. Hence the importance of finding strategic funding for such plans, whose primary interest is to create the most favorable environment possible, is to enable more funds to be mobilized for effective adaptation to the effects of climate change.

As part of SIDS, Belize has priority access to certain climate funds, usually requires high-quality project proposals, and is generally only accessible through accredited bodies such as the Green Climate Fund (GCF) or implementing entities under the Adaptation Fund (AF).

Establishing a sustainable, long-term funding stream is important to build a climate-resilient healthcare system. Funding is necessary to implement the national health action plan, particularly for health and climate change adaptation projects. Strategically accessing funds for high-investment projects lacking finances is particularly important. A key aspect of accessing funding is the capacity building of the MOHW personnel to develop funding proposals effectively.

This HNAP identifies three (3) key actions to begin establishing health and climate change financing over the next 5 years: i) develop a comprehensive resource mobilization plan that identifies financing mechanisms for health, sectors influencing health and climate change, specific proposal options, timelines and responsibilities; ii) advocate for the increase in resource allocation in the health sector resilience to climate variability and change as a line item in national health budgets, and iii) develop and submit project and program proposals on strengthening health system resilience to international climate change financing sources.

Mobilizing external funding sources is crucial and will remain essential for implementing the national climate action plan. There is a wide range of potential sources of climate funding, including national organizations, bilateral support, multinational organizations, non-governmental organizations, and international funding agencies, among others. A strategic and planned approach is needed to access these sources effectively and efficiently. Encourage academia to develop research proposals in climate change and health in collaboration with the Ministry of Health and Wellness. Well-structured coordination for implementing the HNAP activities in the health sector is crucial for accessing funding from external sources.

Integrating climate change into existing health sector policies, strategies, plans, and programs is essential to improve access to domestic funds. The HNAP action plan cost will help improve the inclusion of climate-specific costs in government budgets.

Technical and development partners (TDPs), including bilateral donors, multilateral organizations, UN organizations, and non-governmental organizations, contribute the bulk of climate financing in Belize and can be approached for initial funding to begin implementing the Health National Action Plan. The MOHW can also leverage relationships with development partners to obtain technical assistance on climate-resilient health and integrate HNAP activities into existing or future bilateral cooperation projects and programs. UN agencies have diverse climate financing options, as potential sources for implementing the Health National Action Plan. Many bilateral aid organizations provide adaptation funds and can be considered for implementing activities under the HNAP. Those initially targeted are USAID, AFD, GIZ, UNEP, UNDP, and WHO.

The main multilateral financing instruments that can support the implementation of the NAPs are the Adaptation Fund (AF) established by the Kyoto Protocol, the Green Climate Fund (GCF) considered the world's largest dedicated fund that helps developing countries reduce their greenhouse gas emissions and strengthen their capacity to respond to climate change. The Special Climate Change Fund (SCCF) was created in response to the directives of the Conference of the Parties (COP7) in Marrakech in 2001, the Global Climate Change Alliance Plus (GCCA+), the European Union's flagship initiative to help the world's most vulnerable countries combat climate change, the Global Environment Facility (GEF), created on the eve of the 1992 Rio Earth Summit to help solve the world's most pressing environmental problems. The Least Developed Countries Fund (LDCF) was established under the United Nations Framework Convention on Climate Change (UNFCCC) to address the special needs of Least Developed Countries (LDCs) that are particularly vulnerable to the adverse effects of climate change.

CHAPTER 6: HNAP- MONITORING AND EVALUATION PLAN

An effective monitoring and evaluation (M&E) framework is important in successfully implementing the national health action plan. Monitoring and evaluation of the national action plan is an iterative process with the following objectives: i) to track progress in implementing the HNAP action plan at input and output levels; ii) to assess the effectiveness and adequacy of adaptation measures with the strategic objectives and overall goals of the action plan, including the resources allocated; and iii) to provide information to beneficiaries, implementing agencies and financiers on the progress of HNAP actions.

To strengthen the resilience of Belize's healthcare system, other sectors whose activities may directly or indirectly affect the health of communities must also contribute collectively. The following principles of complementarity and collaboration guide the monitoring and evaluation framework of the Health National Action Plan:

- ✓ ***Collective participation***: health sector departments, divisions, and services at national and departmental levels have a critical role. Collective involvement by all levels will ensure that proposed interventions are coordinated and interconnected for optimal, streamlined processes and results.

- ✓ ***Transparency***: regular progress reports, some of which will be made available to the public, are designed to ensure openness and support from all parties concerned.

- ✓ ***Accountability***: The monitoring and evaluation plan identifies the institutions and departments responsible for each indicator to be monitored and evaluated. The Ministry of Health and Wellness will coordinate the contributions of the other institutions in charge of implementing this action. This facilitates the accountability of all units, sections, and departments responsible for implementing, monitoring, and reviewing the health national action plan.

6.1 Monitoring and Evaluation Logical Framework

The monitoring and evaluation mechanism is based on the following logical framework or results chain, which defines the level of indicators for measuring, monitoring progress, and evaluating the effectiveness of the national action plan for adaptation of the health sector. Monitoring and evaluating the adaptation measures and strategic objectives of the HNAP will be based on quantifiable performance indicators reflecting the results of HNAP implementation with what was planned at input, output, and sometimes outcome levels. The logical framework for monitoring and evaluation is the device that presents the resources (inputs) to be used and the activities to be carried out (processes), as well as the expected results (effects/products) that will contribute to achieving the plan's objectives and goals (impact).

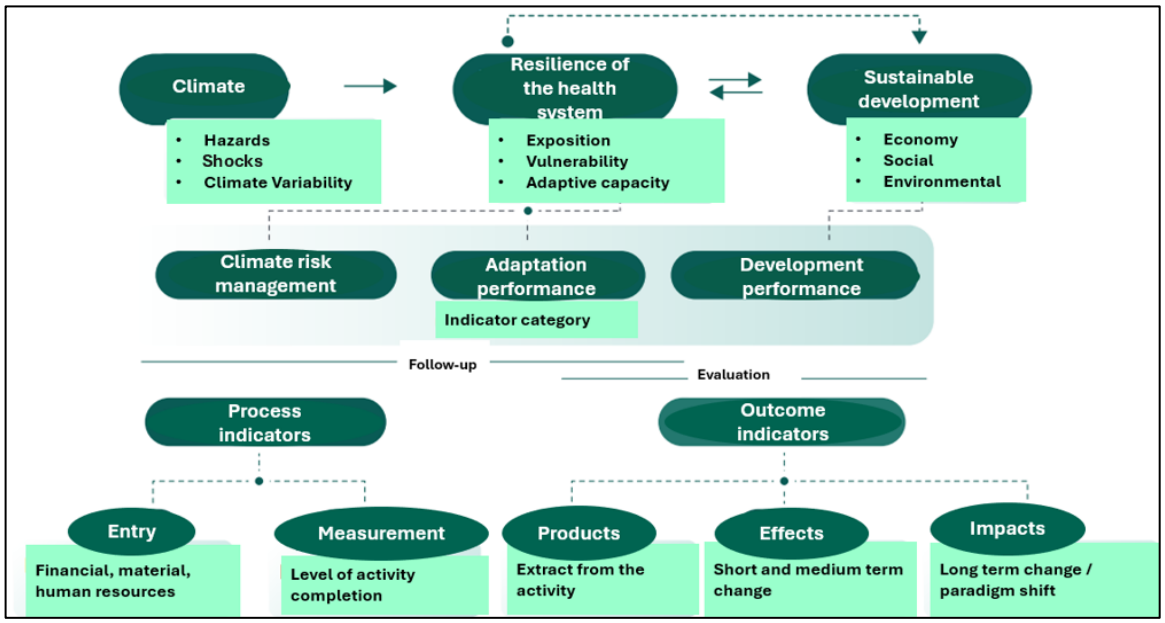

Figure 23: HNAP monitoring and evaluation logical framework (Source: adapted from OECD, GIZ, TAMD, 2014)

Logical Intervention:

M&E of adaptation actions (climate risk management, adaptation performance, development performance) and the strategic objectives of the HNAP are based on process and outcome indicators that constitute quantifiable measures reflecting the achievements of HNAP implementation. In the short term, it focuses on the M&E of integrating climate change adaptation into health sector policies, plans, budgets, and interventions (process indicators), and in the long term on the results (outcome indicators) of adaptation in the health sector. Outcome indicators measure performance with what was planned at the input, output, and milestone levels.

Process indicators (input and measurement) refer to the resources needed to facilitate the implementation of proposed actions to address areas of concern at national and local levels. These may include human and financial resources, technologies, and infrastructures needed to improve adaptive capacity, capacity-building of health personnel, etc.

Outcome indicators (outputs, outcomes, impacts) refer to the deliverables of a specific action in the HNAP action plan, such as completing a targeted number of workshops, training courses, analyses, reports, etc. Impacts refer to long-term change with a transformational impact on health, while effects refer to short- and medium-term change.

Data and information requirements:
The data and information required for the HNAP M&E system will inform the logical framework of indicators. These will be: (i) baseline data, to be collected at the start of the monitoring and evaluation system; and (ii) periodic data (at specific points in time) during the implementation of the HNAP. The data to be collected by level (national, departmental, and local) and by sector, as well as the means and methods of collection, will be specified in

indicator sheets to be drawn up. An indicator sheet will be developed monitoring and evaluation system operationalization of selected indicators.

The data sources for monitoring and evaluating HNAP can be divided into two main categories: (i) those that provide data at the national level; (ii) those that provide data related to administrative and operational activities and health. The monitoring and evaluation system can also use other information sources, such as research on health systems and climate-related aspects (climate risks and vulnerability). The sharing of monitoring and evaluation information during the implementation of the HNAP aims to provide up-to-date information on climate risk management, adaptation performance, and development to public authorities through technical coordination (i) to enable effective management of the planned actions and (ii) achieve the support of all stakeholders involved in these actions through information transparency.

6.2 Monitoring of the HNAP

Under the responsibility of technical coordination, data will be collected using indicator sheets developed at all levels of the health system, primarily at the operational level (community, civil society, etc.), the intermediate level (decentralized structures), and the central level. Feedback must be systematically ensured by the level that receives the activity report. Data collection will be conducted using tools developed and compliant with those of the MOHW and updated semi-annually (every 6 months). The collected data will be compiled, analyzed, utilized, and disseminated at each health system level.

6.3 HNAP review process

The data and information required for the HNAP M&E system will inform the logical framework of indicators. These will be: (i) baseline data, which will be collected at the start of the monitoring and evaluation system; and (ii) periodic data (at specific points in time) during the implementation of the HNAP. The data to be collected by level (national, departmental, and local) and by sector, as well as the means and methods of collection, will be specified in indicator sheets to be drawn up. It should be emphasized that an indicator sheet will be developed for each of the selected indicators for the monitoring and evaluation system operationalization.

6.4 HNAP reporting

Under the responsibility of the technical coordinator, data will be collected using indicator sheets developed at all levels of the health system, principally the operational level (community, civil society, etc.), the intermediate level (decentralized structures), and the central level. Feedback must be systematically provided by the level receiving the activity report. Data will be collected using tools developed by the Ministry of Health and Wellness and updated every six months. The data collected will be compiled, analyzed, and disseminated at each health system level.

6.5 Reporting and Review of the HNAP

The evaluation and review report will inform the review process of the overall objectives of the action plan with the performance indicators of the action plan evaluation and reflect on the effective achievement of the indicators of the harmonized national action plan strategic objectives.

Indicators related to inputs, outputs, and products will be regularly measured (every 6 months) during the annual operational plan check. Result indicators must be reported every two years, or even annually if rapid developments are expected and appropriate measurement systems are available. Outcome indicators should be reported once or twice every five years, which is the average duration of a national health strategy. In this case, the interval is longer because the impact does not evolve rapidly, and its measurement is more complex and often based on recalling events.

Regular reviews will assess performance based on achieved results and outcome indicators. Mid-term and final reviews will be more comprehensive to cover impact indicators. It should be noted that each action plan component will be considered in the annual report.

6.6 Evaluation of the HNAP

The evaluation of the HNAP will be initiated by the Ministry of Health and Wellness, through the division responsible for technical coordination. It assesses the HNAP at various levels and against several criteria (action plan coherence, action effectiveness, territorial impact), which can be adapted to the specifics of the HNAP and the evaluation time frame. The evaluation will occur at two key phases: midway through the HNAP cycle (mid-term evaluation) and at the end (ex-post evaluation). In the mid-term, the assessment aims to measure initial results and good governance and potentially reorient the strategy. Finally, it will provide a comprehensive strategic overview of the effects and impacts of the HNAP and prepare for the upcoming cycle according to a logic of continuous improvement, analyzing relevance, effectiveness, efficiency, and impact of implemented adaptation actions.

- ✓ **Relevance:** relevance of the objective, including risks considered during and after completion of implementation.

- ✓ **Effectiveness:** the extent to which the objective, inputs, outputs, and results were achieved within the various deadlines set in the action plan.

- ✓ **Efficiency:** the extent to which implementation management and plan design were appropriate. This is based on initial budget analysis, disbursement to each executing entity, gaps between incurred expenses, budget forecasts, etc.

- ✓ **Impact:** Impact is broader than results. Results are changes directly related to HNAP objectives. Impact encompasses all direct and indirect differences of the HNAP at the national level.

National stakeholders will conduct internal and external evaluations of the HNAP with the former being supervised by the implementing division and the former involving health sector actors actively participating in HNAP implementation. It will be informed by monitoring results.

Tools used for HNAP evaluation will include:

- ✓ Monitoring and evaluation action plan indicating objectives, expected results, indicators, baseline, target level, studies to be conducted or consulted to obtain necessary M&E information, meetings or reviews planned, frequency, periods, main national or international deadlines, or commitments concerning the strategy.
- ✓ Reports and minutes of meetings and reviews presented following a standard template defined by HNAP monitoring and evaluation authorities.
- ✓ Annual or mid-term reviews of HNAP implementation.

CHAPTER 7: CONCLUSIONS AND RECOMMENDATIONS

7.1 Conclusions

Climate change and health inequalities are two of the greatest challenges to human development in the 21st century. Consequently, many Belizeans will be vulnerable to the health risks of climate change if adaptation measures are not implemented. These vulnerable communities have fewer resources to respond to climate change and health threats, such as increased natural disasters, food, and water insecurity, and shifting disease patterns. The need for a HNAP plan in Belize is evident in this regard, it is crucial to address the World Health Organization's Climate Change and Health Initiative. Addressing a public health approach to climate change adaptation has been strongly advocated.

Health systems are responsible for managing health risks associated with changing climates, as health outcomes are known issues that rely mostly on evidence-based strategies for risk reduction. Thus, successful adaptation will require the development, implementation, evaluation, and modification of interventions to enhance their effectiveness in the face of ongoing climate and societal changes and the rapid scaling up of effective adaptation measures.

The HNAP is pivotal for strengthening health systems and protecting and promoting population health to increase resilience now and in the future. Key elements include (1) a knowledgeable health workforce with adequate tools to promote climate resilience; (2) health information systems enabling effective management of health climate-related health risks; (3) effective health service delivery; and (4) adequate financing, including other sectors (e.g., property insurance) to limit indirect health effects (e.g., effects of catastrophic household losses following extreme weather events). The intervention areas and adaptation measures outlined in the HNAP action plan will facilitate the establishment of a climate-resilient health system in Belize.

7.2 Recommendations

Considering the alignment of health policies with the National Adaptation Plan (NAP) and the existing climate resilience mechanisms, it is critical to address several key recommendations:

- ✓ Strengthen institutional capacities of healthcare personnel to integrate climate change adaptation into policies regarding responses to health emergencies regarding the increased risk of climate-sensitive disease spread.

- ✓ Increase investments in climate and health research to generate new scientific evidence, identify data gaps, and understand climate change health impacts.

- ✓ Promote intersectoral collaboration between the Ministries of Health and Wellness, Environment, Agriculture, and other key stakeholders to develop integrated policies and action plans for health resilience.

- ✓ Establish a strategy for mobilizing substantial funding in collaboration with other ministerial departments and development partners to implement climate resilience projects for local communities and the health system.

- ✓ Establish a technical steering committee under the leadership of the Ministry of Health and Wellness (MOHW) and a sound communication strategy with stakeholders involved in implementing the HNAP.

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