THAILAND'S NATIONAL ADAPTATION PLAN (NAP)

NOVEMBER 2023

FOREWORD

Climate change is a global crisis that affects all lives. To fight this grave and common threat, the Parties to the United Nations Framework Convention on Climate Change (UNFCCC) have raised their commitment to reduce greenhouse gas (GHG) emissions to address the root cause of this problem. Despite this concerted action, the Intergovernmental Panel on Climate Change (IPCC) has voiced concern that the global average temperature would continue to rise as efforts under the nationally determined contributions (NDCs) would unlikely be able to stabilize global warming. As such, all countries would continue to be faced with the devastating impacts of climate change in the forms of extreme weather and slow onset events, resulting in damages and losses of natural resources, properties and lives.

In this connection, adaptation efforts to reduce the risks and respond to the adverse impacts of climate change have become an urgent and significant global agenda in order to save vulnerable communities and future generations. This was reflected in the decision adopted at the 27th Conference of the Parties of the UNFCCC (COP27) which established the Loss and Damage Fund to facilitate financial access for climate-vulnerable countries, in particular developing countries, least developed countries, and small island developing states, to help reduce the risk of climate change and potential impacts.

According to the Fourth Biennial Update Report (2022), Thailand's total GHG emissions was approximately 372 GgCO2eq, which accounted for around 0.8% of the global emissions. However, Thailand is among the top ranking countries affected by the adverse impacts of climate change. Numerous climatic events, such as severe and widespread floods in 2011, 2021 and 2022, have resulted in massive and widespread economic losses in various sectors, such as agricultural, tourism and manufacturing industries. Apart from these, it has also affected city development, biodiversity loss, and spread of infectious diseases. Therefore, climate change remains Thailand's top national agenda that needs both urgent attention and action.

Thailand has joined the global community in fighting the devastating impacts of climate change by becoming a Party to the UNFCCC and the Paris Agreement in 1994 and 2016 respectively. This has obligated Thailand to fulfill our commitments to reduce the GHG emissions and adapt to the adverse impacts of climate change. Moreover, significant steps have been taken by the Royal Thai Government to raise our adaptation actions, including submission of the long-term low GHG emission development strategies (LT-LEDS) with elaborative details of the adaptation efforts and measures as well as its adaptation communication as part of the Fourth National Communications Report. The Royal Thai Government is committed to continue to do so in the upcoming national reports. We have also sought support from the Green Climate Fund to implement adaptation projects. In addition, our firm commitment is reflected in the preparation of this first National Adaptation Plan (NAP).

Thailand's NAP has been developed in consistent with relevant national policies, including the National Strategy B.E. 2561-2580 (2018-2037), the Master Plan under the National Strategy, the National Economic and Social Development Plans, and the Climate Change Master Plan B.E. 2558-2593 (2015-2050). This has been further developed through the integration of domestic development philosophies, such as the Royal Initiative of the Sufficiency Economy Philosophy by His Majesty King Bhumibol Adulyadej The Great and adaptation based on local and traditional knowledge with international adaptation principles, such as ecosystem-based adaptation (EbA) and/or nature based solution (NbS), gender responsiveness, good governance, and public participation, taking into consideration our national circumstances.

Therefore, we foresee the application of agreed upon adaptation measures identified in this NAP in the development of sectoral and area-based policies and plans by sectoral and local governments, as well as by the private sector as a means to build inclusive adaptive capacity and resilience. Priorities have also been given to the adaptation measures with mitigation co-benefits, such as reforestation and development of new green spaces that would enhance carbon sinks, while also reducing floods and drought as well as promote the conservation and rehabilitation of the ecosystem and biodiversity.

Lastly, the Royal Thai Government emphasizes the power of collaboration and synergy among all domestic sectors --- the government, private sector, academia, and the general public --- in taking adaptation actions, which are complemented with international collaboration and support through both bilateral and multilateral channels in the forms of technology, finance and capacity-building, in order to drive Thailand towards climate-resilient growth and inclusive and sustainable development.

H.E. Mr. Srettha Thavisin
Prime Minister of the Kingdom of Thailand

PREFACE

Thailand is constantly identified in the top rank of countries most vulnerable to the impact of climate change and climate-related disasters, such as severe floods, prolonged drought, storms, and landslides. Such catastrophic events continue to increase in their frequency, severity, and fluctuation, consequently resulting in unprecedented loss and damage to the Thai economy and society. Additionally, Thailand has been experiencing the risks and impacts of slow onset events associated with increasing temperatures, land and forest degradation, rise in the sea level, and coastal erosion. Climate change has also affected human settlements, health and wellbeing, biodiversity, and the ecosystem.

To take actions against the adverse impact of climate change, the Ministry of Natural Resources and Environment (MNRE), the agency responsible for formulating the climate change policies and plans, has developed the Climate Change Master Plan 2015-2050 to provide a national policy framework on climate change with three priorities; namely adaptation, mitigation, and capacity-building. Nevertheless, with a view to promote and enhance resilient building, Thailand's NAP was adopted. The development process of Thailand's NAP was conducted using a participatory approach with the meaningful engagement of all sectors comprising the government, private sector, academia, and civil society. It has been considered and approved by various inter-agencies and national committees, including the National Committee on Climate Change Policy and the cabinet. It aims to provide a comprehensive framework and guidelines for the relevant agencies to effectively integrate the adaptation of climate change into sectoral and local planning as well as informing the domestic budget allocation and guiding international support to meet the adaptation needs and priorities. This would also act as a tool to communicate and build awareness and understanding among government agencies, the business sector, and the general public to adapt to the impacts of climate change in all sectors and levels.

In addition, Thailand's NAP outlines the national circumstances, economic and social situations, climate change trends, and evaluation and assessment of the climate change risks in six sectors; namely, water resources management, agriculture and food security, tourism, public health, natural resources management, and human settlements and security. It also specifies the institutional structure in implementing the NAP, targets, indicators, and adaptation measures in each sector, as well as monitoring and evaluation, thus enabling conditions, such as data, research, technology, finance, personnel, and international support needs. Actions and participation by all sectors and international support would facilitate the achievement of Thailand's NAP that would drive the country to being a climate resilient economy and society in line with the sustainable development goals.

H.E. Police General Phatcharavat Wongsuwan
Deputy Prime Minister and Minister of Natural
Resources and Environment

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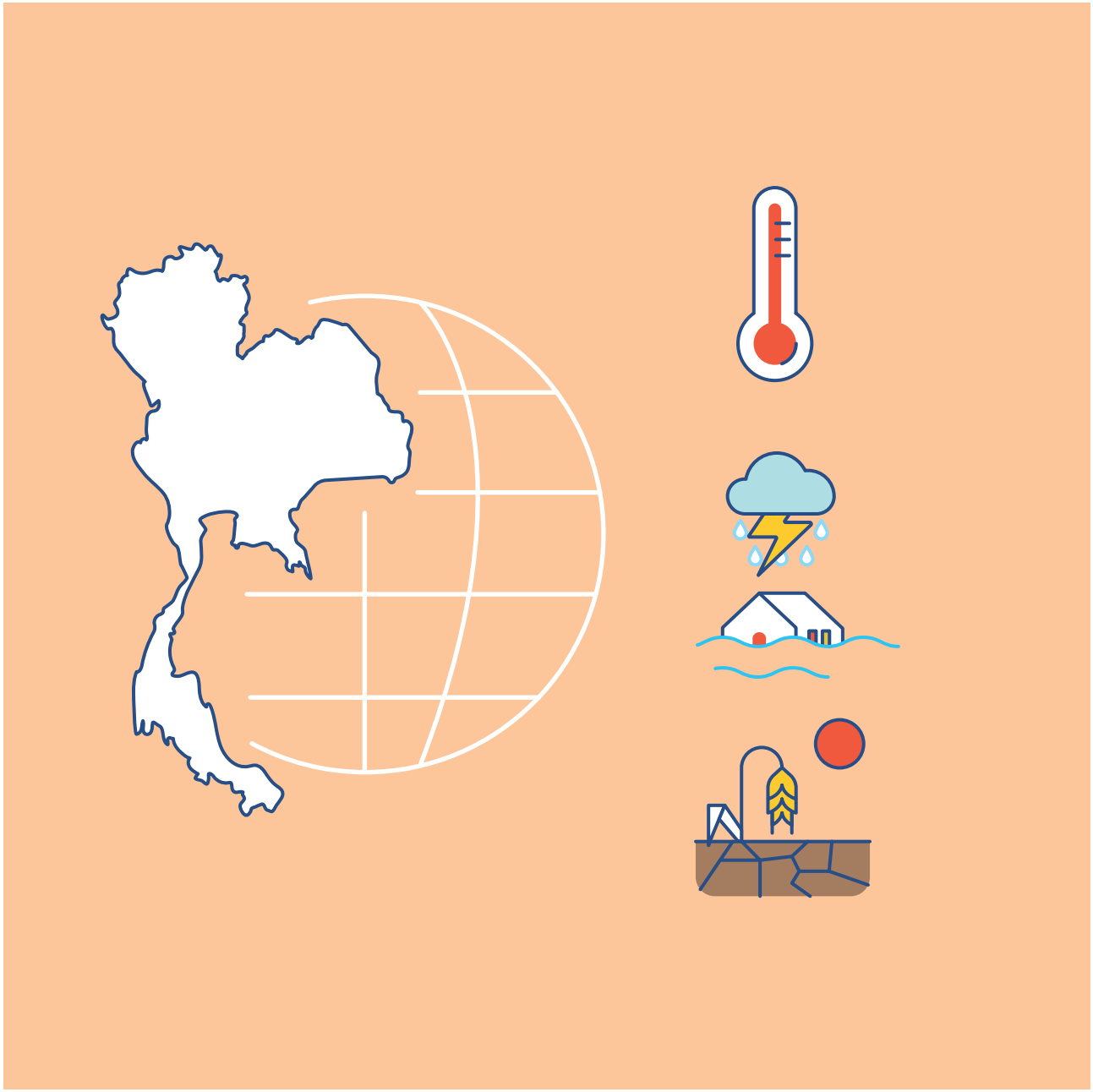
ABBREVIATIONS

AF : Adaptation Fund
AR5 : Fifth Assessment Report
AR6 : Sixth Assessment Report
BCP : Business Continuity Plans
CCBA : Climate Change Benefit Analysis
CCRMDS : Climate Change Risk Maps Database System
CMIP : Coupled Model Intercomparison Project
COP : Conference of the Parties of the UNFCCC
CRI : Global Climate Risk Index
CSR : Corporate Social Responsibility
DCCE : Department of Climate Change and Environment
DDPM : Department of Disaster Prevention and Mitigation
DOH : Department of Health
DOT : Department of Tourism
DPT : Department of Public Works and Town and Country Planning
EbA : Ecosystem-based Adaptation
EPAs : Environmentally Protected Areas
FTI : Federation of Thai Industries
GCF : Green Climate Fund
GCMs : General Circulation Models
GDP : Gross Domestic Product
GEF : Global Environment Facility
GFCS : Global Framework for Climate Services
GHG : Greenhouse Gas
IKI : International Climate Initiative
IPCC : Intergovernmental Panel on Climate Change
IWRM : Integrated Water Resources Management
LAOs : Local Administrative Organizations
LT-LEDS : Long-Term Low Greenhouse Gas Emission Development Strategies
M&E : monitoring and evaluation
MHESI : Ministry of Higher Education, Science, Research and Innovation
MNRE : Ministry of Natural Resources and Environment
MOAC : Ministry of Agriculture and Cooperatives
MOI : Ministry of Interior
MOPH : Ministry of Public Health
MOTS : Ministry of Tourism and Sports
MSDHS : Ministry of Social Development and Human Security
NAP : National Adaptation Plan
NbS : Nature-based Solutions
NCCC : National Committee on Climate Change
NDCs : Nationally Determined Contributions
NFCS : National Framework for Climate Services
OAE : Office of Agricultural Economics
ONEP : Office of Natural Resources and Environmental Policy and Planning
ONWR : Office of the National Water Resources
OPM : Office of the Prime Minister
PA : Protected Areas
PCCB : Provincial Climate Change and Biodiversity Coordination Center
PES : Payment For Ecosystem Services
RCPs : Representative Concentration Pathways
RU-CORE : Ramkhamhaeng University, Center of Regional Climate Change and Renewable Energy
SCCF : Special Climate Change Fund
SEA : Strategic Environmental Assessment
TMD : Thai Meteorological Department
TSRI : Thailand Science Research and Innovation
TWA : Thai Water Assessment
TWP : Thai Water Plan
UNFCCC : United Nations Framework Convention on Climate Change



CHAPTER 1

NATIONAL CIRCUMSTANCES

1.1 National Context

Thailand is located in mainland Southeast Asia encompassing a total area of 513,115 km^2. Thailand's climate is tropical, and influenced by two seasonal monsoon winds most of the year. The southwest monsoon from the Indian Ocean lasts from May until October and results in the rainy season causing abundant rain over most of the country. The northeast monsoon from the South China Sea brings cold and dry air over most of Thailand from October to February. The country's climate can be broadly divided into three seasons: 1) Rainy or the southwest monsoon season, from mid-May to mid-October, 2) Winter or the northeast monsoon season from mid-October to mid-February, and 3) Summer or the pre-monsoon season, from mid-February to mid-May.

Thailand's topography includes high mountains, valleys, and forests covering most of the country's North, where temperatures are cooler than the other parts of the country. The Northern region is thus the origin of streams and rivers, including the Ping, Wang, Yom, and Nan Rivers, which unite to become the Chao Phraya River in the Central Plain. With its landscape of high mountains, steep river valleys, and upland areas, summer storms often occur, and these natural characteristics have made several varieties of agriculture possible, including wet rice farming in the valleys, shifting cultivation in the uplands, and other economic crop farming, such as cassava, maize, longan, lychee, etc.

The Central Plain is a lowland area where the Chao Phraya River and its tributaries flow into a delta at the Bay of Bangkok, all contributing to the region's fertility. Due to the presence of a large amount of flat land, fertile soil, warm weather, rain, a multitude of rivers, canals, and highly developed irrigation systems, the region is one of the most productive agricultural regions in the world with a variety of agricultural produce, including rice, sugar cane, cassava, and various kinds of fruit. Unfortunately, it is also one of the most frequently flooded areas of the country.

The northeastern part of the country is an upland plateau and shallow lakes that flow into the Mekong River. The region is arid and often suffers from drought. Almost every year, there are floods or drought, or both. The Northeast has a long dry season, and much of the area is covered with sparse grass. The Mekong River runs through most of the northern and eastern border of the region, thus enabling cultivation in several provinces, and most of Thailand's jasmine rice is produced in this region.

Southern Thailand is a narrow peninsula and has a total coastline of 3,151.02 km consisting of the Andaman coast to the west and the Gulf of Thailand coast to the east. The sea influences this region on both sides, which means that it experiences heavy rain for most of the year. Most areas are flat with rolling and mountainous terrain, and the absence of large rivers is a conspicuous feature of the South. Its economy depends on rubber and oil palm production for industry. Other sources of income include coconut plantations, fisheries, and tourism, particularly coastal and marine tourism.

Figure 1-1: Thailand's topographic map.
Source: Geo-Informatics Center for Thailand (GISTHAI)

1.2 Socioeconomic Circumstances

1.2.1 Economy

Thailand has a mixed economic system consisting of resource-based, service-based, and industrial-based economic activities. In 2021, the Thai economy grew by 1.6%. The value of the gross domestic product (GDP) at current prices was 16.2 trillion THB (505.6 billion USD), while the GDP per capita was 232,176 THB (7,255.5 USD) per person per annum. For the years 2020-2021, agriculture, manufacturing, and the wholesale and retail trade sectors grew by 1.4%, 4.9%, and 1.7%, respectively. On the other hand, the accommodation and food services sectors and transport and storage services sectors declined by 14.4% and 2.9%, respectively.

In 2021, total agricultural production increased by 1.4% recovering from a decline of 3.5% in 2020. Furthermore, in 2021, total employment in the agricultural sector accounted for approximately 12 million of the labor force (31.78%). On the other hand, tourism has always been a significant part of Thailand's economic growth generating approximately 20-22% of the GDP. In 2022, after the announcement of the ending of the COVID-19 Emergency Decree, the number of domestic and international tourists significantly increased by approximately 200% (224.5 million tourists) from the previous year. The annual revenue from the tourism sector also increased by almost 350% (1.08 trillion THB) from the previous year. In addition, approximately 3.98 million of the labor forces (10.55%) were employed in the tourism sector in 2021.

1.2.2 Changes in population structure and transition into an aging society

Thai society has entered into being an aging society since 2005. By 2020, the elderly population totaled more than 11.6 million (17.57%), and continues to increase. Therefore, it is expected that by 2023, Thailand would become a fully aged society with 19.46% of the total population aged over 60 years. The proportion of the working-age population is continuously decreasing, which could lead to labor shortage problems in the country. Moreover, a higher proportion of the aged population means a higher proportion of vulnerable population groups in terms of more exposure and less adaptive capacity to climate-related health risks and natural disaster-related risks, for instance.

1.2.3 Urbanization

Thailand has become increasingly urbanized. In 2022, the population in the urban areas (municipalities) was about 22,610,822 people (34.21%). As such, infrastructure development has become a challenge with rapid urban expansion, and economic activities have often been concentrated primarily in Bangkok and the Central Plain and Eastern regions with Bangkok having the highest ratio of the provincial product value to the GDP.

This rapid transition into an urban society could create more opportunities by raising the average income and standard of living, driving innovations, and increasing productivity. However, it could also be a leading cause of climate change. Urban areas consume over 78% of the global electricity and produce more than 60% of the global GHG emissions from power generation, transport, industry, etc. Simultaneously, cities are at a high risk of the impact of climate change from the rise in the sea level, increased rainfall, severe and frequent storms and floods, and prolonged intense heat and cold weather, for instance. Moreover, rapid urbanization increases the burden on resources and pollution that impacts the budget for addressing these issues, including other social problems. Therefore, it would be necessary to have effective urban management and planning as well as building resilience to the risks and impacts of climate change to benefit the lives of the urban population and transition into a more low-carbon and climate-resilient urban expansion in the future.

1.3 Climate Trend

Thailand has been ranked ninth as the country most affected by the impact of climate change in the last 20 years (2000-2019) by the Global Climate Risk Index 2021 (CRI), both in terms of human consequences (fatalities) and direct economic losses. The CRI indicated that Thailand was among the highest-risk countries because it had faced many mega natural disasters. During the past 20 years, the country has experienced 137 natural disasters, the worst of which was the major flood in 2011. This flood accounted for 87% of the past total damage; the World Bank estimated that the cost of damage and losses were as high as 1.44 trillion THB (approximately 46.5 billion USD).

Hence, Thailand is making efforts to prepare itself for better management of climate-related impacts. In 2020, the Office of Natural Resources and Environmental Policy and Planning (ONEP) conducted a study to assess Thailand's future climate trends. These are summarized in Table 1.1. Thailand is aware of the Sixth Assessment Report (AR6) from the IPCC, in which more up-to-date scenarios have been developed. However, the current NAP uses data and projected information predominantly from the Fifth Assessment Report (AR5) from the IPCC and localizes data of the Coupled Model Intercomparison Project (CMIP) 5 projection for the impact chain and risk analysis. The reason behind the current usage of the Representative Concentration Pathways (RCPs) based on the AR5 is that most of the national level projection is based on the RCP scenarios, thus the current NAP uses the AR5 instead of AR6 due to the availability of the data.

1.3.1 Temperature

Statistical trends

Between 1981-1990, mean temperatures increased by 0.33°C, while 1991-2000 and 2001-2010 recorded temperature increases of 0.16°C and 0.14°C per decade, respectively. The average temperature in Thailand from 2011 to 2021 increased by an average of 0.09°C per year. In addition, data on temperature fluctuations in Thailand over the 10 years of 2012-2021 showed the highest temperatures. These high temperatures are likely to continue to rise. The annual mean temperature (dry-bulb) in 2020-2021 was 28.0°C and 27.5°C, respectively (Figure 1-2).

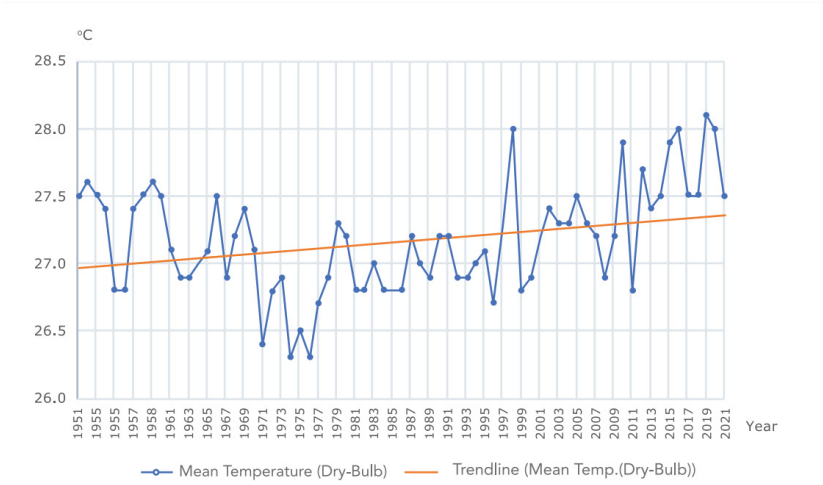


Figure 1-2: Annual mean temperature (dry-bulb) in Thailand (°C) during 1951-2021.

Source: Thai Meteorological Department.

The annual mean maximum temperature in 2020-2021 was 33.7°C and 33.0°C, respectively. In April 2016, Thailand recorded its highest temperature since 1951 at 44.6°C in Mae Hong Son province (Figure 1-3).

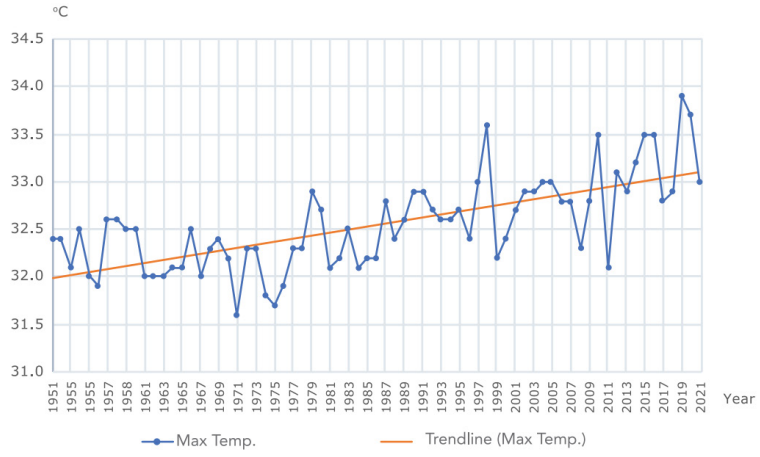


Figure 1-3: Annual mean maximum temperature in Thailand (°C) during 1951-2021.

Source: Thai Meteorological Department.

The annual mean minimum temperature reflected a larger increase from 22.5°C in 1951 to 23.5°C and 23.2°C in 2020-2021, respectively (Figure 1-4).

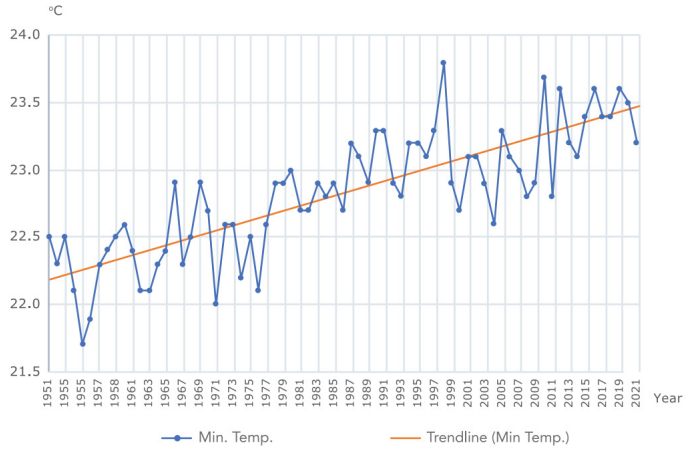


Figure 1-4: Annual mean minimum temperature in Thailand (°C) during 1951-2021.
Source: Thai Meteorological Department.

Projected trends

The analysis of extreme climate change in Thailand can be divided into three cases; namely, anomaly analysis under the mean temperature change of 1°C, 1.5°C, and 2°C, respectively compared to the base years of 1970-2005. All three higher values were calculated from the 10-year moving average of future daily temperature projections. In addition, three general circulation models (GCMs), MPI-ESM-MR, EC-Earth and HadGEM2-ES, were compared with the mean temperature during the base year of the daily temperature data shown in Figure 1-5.

The mean temperature change of 1°C under the RCP4.5 scenario of the three GCMs is projected to occur approximately in the period of 2030-2040, while the RCP8.5 scenario is expected to occur approximately in the period of 2020-2035. Moreover, under the ensemble of the three GCMs under the scenarios, RCP4.5 and RCP8.5 are projected to occur around 2035 and 2030, respectively. The mean temperature change of 1.5°C under the RCP4.5 scenario of the GCMs results is projected to occur as early as 2050 (HadGEM2-ES) and, at the latest, around the year 2080 (EC-Earth), while the ensemble modeling is projected to occur around 2060. Additionally, the RCP8.5 scenario is expected to occur around 2055-2060, and under the ensemble model, it is expected to happen around 2045.

The mean temperature change of 2°C under the RCP4.5 scenario is only the HadGEMS2-ES of the three models, which would experience a mean temperature increase by the end of the century or 2100, which is expected to occur around 2.0°C during the year 2070. The RCP8.5 scenario is projected to occur approximately during 2050-2060 and under the ensemble model, it is expected to occur around 2055.

By the end of the century or 2100, the average temperature in Thailand is projected to increase by around 2°C under the ensemble model RCP4.5 and about 4°C under RCP8.5.

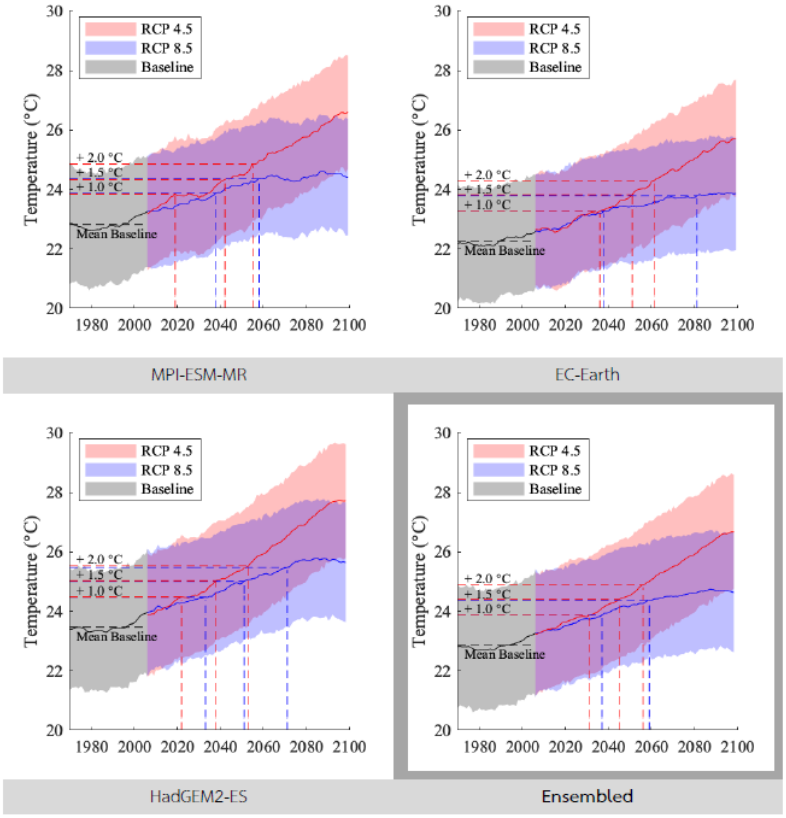


Figure 1-5: Future changes in temperature in Thailand.

Source: Thailand Science Research and Innovation (TSRI) and Ramkhamhaeng University, Center of Regional Climate Change and Renewable Energy (RU-CORE).

1.3.2 Precipitation

Statistical trends

The variation of precipitation and the number of rainy days has oscillated over time. In the last seven years (2015-2021), rainfall variation has fluctuated the most with the lowest rainfall in 40 years in 2019 (1,343.4 mm) since 1979 (1,332.3 mm). The highest annual rainfall in Thailand was recorded in 2017 (2,017 mm). The annual rainfall in 2020 and 2021 was recorded at 1,528.8 mm. and 1,759.3 mm., respectively (Figure 1-6).

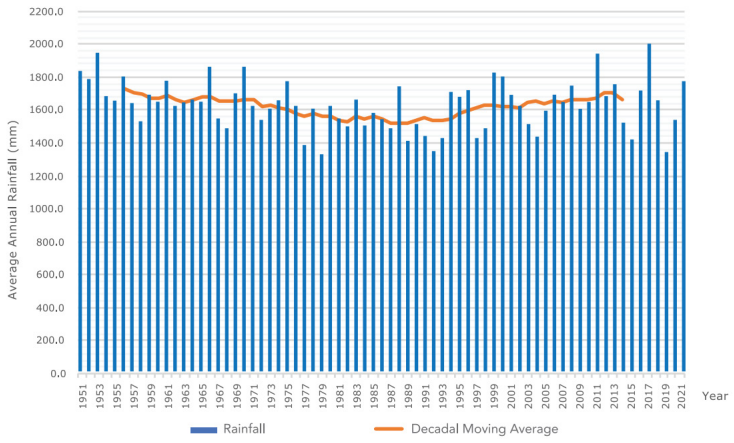


Figure 1-6: Annual mean rainfall in Thailand (mm) during 1951-2021.

Source: Thai Meteorological Department.

Projected trends

Under RCP4.5, the three GCMs; namely, EC-Earth, HadGEM2-ES, and MPI-ESM-MR, and three times horizons: near future (2016-2035), intermediate future (2046-2065), and far future (2081-2099), could display the future projection of extreme rainfall. Figure 1-7 shows that the maximum one-day precipitation (Rx1day) is projected to increase. This reflects the tendency of flash floods from heavy precipitation.

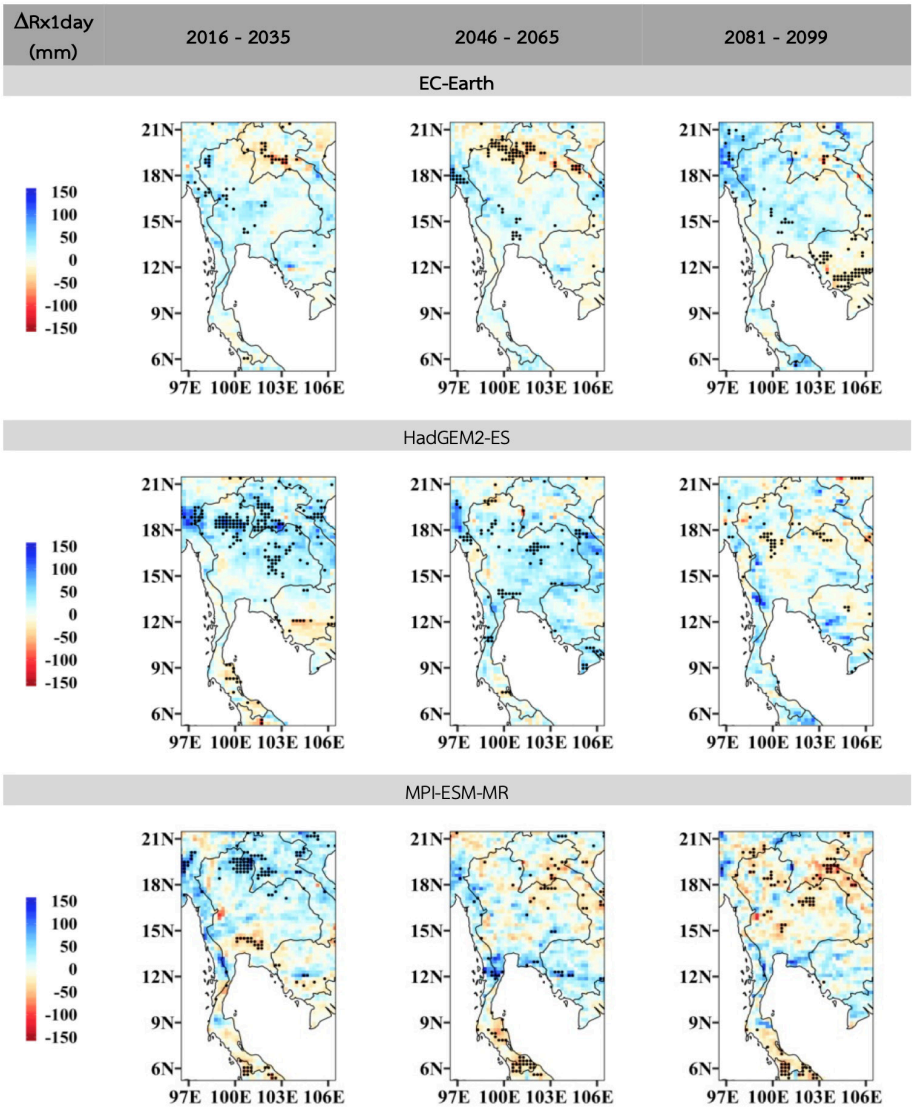


Figure 1-7: Projection of an Rx1day anomaly under RCP4.5.

Source: Thailand Science Research and Innovation (TSRI) and Ramkhamhaeng University, Center of Regional Climate Change and Renewable Energy (RU-CORE).

Figure 1-8 shows that the total annual precipitation is projected to decrease, thus reflecting the signal of drought under future climate change. Under these scenarios, the Northeastern and Southern regions would tend to have higher drought impacts than other regions of Thailand.

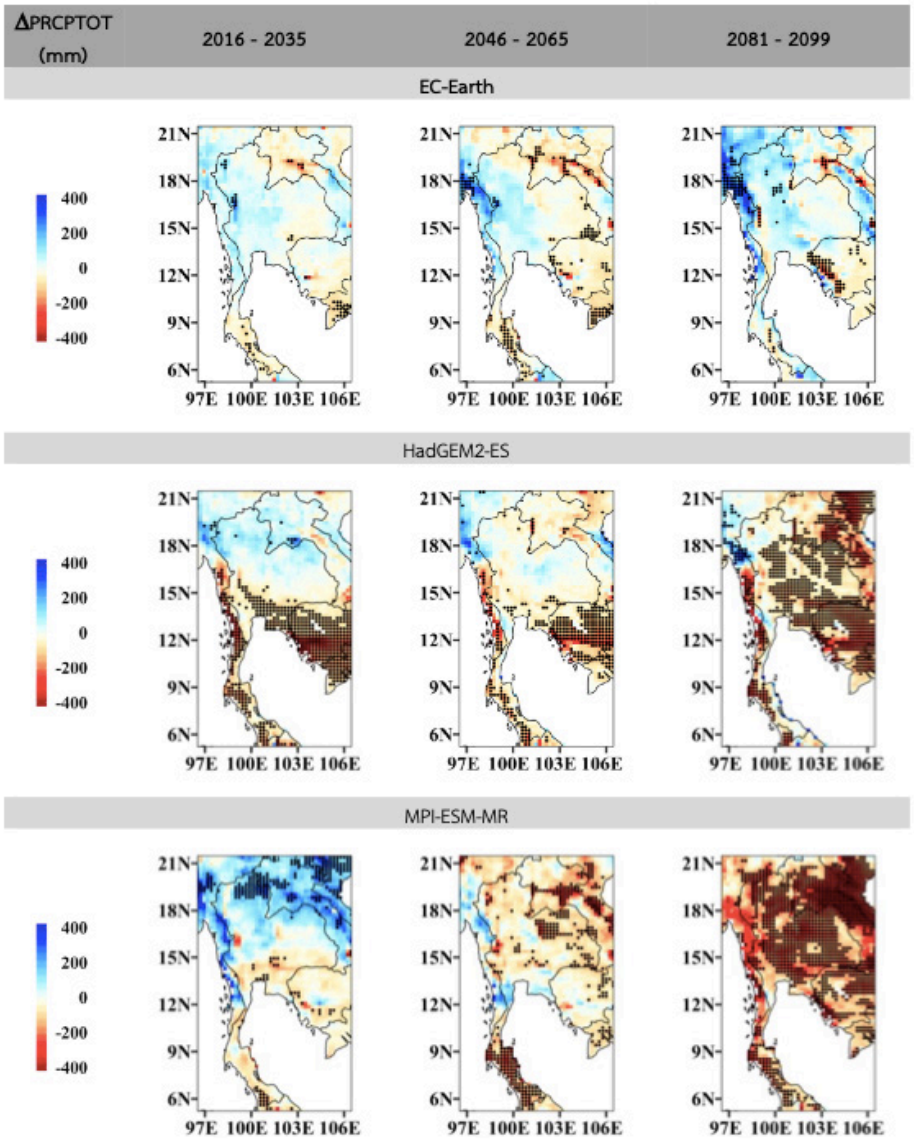


Figure 1-8: Projection of the PRCPTOT anomaly under RCP4.5.

Source: Thailand Science Research and Innovation (TSRI) and Ramkhamhaeng University, Center of Regional Climate Change and Renewable Energy (RU-CORE).

1.3.3 Sea level

Statistical trends

Changes in the sea level in the past 20 years were observed based on the information gathered from two sources: (1) Measuring stations, which provided data from specific spots on the coasts, and (2) satellite altimetry, which provided data at the global level. The average change in the global sea level is in the range of 2.8 mm (measuring stations) to 3.2 mm (satellite) per year. For Thailand, most of the data came from the measuring stations, and most of the calculated changes were on the relative sea level. In some areas, especially in the upper Gulf of Thailand, the change in the relative sea level was higher than in other areas, which was due to widespread pumping of groundwater for public consumption resulting in land subsidence. After the 2004 Tsunami, vertical ground movements in Thailand and the neighboring areas became evident. The uplifting ground motion in Thailand also contributed to changes in the relative sea level.

Projected trends

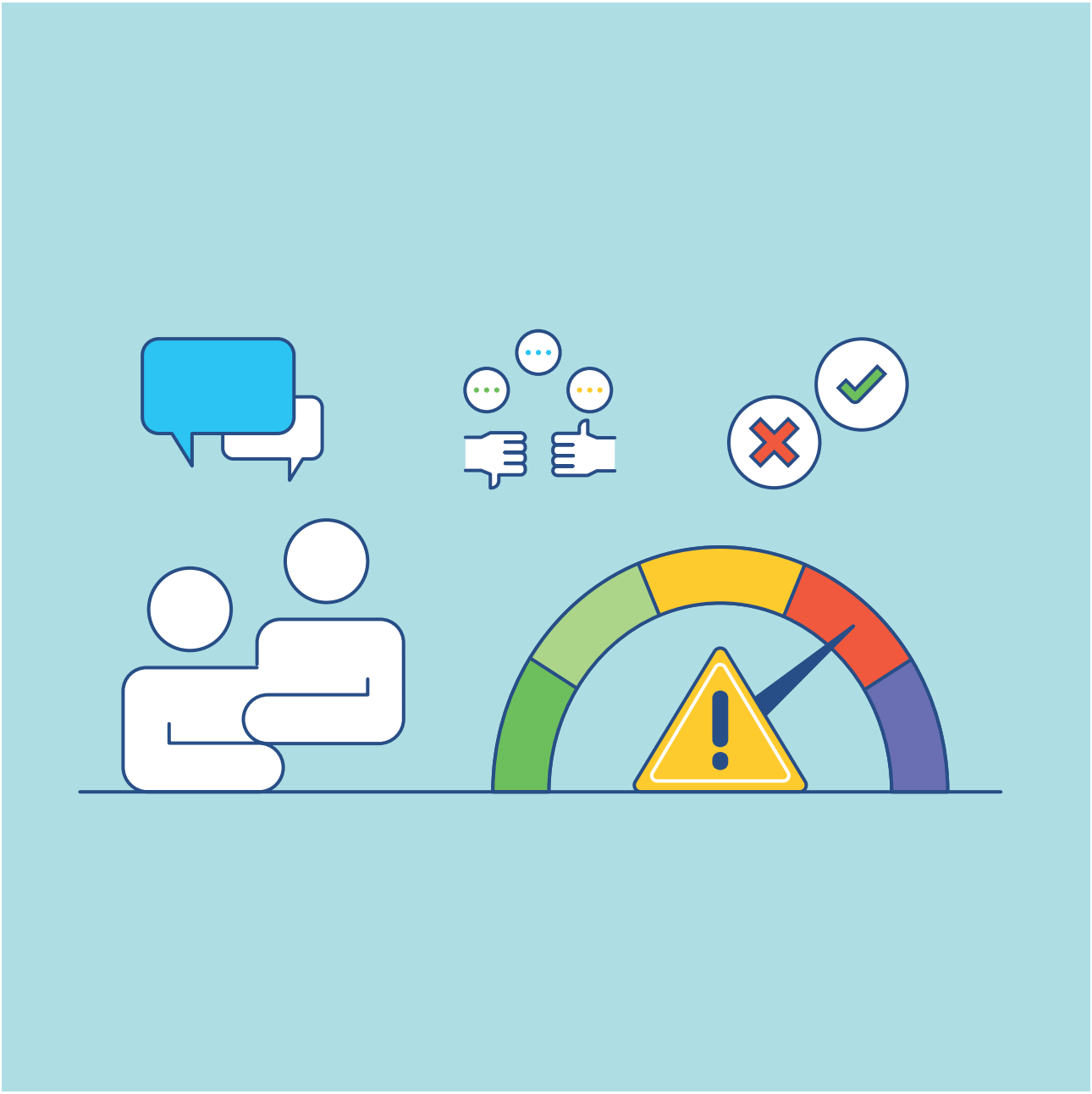
The effects of climate change would affect the sea levels. In particular the area near the equator, for instance, as a result of the melting ice caps and the expansion of ocean water masses from rising sea temperatures. These changes in the trends are in line with the results of a study on the rise of the sea level from data from 13 sea level monitoring stations in the Gulf of Thailand (1985-2009) showing that the annual local mean sea level in 11 stations had increased dramatically depending on the location of the stations. Likewise, the mean sea level has been forecasted to increase at an average rate of 5 mm per year (over a 25-year period). It is also expected that land subsidence at the estuary where the station is located would play a major role in the annual rise of the local mean sea level. In addition, the findings pointed out that Thailand could experience severe coastal recession in the near future if measures are not taken to stop land subsidence near the coast.

Table 1.1: Summary of Thailand's climate trends.

Statistical Climate Trends	Projected Climate Trends
Temperature Between 1981-1990, mean temperatures increased by 0.33°C, while 1991-2000 and 2001-2010 recorded temperature increases of 0.16°C and 0.14°C per decade, respectively. The average temperature in Thailand from 2011 to 2021 increased by an average of 0.09°C per year. Data on the temperature fluctuations in Thailand over the 10 years of 2012-2021 showed the highest temperatures. These high temperatures are likely to continue to rise.	**Temperature** The analysis of extreme climate change in Thailand can be divided into two cases; namely, anomaly analysis under the mean temperature change of 1.5°C and 2°C, respectively compared to the base years of 1970-2005. All two higher values were calculated from the 10-year moving average of future daily temperature projections. In addition, three GCMs, MPI-ESM-MR, EC-Earth and HadGEM2-ES, were compared with the mean temperature during the base year of the daily temperature.

Statistical Climate Trends	Projected Climate Trends
The annual mean maximum temperatures in 2020-2021 were 33.7°C and 33.0°C, respectively. In April 2016, Thailand recorded its highest temperature since 1951 at 44.6°C in Mae Hong Son province. The annual mean minimum temperature reflected a larger increase from 22.5°C in 1951 to 23.5°C and 23.2°C, respectively in 2020-2021.	The mean temperature change of 1.5°C under the RCP4.5 scenario of the GCMs results is projected to occur as early as 2050 and, at the latest, around the year 2080, while the ensemble modeling is projected to occur around 2060. In the RCP8.5 scenario, it is expected to occur around 2055-2060, and under the ensemble model, it is expected to happen around 2045. The mean temperature change of 2°C under the RCP4.5 scenario is expected to occur during the year 2070. The RCP8.5 scenario is projected to occur approximately during the years 2050-2060 and under the ensemble model, it is expected to occur around 2055. By the end of the century or 2100, the average temperature in Thailand is projected to increase by around 2°C under the ensemble model RCP4.5 and about 4°C under RCP8.5.
Precipitation The variation of precipitation and the number of rainy days has oscillated over time. In the last seven years (2015-2021), rainfall variation has fluctuated the most with the lowest rainfall in 40 years in 2019 (1,343.4 mm) since 1979 (1,332.3 mm). The highest annual rainfall in Thailand was recorded in 2017 (2,017 mm). The annual rainfall in 2020 and 2021 was recorded at 1,528.8 mm. and 1,759.3 mm, respectively.	**Precipitation** Under RCP4.5, the three GCMs, namely EC-Earth, HadGEM2-ES, and MPI-ESM-MR and three times horizons: near future (2016-2035), intermediate future (2046-2065), and far future (2081-2099), could display the future projection of extreme rainfall. The total annual precipitation is projected to decrease reflecting the signal of drought under future climate change. Under these scenarios, the Northeastern and Southern regions would tend to have higher drought impacts than other regions of Thailand.

Statistical Climate Trends	Projected Climate Trends
Sea level Changes in the sea level in the past 20 years were observed based on the information gathered from two sources: (1) Measuring stations, which provided data from specific spots on the coasts, and (2) satellite altimetry, which provided data at the global level. The average change in the global sea level is in the range of 2.8 mm (measuring stations) to 3.2 mm (satellite) per year. For Thailand, most of the data has come from the measuring stations, and most of the calculated changes were on the relative sea level. In some areas, especially in the upper Gulf of Thailand, the change in the relative sea level was higher than in other areas due to widespread pumping of groundwater for public consumption resulting in land subsidence. After the 2004 Tsunami, vertical ground movements in Thailand and the neighboring areas became evident. The uplifting ground motion in Thailand contributed also to changes in the relative sea level.	**Sea level** The effects of climate change would affect sea levels. In particular, the area near the equator, for instance, as a result of the melting ice caps and the expansion of ocean water masses from rising sea temperatures. These changes of the trends are in line with the results of a study on the rise of the sea level from data from 13 sea level monitoring stations in the Gulf of Thailand (1985-2009) showing that the annual local mean sea level in 11 stations had increased dramatically depending on the location of the stations. Likewise, the mean sea level has been forecasted to increase at an average rate of 5 mm per year (over a 25-year period). It is also expected that land subsidence at the estuary where the station is located would play a major role in the annual rise of the local mean sea level. The findings pointed out that Thailand could experience a severe coastal recession in the near future if measures are not taken to stop land subsidence near the coast.



CHAPTER 2

NAP PROCESS

2.1 Conceptual Framework and Preparation Process

Thailand's NAP has been developed with the aim to provide a framework for the climate change adaptation actions of the country in order to build resilience, reduce vulnerabilities, and increase the adaptive capacity to be in line with the three dimensions (economic, social, and environmental) of sustainable development. The Plan is also in line with Thailand's national framework policies, including the 20-year National Strategy, National Reform Plan, Thailand 4.0, National Economic and Social Development Plans, Climate Change Master Plan 2015-2050, and the Policy and Plans for the Enhancement and Conservation of National Environmental Quality (2017-2036), and takes into account relevant sectoral plans. Thailand's NAP emphasizes the outcome of long-term actions in six key sectors comprising (1) water resource management, (2) agriculture and food security, (3) tourism, (4) public health, (5) natural resource management, (6) human settlements and security, and cross-cutting issues by applying the following approaches (Figure 2-1):

- Integrating climate adaptation to national policies and plans at all levels.
- Providing guidance of the adaptation options for each sector and for the cross-cutting aspects to be in line with the national context.
- Enabling the relevant agencies to use the Plan as a framework to appropriately implement mainstream climate adaptation into sectoral and subnational policies, plans, and projects, while effectively involving key stakeholders in the sectors and across different area-based levels.

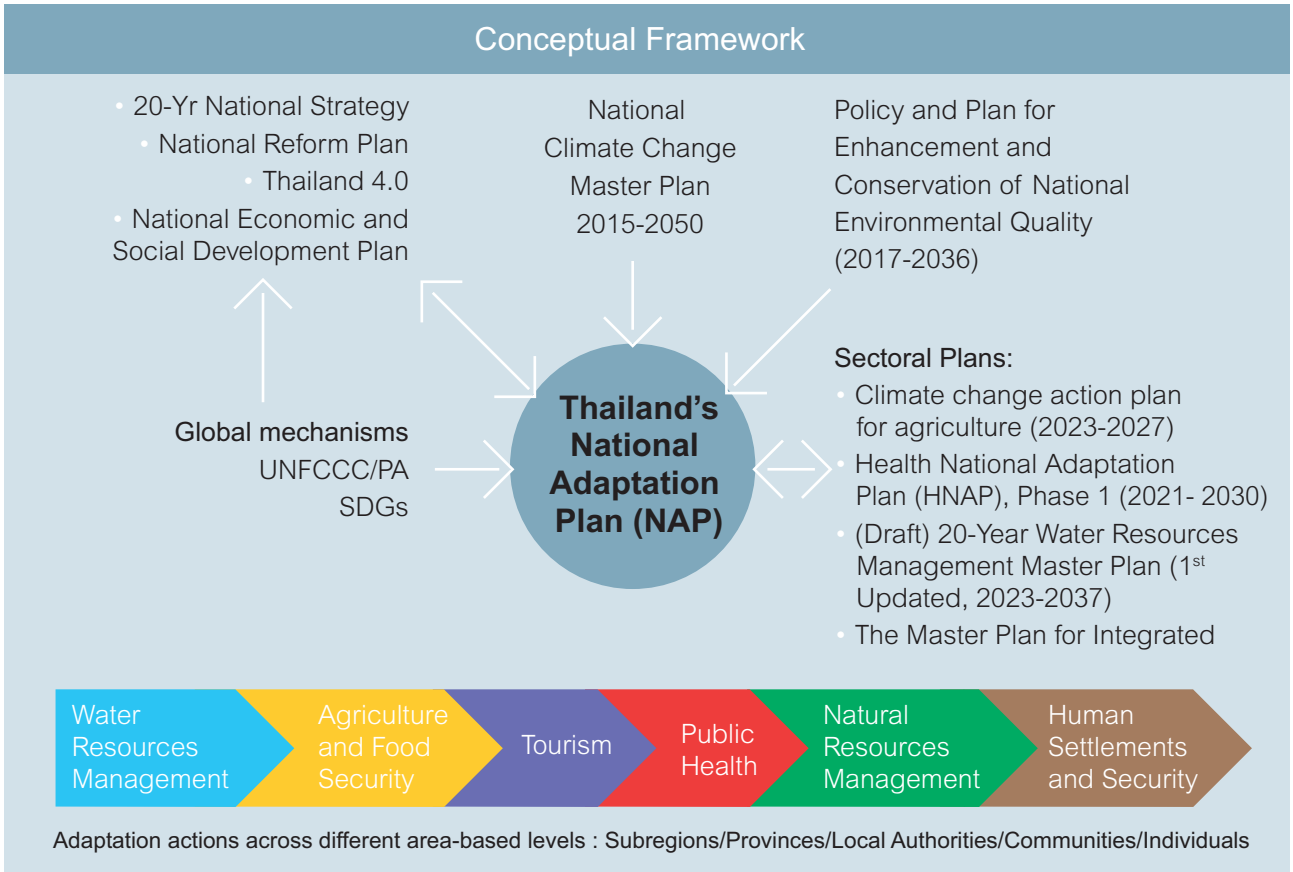


Figure 2-1: Conceptual framework in the development of the Thailand's National Adaptation Plan (Thailand's NAP).

The preparation of the NAP is based on the above conceptual framework. Thailand's NAP process starts with the analyses of the risks and vulnerabilities in each sector by using the global climate models under the IPCC's SRES A1B emission scenario, in which the GHG intensity would be equal to 850 ppm by the end of the 21st century. The downscaling would enable the simulation of the climate trends to be used together with the risk management approach to develop the initial guidelines and measures for the climate change adaptation in each sector. Consequently, the NAP was drafted and presented for consultations with all the concerned sectors such as government, private sectors, academia, and NGOs through a participatory approach.

The draft NAP then went through the process of consideration and endorsement by the Subcommittee on the Integration of Climate Change Policies and Planning under the National Committee on Climate Change (NCCC), and the NCCC itself, respectively. The approved draft would then be submitted for the Cabinet's endorsement, and subsequently submission for publication at the UNFCCC (Figure 2-2).

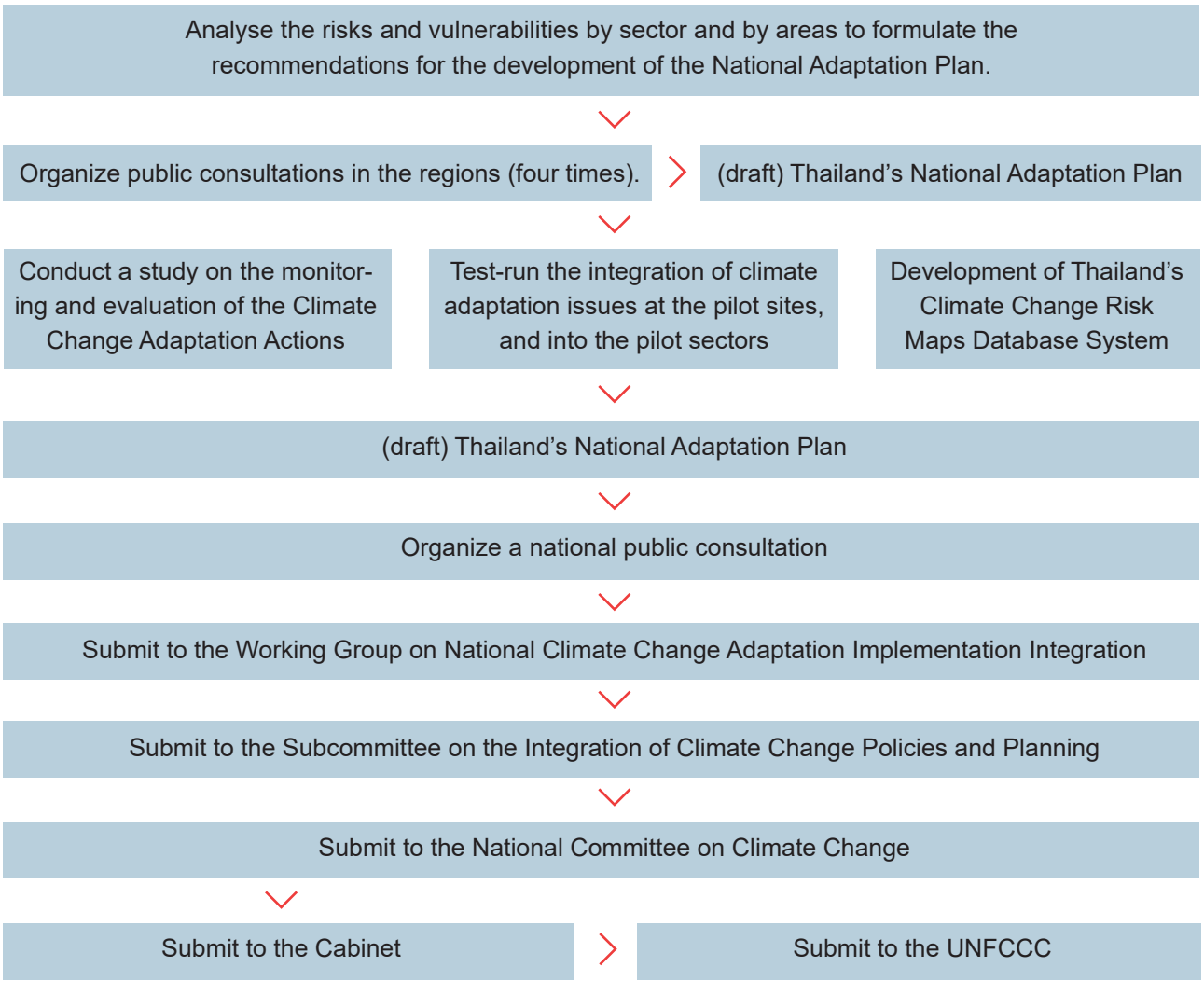


Figure 2-2: Preparation process of the Thailand's National Adaptation Plan (NAP).

2.2 Institutional Arrangement (Governance)

Figure 2-3 demonstrates an institutional arrangement for development of the climate policy, in particular the adaptation policy.

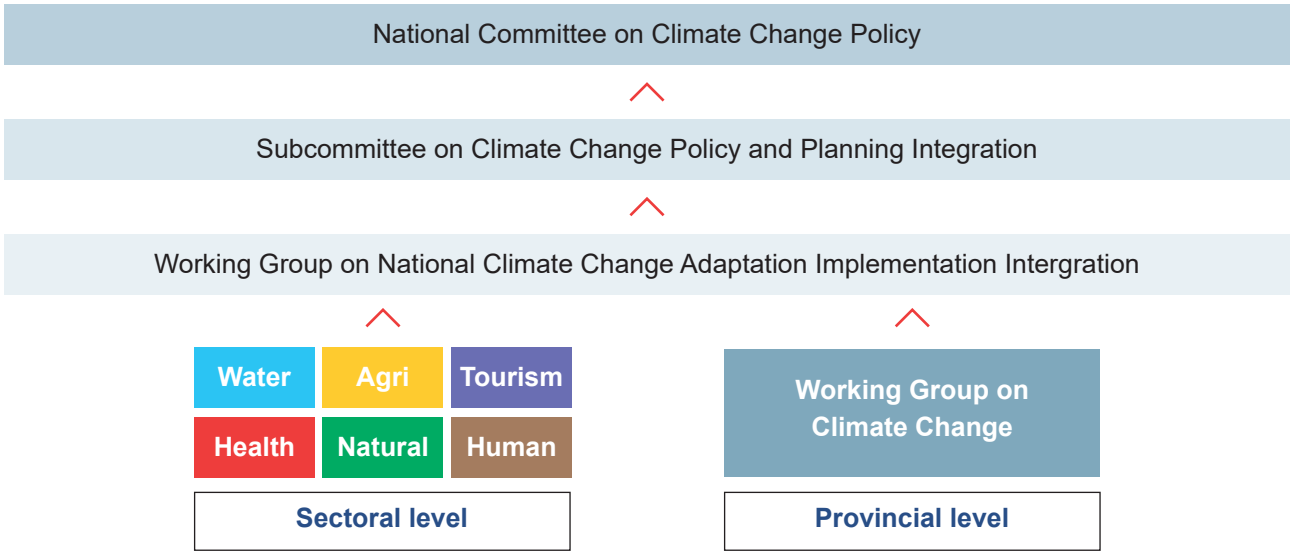


Figure 2-3: Institutional arrangement for climate change adaptation.

2.2.1 National Committee on Climate Change (NCCC)

Thailand established the NCCC in 2007. The NCCC is chaired by the Prime Minister and has members from both the public and private sectors, including experts from relevant agencies. The NCCC has the mandate to define national climate policies and establish guidelines and mechanisms for international collaboration regarding the conventions and protocols on climate change, including supporting and evaluating the relevant domestic agencies to be in accordance with the national established policies and plans.

2.2.2 The Subcommittee on Climate Change Policy and Planning Integration

The roles of the Subcommittee on Climate Change Policy and Planning Integration are to provide comments on policy integration, strategy, and planning that are linked with climate mitigation and adaptation, provide suggestions on the mechanisms and measures, including legal regulations and financial measures, and push forward an integrated budget allocation system on climate change.

2.2.3 Working Group on National Climate Change Adaptation Implementation Integration

The Working Group is tasked with the development of the NAP as well as guiding research, policy, strategies, plans, tools, and mechanisms related to the NAP, supporting the mainstreaming of the NAP into the sectoral and regional plans, driving the implementation of the NAP as well as related policies, strategies and plans, monitoring and evaluating the adaptation measures under the NAP, and inviting representatives of public and private organizations to share information related to climate adaptation to the Working Group.

2.2.4 Implementation of national climate change adaptation at the sectoral level

The implementation of climate change adaptation in Thailand has been collaborated between the Department of Climate Change and Environment (DCCE) and leading agencies of the six following sectors.

1. Water management sector led by the Office of the National Water Resources (ONWR) under the Office of the Prime Minister (OPM).
2. Agriculture and food security sector led by the Office of Agricultural Economics (OAE) under the Ministry of Agriculture and Cooperatives (MOAC).
3. Tourism sector led by the Department of Tourism (DOT) under the Ministry of Tourism and Sports (MOTS).
4. Public health sector led by the Department of Health (DOH) under the Ministry of Public Health (MOPH).
5. Natural resource management sector led by the ONEP under the MNRE.
6. Human settlement and security sector led by the Department of Disaster Prevention and Mitigation (DDPM) and Department of Public Works and Town and Country Planning (DPT) under the Ministry of Interior (MOI).

2.2.5 Implementation of national climate change adaptation at the provincial level

After receiving the funding from Thailand's Environmental Fund for implementing the capacity building for the Provincial Office of Natural Resources and Environment in the development of the climate change work plan at the provincial level project, each province has established a provincial working group on climate change in order to develop information on GHG emissions and a mitigation plan at the provincial level as well as a risk profile that would take affect from the climate change and adaptation plan for coping with these effects at the provincial level. This working group consists of representatives from all sectors relating to climate change implementation and a natural resources and environmental protection volunteer network, which would help in the communication and implementation of the adaptation measures in both the top-down and bottom-up approaches.

2.3 Efforts to Strengthen Thailand's NAP Process

Adaptation mainstreaming is recognized as an interdisciplinary and inter-ministerial process. The development of Thailand's NAP is a starting point and has the initial aim of raising awareness and providing guidance to the relevant sectors and stakeholders to understand how their roles could be linked to climate adaptation. To drive forward actual adaptation mainstreaming and to equip the key sectors and stakeholders with the knowledge and capacity to respond to climate risks and adapt to climate impacts, Thailand is required to make several efforts to strengthen its NAP process. The newly established the DCCE, having taken over the climate mandates from the ONEP, now has the responsibilities to strengthen Thailand's NAP process, and the development of future NAPs. The following efforts are foreseen:

2.3.1 Establishment of the National Framework for Climate Services (NFCS)

The establishment of Thailand's NFCS aims to strengthen the response to the threat of climate change by ensuring the availability of science-based research and systematic observations for decision-making. The Thai Meteorological Department (TMD) as a focal point, with a legal mandate from the (Draft) Climate Change Act, will work on five major components aligned with the Global Framework for Climate Services (GFCS) that are a user interface platform, climate services information system, observations and monitoring, research modeling and prediction, and capacity-building.

As Thailand is working to build its NFCS, the DCCE is trying to establish an interim solution through the development of Thailand's Climate Change Risk Maps Database System (CCRMDS) to consolidate existing climate risk research and data, which could be used as a basis for planning and implementing adaptation action. The objectives of Thailand's CCRMDS are (1) to support sectoral and area-based climate risk assessment, (2) to support policy decisions in integrating the climate risks into the relevant sectoral and subnational plans, and (3) to serve as a channel to build public awareness on the climate risks in a concrete and easily accessible way. The system can provide maps and other information, such as future climate projections in various scenarios, climate hazard information, non-climate index, which would be used for risk analysis, and climate risk information in the various sectors. Currently, the database system incorporates only heat, flood, and drought hazards due to climate change and would be expanded to include other hazards when sufficient data is available. It is expected that the upcoming NFCS could significantly and systematically provide support to strengthen the database system.

2.3.2 Development/refinement of sectoral and area-based adaptation plans, adaptation policy instruments, and monitoring and evaluation (M&E) for climate resilience

With climate services offered by the NFCS, sectoral and subnational agencies could develop and/or refine the relevant analyses, including the impact chain assessment to be based on scientific climate information. This could significantly support sectoral and subnational agencies to understand long-term climate risks and enable these agencies to account for these risks in the sectoral and area-based development plans. The DCCE would coordinate to ensure that climate mainstreaming into sectoral and area-based development planning would be supported with capacity development measures and could be performed effectively. In addition to sectoral and subnational planning, mainstreaming of climate adaptation into the design of policy instruments and into the monitoring and evaluation (M&E) system would be necessary to ensure there would be effective policy instruments to support the adaptation actions by different stakeholders, as well as have an effective M&E system to monitor the progress toward climate resilience. These efforts would also need extensive capacity development support to strengthen the DCCE as the focal point, as well as sectoral and subnational agencies.

To mobilize and prepare for the implementation of the NAP at the subnational level, the MNRE has established the Provincial Climate Change and Biodiversity Coordination Center (PCCB) at the provincial level. It is expected that the PCCB would play a vital role in driving and coordinating area-based climate and biodiversity actions at the provincial level with various stakeholders in different scales, including the ecosystem, catchments, cities, communities, as well as at the individual levels. The PCCB would also have a role in facilitating the involvement of the private sector to create multi-stakeholder partnerships among the government, private, and non-governmental sectors to leverage public and private investments to support the adaptation actions.

2.3.3 Steering for the implementation of flagship adaptation projects/programs

To concretely support the capacity development of the relevant agencies and stakeholders to plan and implement the adaptation actions, the DCCE would focus its roles to steer for the implementation of flagship adaptation projects/programs in priority sectors/topics/areas. This would be a role model of the integrated planning and implementation across agencies, sectors and levels, which could be used as lessons learned for horizontal and vertical mainstreaming, and could be scaled up and replicated. The lessons learned from the implementation of flagship adaptation could inform the design of national policy to support the integrated budget planning and allocation, as well as joint impact monitoring, for instance.

CHAPTER 3

ADAPTATION ACTIONS

Thailand's NAP provides a framework for the climate adaptation actions of the country in order to build climate resilience, reduce vulnerabilities, and increase the adaptive capacity to be in line with sustainable development. The plan identifies six priority sectors, which are (1) water resources management, including flood and drought management, (2) agriculture and food security, (3) tourism, (4) public health, (5) natural resource management, and (6) human settlements and security.

The objectives of Thailand's NAP are:

1) To serve as a framework and guideline for the related agencies to be able to integrate climate adaptation into sectoral plans and strategies.
2) To be a budget allocation framework toward concrete climate adaptation actions in line with the country's sustainable development pathway.
3) To provide the building blocks to strengthen sectoral capacities to adapt and achieve climate resilience, as well as to enhance collaborative and integrated efforts by all sectors and levels to mainstream climate adaptation into sectoral and subnational policies and practices.
4) To create climate awareness among government agencies and all the relevant stakeholders, including the business sector and the general public, for concerted and collaborative climate adaptation actions.

Vision

"Thailand has increased its adaptive capacities and the country's sustainable development is resilient to climate impacts."

Mission

1) To build climate-resilient development by integrating climate adaptation guidelines and strategies in all sectors at all levels;
2) To strengthen the capacity and awareness of the development partners at all levels to implement the climate adaptation policies and plans more effectively;
3) To develop databases, research, knowledge, and technologies to support the climate adaptation actions.

Goals and Timeframe

Overall goals and time frames.

Short-term goals (2023-2027)

- Raise climate awareness.
- Build a basis and instruments for policymaking and mainstreaming.
- Establish data and knowledge infrastructure to support decision-making.

Medium-term goals (2028-2032)

- Strengthen policy instruments and mainstreaming across the priority sectors.
- Enhance the implementation capacities.
- Enhance data and knowledge capacities to measure progress and support decision-making.

Long-term and continuous goals (2033-2037)

- Ensure climate resilience in the country's development actions.
- Ensure continuity of climate awareness, data and knowledge capacities.
- Ensure regular monitoring of progress and updating of the relevant policies and plans.

3.1 Specific Sectoral Goals

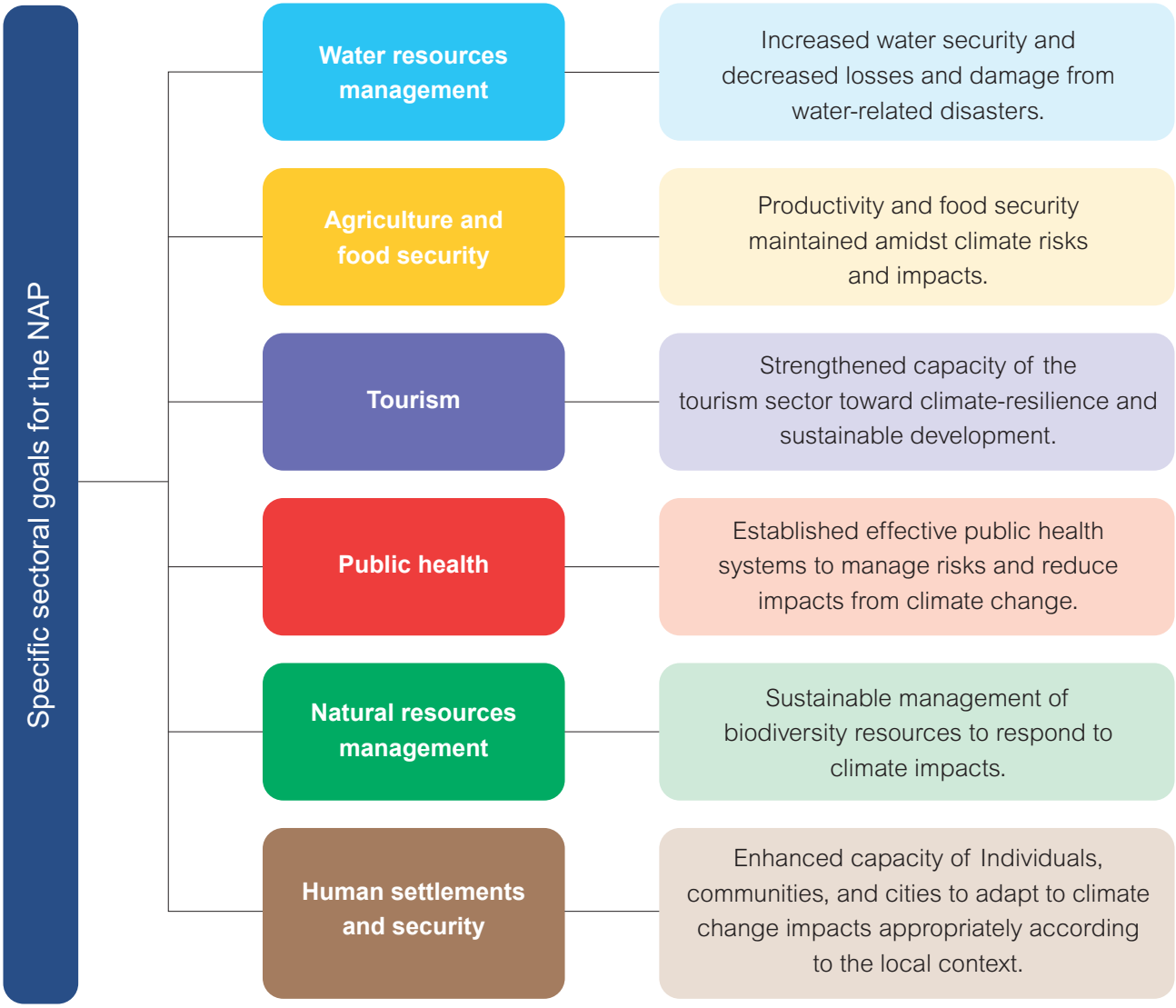


Figure 3-1: Specific sectoral goals for the Thailand's NAP.

3.2 Adaptation Guidelines by Sector

1) Water Resources Management

The total amount of surface water in Thailand, less infiltration and evaporation, is 285,221 million cubic meters, and the average runoff is 3,496 million cubic meters. The average demand for water in Thailand, based on the information during 2015-2020, was approximately 41,042 million cubic meters, excluding rainfed agricultural areas and water usage for maintaining the ecosystem. Thus, the amount of surface water was considered sufficient for domestic usage. Thailand's water demand could be divided into the agricultural sector, which has the highest demand, amounting to 83% of the total water consumption, followed by the service and industrial sectors, respectively. Future climate variability would undoubtedly pose challenges to water resource management in the country. Under the RCP4.5 and 8.5 scenarios, the highest mean rainfall would likely increase, while the number of days with rainfall would remain the same, and the rainfall distribution is predicted to be less in range. This means that in future scenarios, some areas could be more prone to severe drought, while others could be more prone to severe floods, or there could be higher risks to severe drought and floods at different times of the year, consequently making the country's water resource management efforts much more complicated.

National level climate modeling was done by the ONEP and its consultants, in which heat stress, drought, and floods were modeled under the RCP4.5 and 8.5 scenarios. Several provinces in Thailand were listed vulnerable to a different degree under the model as shown in Table 3-1 and Figure 3-2 below.

Table 3-1: Top 10 risk areas divided by climate scenarios during 2016-2035 for the water resources management sector.

Risks for the Water Resources Management Sector		Areas
Risk areas to heat stress	RCP 4.5	Bangkok, Nakhon Ratchasima, Ubon Ratchathani, Chon Buri, Samut Prakan, Buri Ram, Si Sa Ket, Surin, Roi Et, and Khon Kaen.
	RCP 8.5	Bangkok, Nakhon Ratchasima, Ubon Ratchathani, Chon Buri, Samut Prakan, Si Sa Ket, Buri Ram, Surin, Roi Et, and Khon Kaen.
Risk areas to floods	RCP 4.5	Nakhon Ratchasima, Nakhon Si Thammarat, Chiang Mai, Bangkok, Nakhon Sawan, Chiang Rai, Khon Kaen, Ubon Ratchathani, Phitsanulok, and Nan.
	RCP 8.5	Nakhon Ratchasima, Bangkok, Nakhon Si Thammarat, Chiang Mai, Nakhon Sawan, Khon Kaen, Chiang Rai, Ubon Ratchathani, Phitsanulok, and Phra Nakhon Si Ayutthaya.
Risk areas to drought	RCP 4.5	Nakhon Ratchasima, Bangkok, Khon Kaen, Ubon Ratchathani, Roi Et, Chaiyaphum, Surin, Buri Ram, Udon Thani, and Si Sa Ket.
	RCP 8.5	Nakhon Ratchasima, Bangkok, Khon Kaen, Ubon Ratchathani, Roi Et, Nakhon Sawan, Udon Thani, Buri Ram, Sakon Nakhon, and Chaiyaphum.

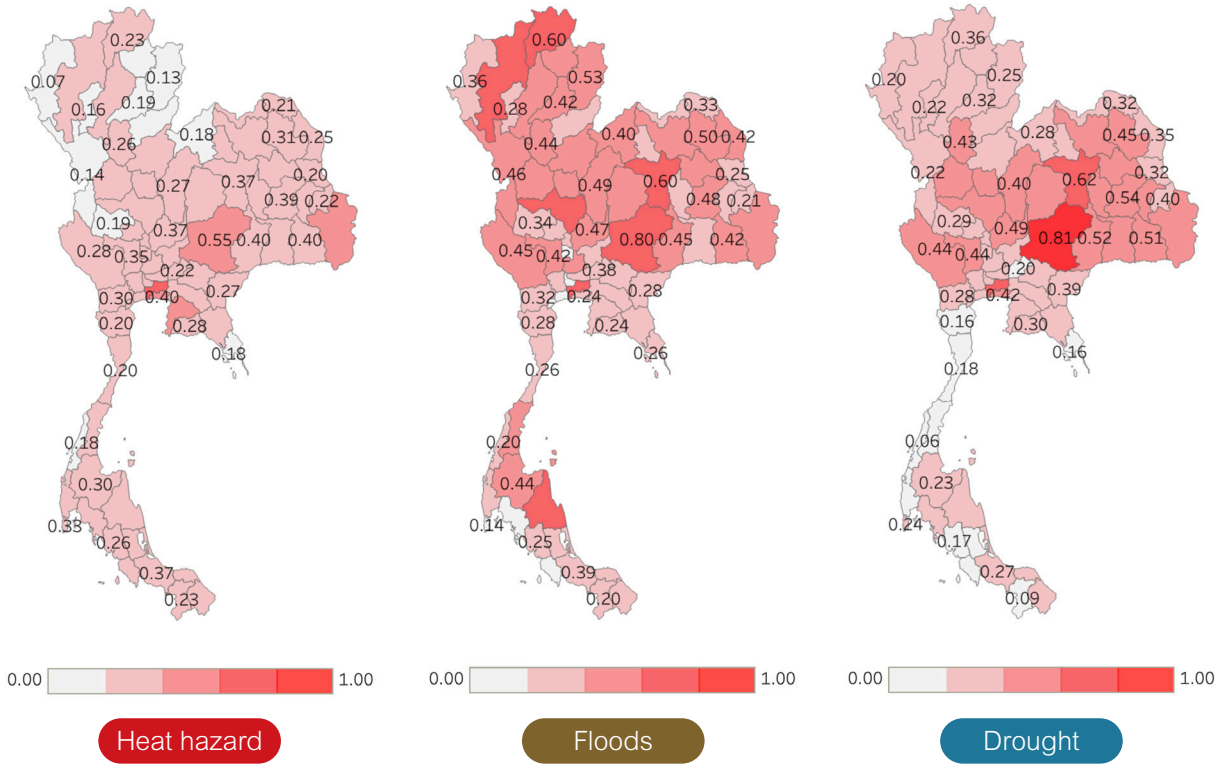


Figure 3-2: Risk areas for the water resources management sector under RCP4.5 with a focus on heat hazard, floods, and drought area shown in the country map during 2016-2035. The darker color indicates more severely impacted areas.

Source: Office of Natural Resources and Environmental Policy and Planning (2021).

Adaptation action guidelines for water resources management

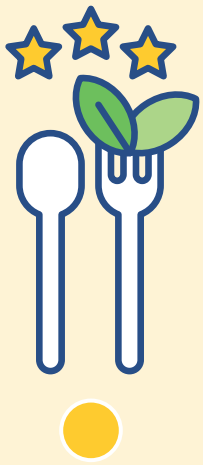
Climate adaptation guidelines for water resources management have been based on the principles of river basin management with measures that align with and are appropriate for local area-based management. These can be categorized into (1) Upstream management prioritizing the conservation and preservation of upstream areas, (2) Midstream and downstream management of areas with water consumption by various sectors, such as households, agriculture, industry, etc. Measures here would focus on the management of floods and drought that would impact these sectors. (3) Downstream management of areas at the end of river basins that connect to other basins or are situated at river mouths or coastal areas. Measures here would focus on managing the quality of the water sources as well as restoration of water sources and conservation of ecosystems. Apart from river basin-based management principles, there would also be (4) Supporting mechanisms for water resources management. The details are laid out as follows:

Guidelines/Measures	Output
Guideline 1: Upstream management	
(1) Conservation and restoration of declining watershed forests and preventing topsoil collapse.	All watershed forests in the 22 main river basins are conserved and restored to pristine conditions.
(2) Promote a participatory approach with local administrative organizations (LAOs) and communities in upstream areas in developing policies and land use plans.	LAOs and upstream communities take part in developing policies and plans for land use in the form of River Basin Committees in all 22 main river basins.
(3) Promote economic instruments as incentives for upstream communities to protect and conserve the ecosystem.	Upstream communities adapt economic instruments to protect and conserve upstream ecosystems.
Guideline 2-1: Midstream and downstream management - Flood management	
(1) Develop infrastructure for flood responses, which would consider the characteristics of each locality, ecosystem, and community.	Infrastructure for flood responses would be established and effective in all flood-risk areas.
(2) Increase the efficiency of drainage.	Flood risk areas have improvements made to water obstacles and barriers, shallow natural waterways, and urban and economic area drainage systems to be more efficient in draining water.

Guidelines/Measures	Output
(3) Develop an urban flood protection system by creating a water plan and drainage plan at the river basin, province, and city levels.	Flood risk areas have water plans and drainage plans at the river basin, province, and city levels.
(4) Develop pollution control plans for flood situations in risk areas.	Pollution control plans for flood situations are developed in all flood risk areas throughout the country.
Guideline 2-2: Midstream and downstream management - drought management	
(1) Develop database systems on the water footprint, water budget, and water demand of each sector in all of Thailand's 22 main river basins.	Database systems on the water footprint, water budget, and water demand in each sector are established to support water resources management planning for fair and effective water allocation to all sectors.
(2) Increase effectiveness in water budget and water retention management by setting a water usage ratio for each sector taking into consideration the amount of runoff and reserved water in each of Thailand's 22 main river basins.	Water usage ratio for each activity which corresponds with the amount of runoff and reserved water in each catchment is specified, and appropriate water allocation for the demand in each sector is executed.
(3) Develop infrastructure to reserve rainfall and water allocation systems in areas with chronic drought, areas outside irrigated zones, and areas using groundwater.	Water resources are developed in chronic drought areas, non-irrigated zones, and areas using groundwater, and irrigation systems are expanded to cover all areas with the agricultural potential of the country.
(4) Increase effectiveness in the conjunctive management of surface water and groundwater in drought prone areas.	Effective conjunctive management of surface water and groundwater, such as restoring groundwater resources in drought prone areas across all catchments.
(5) Develop a water grid system.	A connected water grid system is developed for each domestic river basin.
Guideline 3: Downstream water management	
(1) Conservation and restoration of rivers and natural water sources across the country with participation by all sectors.	Main river basins have a conservation and restoration plan for rivers and natural water sources and allocation plans for the protection of the ecosystem.
(2) Improve the efficiency of water treatment and control of wastewater released into the environment.	Urban communities and industrial zones have installed efficient water treatment systems.

Guidelines/Measures	Output
(3) Promote the development and application of wastewater treatment technology to recycle water usage in the household and industrial sectors.	Flood risk areas have developed wastewater treatment technology and methods developed to support effective water recycle systems appropriate for households and industries.
(4) Increase effectiveness in managing saltwater intrusion caused by the changing sea level, drought, and changes in runoff from human activities.	Infrastructure to prevent saltwater intrusion is improved, and the water budget has increased in all risk areas across the country.
Guideline 4: Supporting mechanisms for water resources management	
(1) Develop a national Water Security Index.	A Water Security Index is developed.
(2) The EbA and/or NbS for river basin water resources management.	A manual for EbA and/or NbS in water resources management is developed and capacity building is conducted.
(3) Develop a system for water forecasting and reporting.	Accurate and precise water forecast and reporting systems are in place and disseminated to public users in local areas.
(4) Integrated risk mapping in the form of One Map created together by the relevant agencies to predict climate change impacts on water resources management.	Area-level risk maps and forecasts of the climate change impact on water resources management.
(5) Develop water resources management plans, river basin master plans, and operation plans.	River basins have emergency water resources management plans created by the participation of all sectors.
(6) Build disaster watch networks in risk areas by strengthening the capacities of the general public from the household to national levels.	Networks for disaster watching and early warnings are established with information sharing channels on floods, drought, and landslides, which are interlinked from the household to the national levels, thus reducing the losses and damage on life and assets.
(7) Support the integration of local wisdom into water resources management innovation appropriate for each local context.	Effective integration of local wisdom into water resources management innovation is implemented at the local level.
(8) Enhance continued collaboration under the cooperation mechanisms on water resources management in the catchments with international significance.	Water resources management strategy under the active cooperation mechanism is integrated into the local water management plans of all provinces impacted by water resources management in the Mekong River.

Responsible agencies of the water management sector: ONWR, MNRE, MOAC, and MOI.



2) Agriculture and Food Security

The agricultural sector has experienced multiple effects from climate change directly due to changes in temperature, rainfall, sea level, and seasonal shifts. These changes have also impacted the properties of the soil and water resources, plant diseases, and insect and other species habitat and distribution, which have indirectly impacted agricultural production.

Approximately 1,178.91 square kilometres (km²) or 0.49 % of the total agricultural land areas of 238,803.92 km² were affected by storms in 2022, while 2,848 km² (1.20%) were affected by drought in 2020, and 9,120 km² (3.82%) were affected by floods in 2021, as well as another 3,341.22 km² (1.40%) were destroyed by floods in 2021. The total value of loss and damage to lives, assets, housing, agricultural land, and other damages due to storms, drought, and floods during 2011-2019 was 17,487,816.67 USD from storms, 119,386,225.58 million USD from drought, and 23,744,843.00 USD from floods.

Due to significant implications for the country's food security, it would be important to gain a better understanding of future climate risks and the impact on the agricultural sector. In 2016, the ONEP undertook a study to project future climate risks and the impact on rice, other primary field crops (e.g., rice, sugar cane, maize, cassava, and rubber), and horticulture. The study indicated that 25,569.25 km² of rice fields could be subject to flood risks, and the highest risk areas were in the Central Plain. For other primary field crops, there were flood risk areas in the North. For horticulture, the highest risk areas from floods were in the Central Plain. For the assessment of the drought risk area, the highest risk areas for rice fields, other field crops, and horticulture were in the North.

National level climate modeling was done by the ONEP and its consultants in which heat stress, drought, and floods were modeled under the RCP4.5 and 8.5 scenarios. Several provinces in Thailand were listed vulnerable to a different degree under the model as shown in Table 3-2 and Figure 3-3 below.

Table 3-2: Top 10 risk areas divided by climate scenarios during 2016-2035 for the agriculture and food security sector.

Risk for Agriculture and Food Security Sector		Areas
Risk areas to heat stress	RCP 4.5	Nakhon Ratchasima, Ubon Ratchathani, Buri Ram, Si Sa Ket, Khon Kaen, Surin, Roi Et, Nakhon Si Thammarat, Udon Thani, and Nakhon Sawan.
	RCP 8.5	Nakhon Ratchasima, Ubon Ratchathani, Buri Ram, Si Sa Ket, Khon Kaen, Surin, Roi Et, Nakhon Si Thammarat, Udon Thani, and Nakhon Sawan.
Risk areas to floods	RCP 4.5	Nakhon Ratchasima, Khon Kaen, Nakhon Sawan, Chiang Rai, Ubon Ratchathani, Chiang Mai, Kamphaeng Phet, Phitsanulok, Sakhon Nakhon, and Phetchabun.
	RCP 8.5	Nakhon Ratchasima, Nakhon Sawan, Khon Kaen, Kamphaeng Phet, Nakhon Si Thammarat, Ubon Ratchathani, Chiang Mai, Chiang Rai, Buri Ram, and Suphan Buri.
Risk areas to drought	RCP 4.5	Nakhon Ratchasima, Khon Kaen, Ubon Ratchathani, Si Sa Ket, Udon Thani, Chaiyaphum, Roi Et, Buri Ram, Surin, and Nakhon Sawan.
	RCP 8.5	Nakhon Ratchasima, Khon Kaen, Ubon Ratchathani, Udon Thani, Nakhon Sawan, Roi Et, Sakhon Nakhon, Buri Ram, Si Sa Ket, and Chaiyaphum.

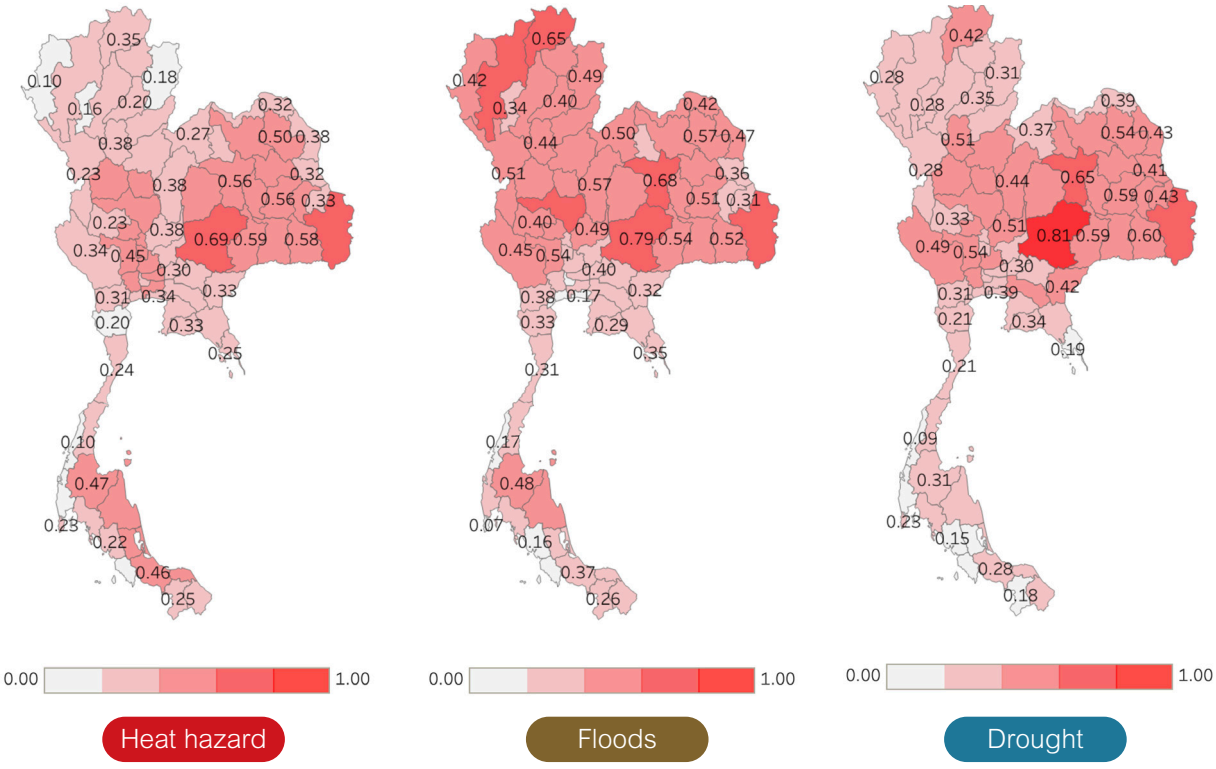


Figure 3-3: Risk areas for the agriculture and food security sector under RCP4.5 with a focus on heat hazard, floods, and drought areas shown in the country map during 2016-2035. The darker color indicates more severely impacted areas.

Source: Office of Natural Resources and Environmental Policy and Planning (2021).

Adaptation action guidelines for agriculture and food security

Climate adaptation guidelines in the agriculture and food security sector have been developed based on the agricultural production systems at risk; namely, (1) Management of crop farmland, (2) Management of livestock farmland, (3) Management of fisheries and aquaculture, as guidelines for suitable measures in area-based management, as well as (4) Supporting mechanisms for agriculture and food security. The details are laid out as follows:

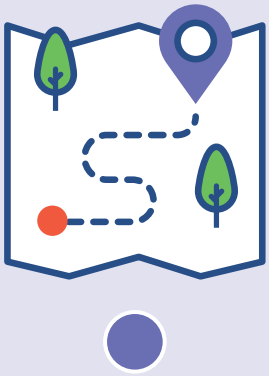
Guidelines/Measures	Output
Guideline 1: Management of crop farmland	
(1) Encourage adjustment in agricultural patterns in response to the changing climate.	Agricultural patterns and behavior in the risk areas are adjusted in response to the changing climate and appropriate to the local context.
(2) Promote integrated farming or crop rotation to mitigate risks and damages from climate change.	Farmers in risk areas adopt integrated farming, thus reducing monocultures.
(3) Develop and improve water resources management in irrigated zones in flood risk and drought risk areas to be more effective.	Integration of water resources management in irrigated agricultural land in flood risk and drought risk areas with water resources management in other sectors to have framework agreements on water utilization in the areas.
(4) Develop water resources in non-irrigated zones to be more effective and sufficient to meet the demand for crops and livestock.	An improved rainfall reserve system is in place, and on-farm small-scale water resources are developed in non-irrigated zones in risk areas with effective management.
(5) Promote measures for soil conservation, rehabilitation, and soil fertility maintenance in degraded agricultural land, such as undertaking cover cropping, contour tillage, and crop selection according to the soil and climatic conditions in degraded agricultural land to increase production per unit, strengthen food security, and enhance the productivity of the areas.	Farmers in degraded agricultural land take measures on soil conservation, rehabilitation, and soil fertility maintenance with increasing production per unit, and reducing areas with land degradation in the country.

Guidelines/Measures	Output
Guideline 2: Management of livestock farmland	
(1) Develop livestock management systems and products to respond to the climate change trends.	Farmers in the risk areas can develop and improve livestock management systems and products to respond to climate change.
(2) Develop systems to control, prevent, and treat livestock diseases caused by climate change and epidemics caused by floods and drought.	Adequate systems to control, prevent, and treat livestock diseases caused by climate change and epidemics caused by floods and drought.
Guideline 3: Management of fisheries and aquaculture farmland	
(1) Develop fishery management systems to respond to climate change trends.	Farmers in the risk areas use the improved varieties for further breeding. As well, building coastal erosion protection zones to protect the spawning grounds.
(2) Restore fishery resources and aquatic habitats to create a balance for aquatic biodiversity.	Aquatic habitats are restored and have a diversity of aquatic species.
(3) Develop systems for controlling, preventing, and treating animal diseases.	Guidelines and prevention systems to reduce the impacts of damages caused by floods and drought in fisheries and aquaculture production.
Guideline 4: Supporting mechanisms for agriculture and food security	
(1) Develop an index for the capacity of the agricultural sector's self-reliance in the event of climate-related disasters to assess farmers' capacity in different areas.	An index for the capacity of the agricultural sector's self-reliance in the event of climate-related disasters.
(2) Develop an early warning system for the agricultural sector, which is accurate, easily accessible, timely, and linked effectively with other early warning systems.	An effective early warning system for the agricultural sector with interlinkages with other related systems is established and easily accessible for farmers, especially in disaster-risk areas.
(3) Map climate-risk agricultural areas and climate change impacts at the local level and make the information available for farmers to access and apply.	Maps of climate-risk agricultural areas and the projection on climate change impacts at the local level with interlinkages to other critical socio-economic and environmental databases and information transfer channels to areas at risk.

Guidelines/Measures	Output
(4) Develop precision farming technology to lower the cost of operation, thus allowing more comprehensive access and adoption among farmers and increasing the effectiveness in planning and managing agricultural activities.	Farmers can access and adopt precision farming technology effectively.
(5) Promote agro-economic zoning using a proactive agri-map and mega farm systems for total production.	Designation of agro-economic zones and extension activities to encourage farmers to conduct agricultural practices according to the zoning completed in all areas of the country.
(6) Promote production with New Theory Agriculture, Sustainable Agriculture, and Integrated Farming to produce sufficient food for household consumption, reduce the risk of food shortages, and always have access to food.	Farming communities have sufficient food for consumption using New Theory Agriculture, Sustainable Agriculture, and Integrated Farming.
(7) Promote the restoration of local household food reserve storing traditions.	Farming communities have reserved food stores.
(8) Establish seed banks for crops, livestock, and aquatic species to loan the means of production and act as a reserve in events of natural disasters.	Seed banks for crops, livestock, and aquatic species to loan the means of production across the entire country are established.
(9) Promote the improvement of crop/livestock varieties to accommodate the changes in climatic conditions and support farmers' access to these varieties.	Farmers in the risk areas are able to use the improved crop/livestock varieties effectively in their production processes.
(10) Develop a national food reserve system with effective distribution, and a plan to prevent shortages of raw materials in food industries when agricultural productivity is impacted by natural disasters.	A national food reserve system with an effective distribution mechanism is established.
(11) Support research and development to reduce food loss and food waste in the agricultural sector.	Research and development on technology to reduce food loss and food waste in agricultural products are available.

Guidelines/Measures	Output
(12) Support networks building for climate change adaptation in the agricultural sector to enable cooperation on early warnings, climate risk assessments, and exchanges of knowledge, technology, and agricultural innovation with linkages to the local context.	Cooperation networks on climate change adaptation are established with active early warning systems and exchanges of knowledge, technology, and innovation.
(13) Enhance farmers' awareness of climate change impacts on the agricultural sector and capacity building of farmers to adaptive and climate-risk management.	Farmers and all relevant stakeholders in the agricultural sector have access to the databases on local wisdom related to climate change impacts and adaptation.
(14) Develop research to assess climate change factors that may impact the agricultural sector (crop farming, livestock production, fishery, and aquaculture resources).	Research that shows the assessment of climate change factors that impact the agricultural sector that can be used to set systematic adaptation measures.

Responsible agencies of the agriculture and food security sector: MOAC, MHESI, and MNRE.



3) Tourism

Tourism is an important economic sector in Thailand. Climate change has a direct impact on tourism because the sector's several aspects, including nature-based, historical, and cultural tourism depend on specific climatic conditions. Natural tourist destinations often rely on vulnerable ecosystems, while cultural assets are at risk from current changes in climate variables and future climate change.

The more extreme trends of climate change may lead to shorter winters that are not as cold as expected, longer and hotter summers with the wet season remaining the same duration but with more frequent heavy rain, thus affecting the condition of tourism destinations, especially those with fragile ecosystems. Some plant species may not be able to withstand the changes in temperature and humidity. Some flowering species may not bloom in-season, and the affected tourism destinations could become less attractive or it would become more difficult to plan the visit. Changes in the amount and distribution of rainfall would alter the water volume of the waterfalls and could also limit activities, such as rafting, caving, and hiking. These changes could negatively affect tourist satisfaction and could limit future tourism activities. Fewer tourists would mean the tourism industry would become more at risk over loss of revenue, which 10.55% of Thailand's labor force are currently dependent on (based on 2021 information from International Labour Organization).

The ONEP conducted a study to project future climate risks and impacts on the tourism sector in Thailand focusing on natural and cultural tourism destinations. The study categorized the risk areas into three groups: flood risk, drought risk, and landslide risk. From the analysis, it was found that 736 tourist destinations were in drought risk areas. Most of them were located in the North, followed by the Central Plain, West, and the East, respectively. One hundred and sixty-nine tourist destinations were located in flood risk areas; most of them were in the Central Plain and the West, followed by the South and the Northeast, respectively.

National level climate modeling was done by the ONEP and its consultants in which heat stress, drought, and floods were modeled under the RCP4.5 and 8.5 scenarios. Several provinces in Thailand were listed vulnerable to a different degree under the model as shown in Table 3-3 and Figure 3-4 below. Several provinces affected are tourism hubs in the country. This could potentially impact the tourism sector negatively.

Table 3-3: Top 10 risk areas divided by climate scenarios during 2016-2035 for the tourism sector.

Risk for the Tourism Sector		Areas
Risk areas to heat stress	RCP 4.5	Trat, Bangkok, Phuket, Mukdahan, Surat Thani, Krabi, Satun, Prachuap Khiri Khan, Ubon Ratchathani, and Chon Buri.
	RCP 8.5	Trat, Bangkok, Phuket, Mukdahan, Surat Thani, Krabi, Satun, Prachuap Khiri Khan, Ubon Ratchathani, and Khon Kaen.
Risk areas to floods	RCP 4.5	Surat Thani, Chiang Mai, Trat, Bangkok, Phang-nga, Nakhon Si Thammarat, Tak, Chiang Rai, Phitsanulok, and Khon Kaen.
	RCP 8.5	Surat Thani, Chiang Mai, Bangkok, Nakhon Si Thammarat, Trat, Tak, Phang-nga, Prachuap Khiri Khan, Chon Buri, and Nakhon Ratchasima.
Risk areas to drought	RCP 4.5	Nakhon Ratchasima, Bangkok, Khon Kaen, Chaiyaphum, Roi et, Chiang Mai, Ubon Ratchathani, Chon Buri, Udon Thani, and Nakhon Sawan.
	RCP 8.5	Nakhon Ratchasima, Bangkok, Khon Kaen, Chiang Mai, Phuket, Nakhon Sawan, Roi Et, Sakon Nakhon, Udon Thani, and Chaiyaphum.

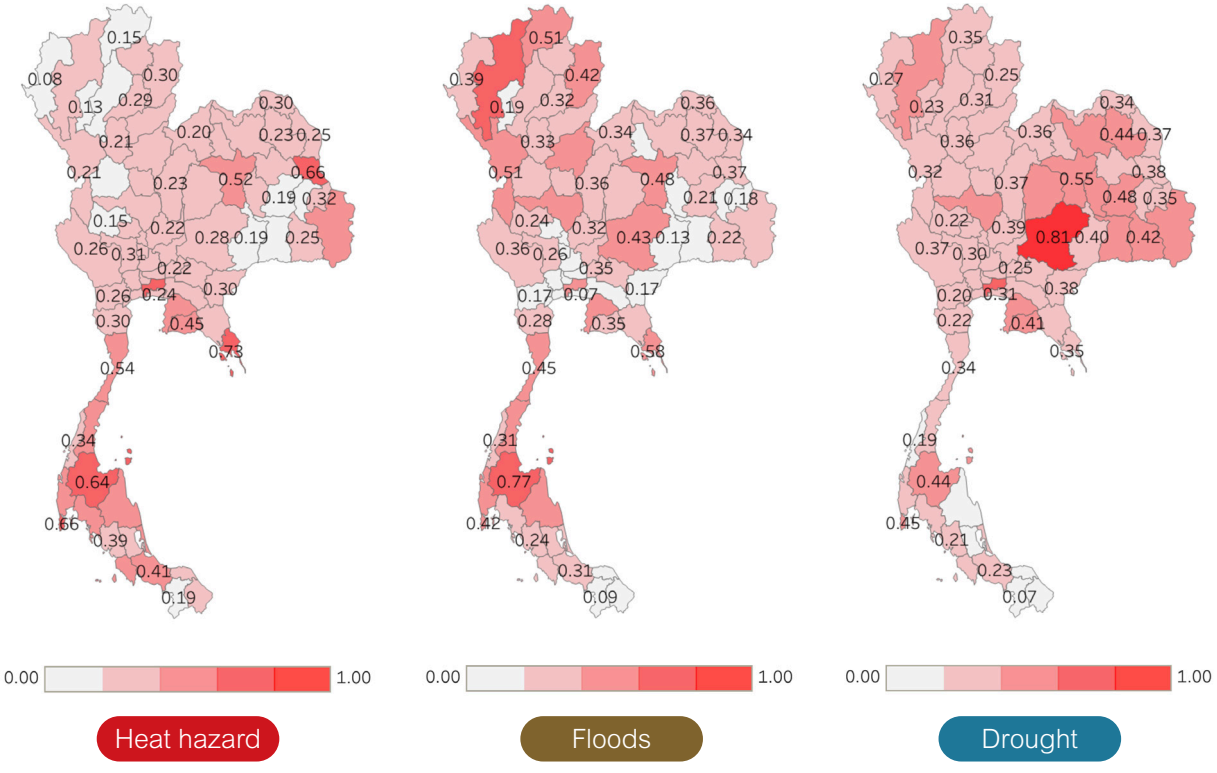


Figure 3-4: Risk areas for the tourism sector under the RCP4.5 with the focus on heat hazard, floods, and drought areas shown in the country map during 2016-2035. The darker color indicates more severely impacted areas.

Source: Office of Natural Resources and Environmental Policy and Planning (2021).

Adaptation action guidelines for tourism

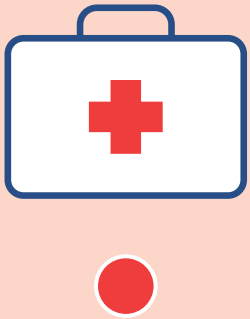
Climate adaptation guidelines for the tourism sector focus on risk management and the mitigation of damages on tourism caused by climate-related disasters and climate factors, development and promotion of tourism that would harmonize with the changing climate, and capacity-building for the relevant sectors to adapt to the climate impacts in the tourism destinations and in tourism policymaking. Climate adaptation guidelines for tourism were categorized based on the types of the tourism destinations and activities. The three categories were: 1) Management of natural tourism destinations, 2) Management of man-made tourism destinations, and 3) Supporting mechanisms for tourism. The details of each measure are as follows:

Guidelines/Measures	Output
Guideline 1: Management of natural tourism destinations	
(1) Adjust the tourism calendar to correspond to the changing seasonal pattern.	Improved tourism calendars consistent with the changing seasonal pattern in place for the tourism destinations.
(2) Develop tourism styles that take into account the carrying capacity in relation to the changing climatic conditions in the risk areas.	Tourism plans that take into account the physical carrying capacity developed for destinations in risk areas, and are effectively implemented to control the number of tourists in accordance with the carrying capacity.
(3) Develop and reserve additional water sources for natural tourism destinations in drought risk areas by taking into account ecosystem-based approaches.	Tourism destinations in drought risk areas have water reserve systems to ensure service during drought.
(4) Additional measures to manage marine tourism destinations impacted by climate change.	Marine tourism destinations in areas at risk of ocean temperature rise have effective measures for response and for natural recovery of the tourism destinations.
(5) Develop natural disaster response plans.	Disaster response plans that cover refuge, evacuation, food and water reserves, and back-up power are developed.

Guidelines/Measures	Output
Guideline 2: Management of art and culture tourism destinations	
(1) Develop tourism infrastructure and flood prevention systems of art and culture tourism destinations in risk areas.	Art and culture tourism destinations in flood risk areas have effective infrastructure and flood prevention systems.
(2) Develop additional measures to prevent the decay of valuable art structures and architecture from temperature change, humidity, and atmospheric CO_2 levels.	Measures to protect valuable art structures and architecture from the impacts of temperature change, humidity, and atmospheric CO_2 are implemented at tourism destinations in at-risk areas.
(3) Develop additional measures to prevent structural damage of valuable art structures and architecture at risk from climate-related damage and disasters.	Measures to protect valuable art structures and architecture from the impacts of climate-related disasters are implemented at tourism destinations in at-risk areas.
Guideline 3: Supporting mechanisms for tourism	
(1) Produce a risk and impact assessment of climate change on tourism destinations, as well as risk maps.	Risk and impact data are presented to the tourism destinations with climate change risk maps being available.
(2) Develop or improve the infrastructure of tourism destinations to alleviate and mitigate the impacts of extreme heat as appropriate for that area.	Tourism destinations at risk of extreme heat have sufficient resting points and relevant measures are implemented.
(3) Integrate tourism climate change adaptation plans into the community and LAO plans.	Localities in risk areas have climate change adaptation plans for tourism that are integrated into local plans with appropriate tourism models for the local context and can effectively respond to climate change.
(4) Develop and diversify activities in tourism destinations with high potential in order to build resilience and minimize the impacts of climate change.	The number of tourists choosing alternative options, which reduce the pressures on natural resources and climatic conditions specific to the areas is increased, and the economic value of climate-resilient tourism increases.
(5) Strengthen communities' and LAOs' capacity to manage diverse climate resilient tourism activities.	Tourism entrepreneurs, communities, and LAOs in risk areas have the capacity to respond to climate risks for tourism, and identify climate resilient tourism activities that are appropriate for the local context.

Guidelines/Measures	Output
(6) Support tourism business entrepreneurs in developing business continuity plans (BCP).	Tourism entrepreneurs have a BCP that incorporates climate risk assessment.
(7) Build tourism-related disaster surveillance and early warning systems that are fully connected and integrated with other warning systems and create networks in response to climate change.	A tourism-based warning and reporting system that fully integrates and connects to other relevant warning systems is fully operational. Local tourism entrepreneurs have appropriate climate change tourism plans, and tourists are updated on the situation of each tourism destination to help them make their decisions.
(8) Raise awareness and educate tourists about climate risks and the vulnerabilities of tourism destinations.	A manual and bodies of knowledge for tourists are developed and publicized to tourists.

Responsible agencies of the tourism sector: MOTS, MOI, and MNRE.



4) Public Health

Ecosystems change as a result of climate change that could lead to direct and indirect health impacts, such as respiratory diseases, cardiovascular diseases, food-and-water-borne diseases, heat-related illnesses, malnutrition, and mental health issues. The scenarios of illness and death caused by climate change in Thailand have been described as follows:

1) Injuries and deaths from natural disasters - Climate change is a cause of many natural disasters, including floods, storms, and drought. These natural disasters have become more extreme, thus causing damages to life (injuries and deaths) and property. Moreover, they affect the economy, society, and environment, as well as public utilities and public health services. In 2015, over 15 public health facilities in drought areas experienced water shortages, consequently negatively impacting the services provided to the people in the area. Furthermore, climate change causes a rise in the sea level, which can affect public health services, especially in flood areas, areas below sea level, and areas facing coastal erosion. It is estimated that more than 2.5 million Thais would be affected annually by the rise of the sea level in 2030 if business proceeds as usual.

2) Impacts of high temperature - With temperatures increasing every year, the heat situation in Thailand from past to present is on an upward trend. During 2016-2023, the average maximum temperature was 43.5ºC (Thai Meteorological Department, 2023). Heat-related illness cases usually peak in the summer from March to May affecting the working-age population the most as a result of outdoor work. Professions with the highest morbidity were farmers followed by labor for hire, and military draftees. Although heat-related illness cases in Thailand have shown a decreasing trend during 2013-2022, morbidity was 2.43-0.2 (Health Data Center, Ministry of Public Health, 2023), and mortality rates during 2018-2022 also declined (Department of Disease Control, 2023). Future risk estimates show that if GHG emissions continue to rise, the mortality rates in the elderly would be within 14,000 persons in 2050 and 2080, respectively when compared to the number of deaths in 1961 (WHO, 2015).

3) Vector-borne diseases - Vector-borne diseases in Thailand from 2012-2021 showed that the morbidity and mortality from dengue fever had decreased, peaking in 2013 and the highest death toll from dengue fever was in the Northern region, followed by the Central Plain (excluding Bangkok), the Northeastern region, and the Southern region, respectively. The morbidity and mortality from malaria decreased from 2012-2021. Most cases of malaria were found in the Northern region, followed by the Central Plain (excluding Bangkok), and Southern region (Strategy and Planning Division, Ministry of Public Health, 2023).

4) Food- and water-borne diseases - Regarding food- and water-borne diseases, such as diarrhea, in a 10-year period (2012-2021), it was found that the morbidity of these diseases had decreased but peaking in 2015, with the exception of diarrhea which had increased during 2012-2015, but decreased in 2015-2021. The mortality rate of diarrhea increased during 2012-2021, and most cases of diarrhea were in the Northeastern region, Central Plain (excluding Bangkok), and Northern region, respectively (Strategy and Planning Division, Ministry of Public Health, 2023).

5) Respiratory diseases - The morbidity rate of respiratory diseases between 2012-2021 decreased, while the mortality rate of respiratory diseases from 2012-2021 had increased (Strategy and Planning Division, Ministry of Public Health, 2023).

6) Malnutrition - The morbidity rate for malnutrition between 2012-2015 peaked in 2015 and decreased during 2015-2018 and increased again during 2018-2021, while death from malnutrition increased from 2012-2023, peaking in 2019, and stabilized during 2019-2021 (Strategy and Planning Division, Ministry of Public Health, 2023).

From the data above, illnesses and deaths from all six key diseases were related to climate change either directly or indirectly. This could result in increased costs to public health, healthcare, and economic loss. Thailand currently has one of the highest overall health costs in Asia with 19.82% of household health expenses and 20.18% of government health expenditure. Many agencies at the national, regional, and global levels are thus working to develop policies and measures to mitigate and prevent future climate impacts in relation to health. Areas that have been identified as having high health risks and vulnerabilities from floods are Bangkok, the Upper Central Plain, Northeastern region, and the Southern region. In the case of drought, it was found that areas with high health risks and vulnerabilities were Bangkok, the Northern region, Central Plain, the Western region, as well as most areas in the Northeastern region.

National level climate modeling was done by the ONEP and its consultants, in which heat stress, drought, and floods were modeled under the RCP4.5 and 8.5 scenarios. Several provinces in Thailand were listed vulnerable to a different degree under the model as shown in Table 3-4 and Figure 3-5 below.

Table 3-4: Top 10 risk areas divided by climate scenarios during 2016-2035 for the public health sector.

Risk for the Public Health Sector		Areas
Risk areas to heat stress	RCP 4.5	Bangkok, Nakhon Ratchasima, Ubon Ratchathani, Buri Ram, Khon Kaen, Si Sa Ket, Surin, Nakhon Si Thammarat, Roi Et, and Kalasin.
	RCP 8.5	Bangkok, Ubon Ratchathani, Nakhon Ratchasima, Buri Ram, Si Sa Ket, Khon Kaen, Nakhon Si Thammarat, Surin, Songkhla, and Roi Et.
Risk areas to floods	RCP 4.5	Bangkok, Nakhon Ratchasima, Ubon Ratchathani, Nakhon Sawan, Chiang Mai, Khon Kaen, Chiang Rai, Chaiyaphum, Buri Ram, and Phitsanulok.
	RCP 8.5	Bangkok, Nakhon Ratchasima, Ubon Ratchathani, Nakhon Sawan, Buri Ram, Chiang Mai, Khon Kaen, Chaiyaphum, Kalasin, and Nakhon Si Thammarat.
Risk areas to drought	RCP 4.5	Bangkok, Nakhon Ratchasima, Ubon Ratchathani, Khon Kaen, Buri Ram, Si Sa Ket, Roi Et, Surin, Maha Sarakham, and Chaiyaphum.
	RCP 8.5	Bangkok, Nakhon Ratchasima, Ubon Ratchathani, Khon Kaen, Roi Et, Buri Ram, Maha Sarakham, Udon Thani, Si Sa Ket, and Surin.

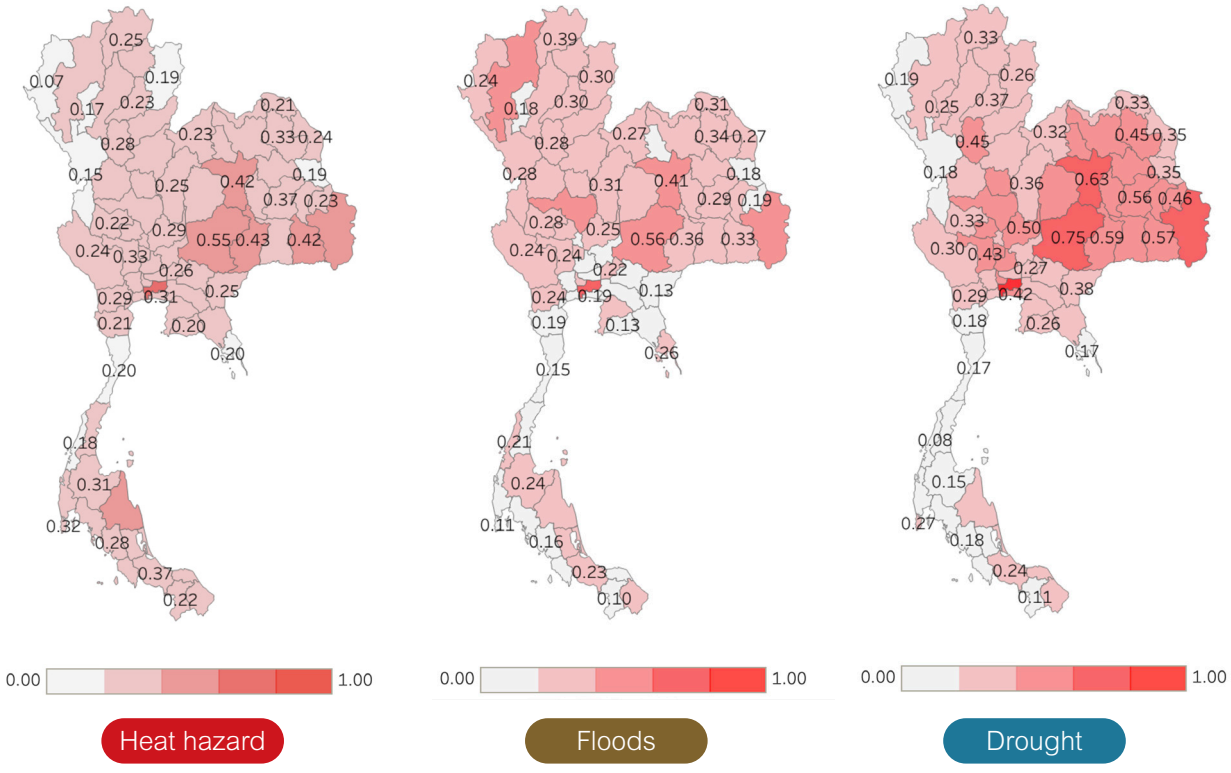


Figure 3-5: Risk areas for the public health sector under the RCP4.5 with a focus on Heat hazard, floods, and drought areas shown in the country map during 2016-2035. The darker color indicates more severely impacted areas.

Source: Office of Natural Resources and Environmental Policy and Planning (2021).

Guidelines and measures for public health

Climate adaptation guidelines for public health were based on the principles of categorizing direct and indirect climate change related health risks in key diseases consisting of respiratory diseases, vector-borne diseases (dengue fever and malaria), heat-related diseases, illnesses from flood and drought, and health impacts caused by the lack of water and food. This would focus on health-risk populations; namely, children, the elderly, pregnant women, patients with chronic conditions, farmers and laborers, and the underprivileged. The guidelines can be categorized and detailed as follows:

Guidelines/Measures	Output
Guideline 1: Preventing climate change health impacts	
(1) Strengthen the capacity to protect and provide healthcare to health-risk groups.	Healthcare facilities at all levels comply to the healthcare standard. Reduce the morbidity rate in climate change related health-risk groups.
(2) Improve the standard of medical and public health services in response to climate change.	Healthcare facilities at all levels comply to the healthcare standard. Establishment/enhancement of healthcare systems to cover both care and protection from climate change related health impacts.
(3) Strengthen the capacity of the general public by creating knowledge, understanding, and awareness on climate change related health impacts, and promote public participation in proper climate change adaptation and management.	The public has knowledge, health literacy, and can prevent and practice self-care for climate change related diseases.
Guideline 2: Supporting mechanisms for public health	
(1) Develop surveillance and forecast systems for climate change related health impacts.	National, regional, and provincial climate change related surveillance and forecast systems, health-risk maps, and warning mechanisms to report the situation and provide health information regarding morbidity and mortality as a result of climate change and how to resolve such issues are developed.

Guidelines/Measures	Output
(2) Improve the quality and effectiveness of the health insurance system to cover all groups of the population with climate-related risks and sensitivity.	Improved criteria of the health insurance system to cover people with climate-related risks and sensitivity, and effective access to public health services for these groups of people.
(3) Develop research, knowledge, technology, and innovation to reduce and manage health-related risks from climate change.	Medical innovation and products. which can be used to reduce and manage health risks from climate change have increased.
(4) Develop model hospitals on reducing and managing health risks related to climate change at the local level.	Model hospitals in risk areas are able to manage health risks related to climate change effectively and according to the standard.
(5) Develop standards for emergency responses in the event of climate change related public health problems.	Healthcare facilities at all levels comply to emergency response standards to prevent climate change related health impacts, referrals, and transfers.
(6) Strengthen the capacity of public health officials at all levels on pro-active responses to climate change.	The capacity of public health officials at all levels, including public health volunteers, are strengthened with the skills to pro-actively address health problems related to climate change.
(7) Develop cooperation mechanisms among all sectors inside and outside the public health system to prevent and reduce health impacts from climate change.	Cooperation networks among government agencies, academic institutions, local authorities, and the public that are integrated with exchanges of information on surveillance and preparedness for health risks related to climate change are established.
(8) Improve the public health station infrastructure to respond to climate change, especially in risk-areas.	Healthcare facilities in climate change risk areas are designed to be more resilient to climate change.

Responsible agencies of the public health sector: MOPH, MHESI, and MOI.

5) Natural Resources Management

Climate change heavily impacts the natural resource management sector in Thailand. Climate is a key factor in the life cycle of flora and fauna ranging from their ability to reproduce, and their migratory pattern to parameters that allow them to live and flourish at different locations, ecosystems, and elevations. Changes in the climate, such as temperature, and rainfall pattern and availability affect all organisms in the ecosystem. The changes may cause a decrease in certain species or push some species to extinction if they cannot adapt to the changes. Climate change could also act as a catalyst that could intensify other existing pressures, such as overharvesting or habitat loss. Moreover, climate change could affect the biogeochemical cycle that would produce and transfer energy within the ecosystem by creating the potential for feedback that would alter both the warming and cooling processes in the future. For example, as soils warm, the rate of decomposition would increase, thus adding more CO_2 to the atmosphere. In addition, both climate and biogeochemistry interact strongly with environmental and ecological concerns, such as biodiversity loss, freshwater and marine eutrophication, air pollution, human health, food security, and water resources.

Biodiversity in natural ecosystems is essential to the environment, economy, livelihood, and culture in the Thai context. This would be rapidly threatened by temperature increases between 1.0-3.5ºC and in the next 100 years would change the current climate parameters in each climate zone, which would also include zones covering Thailand. The composition and distribution of organisms in the natural ecosystems would change in response to new conditions. Climate change along with other existing pressures, such as deforestation, other environmental and human pressures, change of humidity, and loss of the groundwater table would affect the types and growth of various flora and fauna. Plant and animal species that failed to adapt in time could become extinct, consequently resulting in an irreversible loss to biodiversity. Each species has a different capacity to adapt to the changing environment. These different capacities could lead to loss of species and changes in ecosystem dynamics.

National level climate modeling was done by the ONEP and its consultants in which heat stress, drought, and floods were modeled under the RCP4.5 and 8.5 scenarios. Several provinces in Thailand were listed vulnerable to a different degree under the model in terms of its natural resource management as shown in Table 3-5 and Figure 3-6 below.

Table 3.5: Top 10 risk areas divided by the climate scenarios during 2016-2035 for the natural resources management sector.

Risk for the Natural Resource Management Sector		Areas
Risk areas to heat stress	RCP 4.5	Ubon Ratchathani, Chiang Mai, Tak, Lampang, Kanchanaburi, Chiang Rai, Mae Hong Son, Nakhon Ratchasima, Nan, and Phrae.
	RCP 8.5	Ubon Ratchathani, Chiang Mai, Tak, Kanchanaburi, Lampang, Chiang Rai, Mae Hong Son, Nakhon Ratchasima, Nan, and Phrae.
Risk areas to floods	RCP 4.5	Ubon Ratchathani, Nakhon Ratchasima, Udon Thani, Chiang Mai, Chaiyaphum, Khon Kaen, Si Sa Ket, Lampang, Sakon Nakhon, and Kanchanaburi.
	RCP 8.5	Ubon Ratchathani, Nakhon Ratchasima, Udon Thani, Chiang Mai, Sakon Nakhon, Lampang, Chaiyaphum, Khon Kaen, Kanchanaburi, and Si Sa Ket.
Risk areas to drought	RCP 4.5	Chiang Mai, Tak, Mae Hong Son, Nan, Chiang Rai, Lampang, Kanchanaburi, Ubon Ratchathani, Phrae, and Uttaradit.
	RCP 8.5	Chiang Mai, Tak, Mae Hong Son, Kanchanaburi, Nan, Lampang, Chiang Rai, Ubon Ratchathani, Phrae, and Phetchaburi.

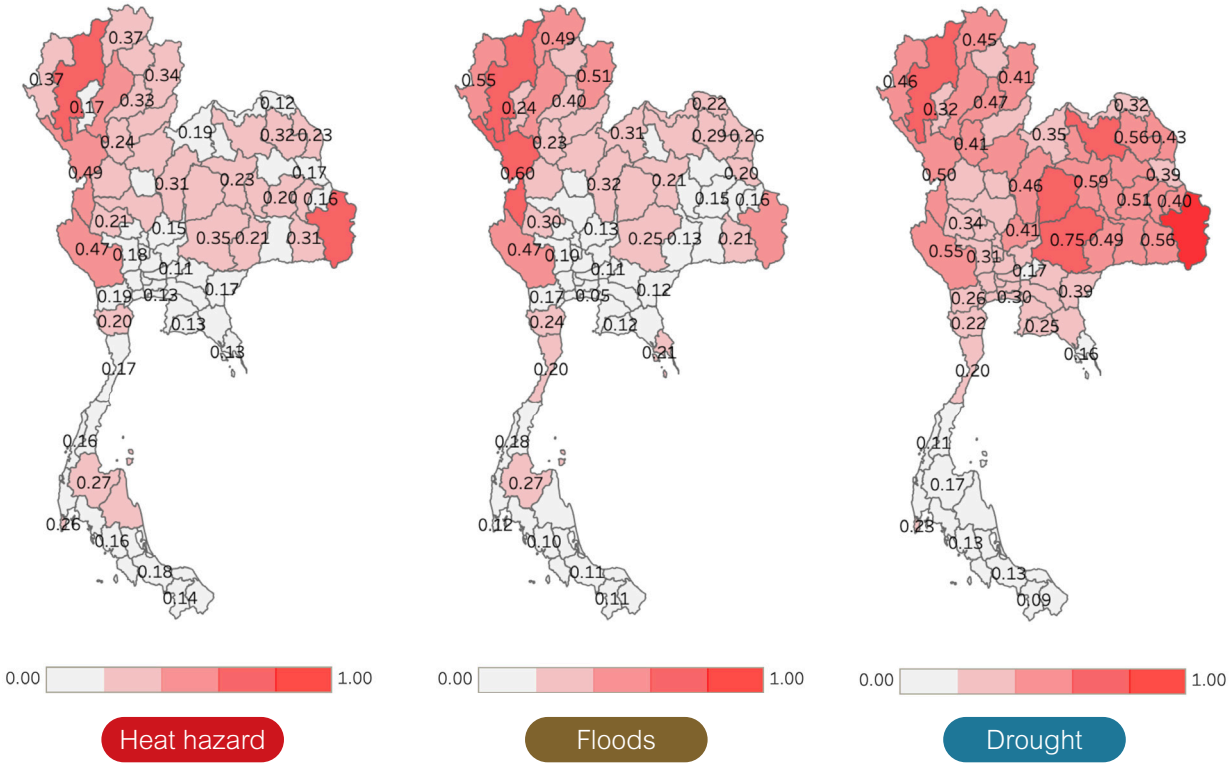


Figure 3-6: Risk areas for the natural resources sector under the RCP4.5 with a focus on Heat hazard, floods, and drought areas shown in the country map during 2016-2035. The darker color indicates more severely impacted areas.

Source: Office of Natural Resources and Environmental Policy and Planning (2021).

For the natural resources management sector, the impacts would be direct physical ones from the climate change on the natural resources as well as nonphysical impacts described as follows:

1) Impacts on plant species distribution: Plants in tropical rainforests have shallow root systems and leaves that are less resistant to drought than mixed deciduous forests. Therefore, changes in rainfall and rain distribution that result in heavy rain over a short period followed by prolonged drought and even a slight increase in temperature would cause rainforest plant species to be replaced by deciduous species. Deciduous plants, such as teak and ironwood, would spread further. However, it was found that future climate change would not have much of an impact on plant distribution in Southern Thailand because of its geography being a peninsula under the influences from both the Indian Ocean and Gulf of Thailand.

2) Impacts on wildlife: Climate change would have an impact on all groups of animals. For example, birds are sensitive to the effects of climate change, and this could be used as an indicator of changes in the climate by observing different behavior, such as migration, nesting, mating, singing, or suitable home range, for instance. Impacts on terrestrial wildlife would also be observed in amphibians as well as altitudinal distribution range shifts from changing climate causing some area to be not suitable for these species as habitat.

3) Impacts on wetland ecosystems - Changes in the climate factors could result in higher temperatures, increased or decreased rainfalls, greater chance of forest fires, and a rise in the sea level, which would affect the risks or vulnerability of wetland ecosystems that could change its structure and roles and species within such ecosystem, thus leading to biodiversity loss.

4) Impacts on marine and coastal resources: A rise in the sea level and increase in ocean temperature would be the relevant impacts of climate change on the oceans and coastal seas, consequently negatively impacting humans and coastal ecosystems. This would include changes in long-term averages or slow onset changes; for example, increased average sea level, ocean acidification, increased average ocean temperature, and short-term changes that would be usually related to meteorological phenomena.

The interactions between the natural resources, biodiversity, and climate change could occur in both directions. While natural resources and biodiversity could be threatened by climate change, proper management of natural resources and biodiversity could also create resilience to the impacts of climate change.

Guidelines and measures for the natural resources management sector

Guidelines for adaptation to climate change in the natural resources management sector would be divided according to the main ecosystems: 1) Terrestrial ecosystem management, 2) wetland ecosystem management, 3) marine and coastal ecosystem management, and 4) supporting mechanisms for the management of natural resources and biodiversity. The guidelines can be categorized and detailed as follows:

Guidelines/Measures	Output
Guideline 1: Management of terrestrial ecosystems	
(1) Conserve pristine protected areas through an ecosystem-based approach by creating ecological corridors and developing buffer zone management.	Buffer zone forests along the boundary of protected areas and ecological corridors in key forest clusters with increased significance of high biodiversity.
(2) Promote reforestation and afforestation with appropriate incentives, such as carbon credits in encroached areas, degraded watersheds, or vacant land outside natural forests, including private forests.	Encroached and degraded forests as well as vacant land outside the forests, including private forests, are rehabilitated to pristine conditions. The rehabilitation would increase the ecosystem's resilience to impact from climate change, while providing ecosystem services for adjacent communities.
(3) Establish criteria for coexistence between humans and forests using EbA and/or NbS.	Encroachment of highland communities and areas surrounding forests for monoculture farming decreases, and reciprocal farming and animal husbandry practices that promote sustainable coexistence with forest ecosystems are implemented.
(4) Support the conservation of endemic and endangered species in terrestrial ecosystems, especially carnivores, affected by climate change, as well as prevent invasive alien species, which could become widespread due to the changing climatic conditions.	Research on breeding rare or endangered species are available, and regulations and measures for conserving and protecting biodiversity resources in terrestrial ecosystems, especially threatened species, are in place.
(5) Establish forest fire prevention networks in risk areas with communities' participation by increasing their capacity on the prevention and control of forest fires.	Forest fire prevention networks are established with the capacity to manage and address the problem of forest fires and with surveillance, follow-up, and forecasting tools to manage risks at the local level.
Guideline 2: Management of wetlands	
(1) Expedite the designation of the environmentally protected areas (EPAs) in areas with fragile ecosystems and threats to biodiversity resources, which are outside the protected areas (PA).	Areas with fragile ecosystems and threats to biodiversity resources are designated as EPAs.
(2) Develop management plans for wetlands of international, national, and/or local significance.	Management plans for wetlands of international, national, and/or local significance are developed.

Guidelines/Measures	Output
(3) Develop and rehabilitate wetlands as water banks to slow and prevent flooding by using both natural and man-made wetlands without impacting the ecosystem and ecosystem services.	Wetlands are developed and rehabilitated into water banks to slow and prevent flooding.
(4) Strengthen the capacity for bog fire risk management.	Bog fire surveillance and prevention plan are created through a participatory approach with the cooperation of all sectors.
(5) Promote a cooperative network for the conservation, rehabilitation, and appropriate and sustainable use of wetlands.	Cooperative networks for the conservation, rehabilitation, and appropriate and sustainable use of wetlands are established.
(6) Advocate the proposal of Thailand's significant wetlands.	Wetlands are proposed as Ramsar sites and migratory bird network areas.
Guideline 3: Management of marine and coastal ecosystems	
(1) Conserve and protect marine and coastal resources, including increasing and rehabilitating mangrove areas for an ecological balance through a participatory approach.	Specific measures for the conservation and rehabilitation of marine and coastal resources in each marine and coastal community are developed with public participation, and integrated into the strategic plan of the area with effective implementation.
(2) Support the conservation of endemic and endangered species in marine and coastal ecosystems affected by climate change, as well as prevent invasive alien species, which could become widespread due to the changing climatic conditions.	Research on breeding rare or endangered species are available, and regulations and measures for conserving and protecting biodiversity resources in marine and coastal ecosystems, especially threatened species, are in place.
(3) Expedite the designation of the EPAs in marine and coastal areas with fragile ecosystems and threats to biodiversity resources, which are outside the PAs.	Marine and coastal areas with fragile ecosystems and threats to biodiversity resources are designated as EPAs.
(4) Assessment of Thailand's Ocean Health Index and development of surveillance and monitoring systems for changes to seawater as a result of climate change factors.	Surveillance and monitoring systems for changes to seawater as a result of climate change factors are developed.

Guidelines/Measures	Output
(5) Prepare an integrated plan for coastal zone management across the country to reduce the impact of coastal erosion through a participatory approach.	Integrated plans for coastal zone management are developed comprising protection, restoration, or rehabilitation measures of coastal areas across the country, and mainstreamed into the area-based strategic plan in each locality with effective implementation.
(6) Strengthen the capacity of coastal areas to respond to and prevent the impact of storm surges.	Plans to mitigate the impact, establish evacuation routes in the event of storm surges in coastal areas are developed, and response manuals and drills are produced and conducted.
(7) Enable networks of people organizations, community-based organizations, and LAOs along the coastal zones to conserve and rehabilitate marine and coastal resources.	Networks of people organizations, community-based organizations, and LAOs collaborate to develop measures on nature-based coastal restoration and participate in regulating the utilization of mangrove areas.
Guideline 4: Supporting mechanisms for natural resources management and biodiversity	
(1) Develop biological indicators of different ecosystems to cover all risk areas across the country.	Biological indicators of different ecosystems are developed to cover all risk areas across the country.
(2) Develop a complete version of Thailand's Red List Index.	Thailand's Red List Index is completed.
(3) Build networks for the monitoring and evaluation of biological indicators.	Local communities have the capacity to apply the monitoring and evaluation system of biological indicators of different ecosystems as part of their daily life.
(4) Increase the designated protected areas to support the migration of migratory species vulnerable to climate change.	More areas are designated as protected areas to increase the capacity for supporting migratory species vulnerable to climate change.
(5) Promote research on the impact of climate change on different ecosystems, including plant and animal species.	Research and bodies of knowledge on climate-related impacts on ecosystems, including plants and animal species are developed.
(6) Develop mechanisms to promote the role of ecologically friendly communities in preserving and conserving natural resources and ecosystems.	Suitable mechanisms are developed to promote the role of ecologically friendly communities in risk areas in the preservation and conservation of natural resources, ecosystems, and biodiversity.

Guidelines/Measures	Output
(7) Promote and enable communities with ecologically friendly livelihoods or "eco-villages" to be able to maintain their way of life in harmony with nature, and support communities' roles in natural resource protection.	Communities in risk areas have mechanisms to utilize natural resources sustainably, which are based on local beliefs, wisdom, and practices with the capacity to protect the natural resources and to live in harmony with nature.
(8) Encourage collaboration with the private sector and the general public on preserving and conserving natural resources and biodiversity through corporate social responsibility (CSR).	The roles of the private sector and general public in preserving and conserving natural resources and biodiversity in collaboration with the government agencies or local authorities are augmented.
(9) Build knowledge and understanding on the impact of climate change and enhance the adaptive capacity of all stakeholders through EbA and/or Nbs in natural resources management and sustainable use of biodiversity and ecosystem services approaches.	Training modules to build knowledge and develop the capacity of all stakeholders in natural resources management under climate change conditions by using the EbA and/or Nbs approach are developed and implemented.

Responsible agencies of the natural resources management sector: MNRE, MHESI, and MOI.

6) Human Settlements and Security

Human settlements in the past took great consideration of the climatic and natural imperatives. The settlements needed to synchronize with the geographical, climatic, and ecological characteristics of each location. Differences in the physical locations also contributed to different ways of life and cultural practices with diverse learning processes to manage and adapt to the changing climatic conditions. However, as social and economic systems changed, technological developments and economic activities have made human societies and settlements more secure. This has resulted in the climate-conscious settlement considerations used in the past have become less of a priority with modern engineering and management methods that have allowed communities to continue while managing the risks. As climate change would have an increasingly severe impact on human settlements in the future, climate factors would need to be taken more into account in the development policies and planning related to human settlements.

Bangkok and its surrounding environs are the center of national development with the highest population density and the most important economic clusters (besides agricultural activities). The settlements and development direction of Bangkok and its surrounding environs have been expanding to connect with the eastern part of the country, which is in accordance with the direction of the industrial and tourism expansion.

Other major cities in the provinces with a population of about one million up are distributed in different regions of Thailand. Most of these large cities are located along the major rivers of the country. Overall, areas with key development and significant functions in Thailand are clustered in the flood plains, along the major rivers, and along the coasts, especially in Greater Bangkok and the connecting coastal zones in the provinces in the East, as well as in the main cities in other regions. These areas are exposed to high disaster risks from the changing climatic conditions, including floods caused by the changing patterns and intensity of rainfall, rise of the sea level, drought, and the increasing heat index. According to a study by the ONEP in 2016, the impact of climate change on human settlements in Thailand are projected as follows:

Flood disasters or flood situations: The projection under the two scenarios have indicated that areas with high flood risks are most of the areas in the Central Plain and the flood plains in the Lower North, especially along the Yom, Nan, and Chao Phraya Rivers. Areas with moderate flood risks are scattered along the major rivers, particularly in the East and some parts of the North, and in the coastal areas, especially on the Gulf of Thailand side in the South and the East. The changing amount and intensity of rainfall as well as the rise in the sea level would expose these areas to increasing flood situations, stagnant floods in low-lying areas from continuous heavy rain, and coastal erosion. Areas with settlement density in Thailand are along the rivers and the coasts; hence, all of them face high flood risks due to climate change. Simultaneously, the flood situations in Bangkok and its surrounding environs as well as in the eastern and the southern coasts would be more intense coupled with the impact from the rise in the sea level.

Heat situations: It is projected that, overall, most of the areas in the country would be moderately hotter, while the mountainous areas would have lower heat risks. When examining in more detail at the provincial level, it was found that the heat situations tended to become more intensified in the future in the areas in the Central Plains and in the North, which already have a high heat index at the present time. The analysis also showed that there would be a wider expansion of areas with a high heat index covering almost all areas in the Central Plains and the South, as well as most of the areas in the North and some areas in the East. In addition, it indicated that the difference between the current heat index in the North and its future heat index was very high, which means that the North would likely be critically impacted by climate change in terms of heat.

National level climate modeling was done by the ONEP and its consultants in which heat stress, drought, and floods were modeled under the RCP4.5 and 8.5 scenarios. Several provinces in Thailand were listed vulnerable to a different degree under the model as shown in Table 3-6 and Figure 3-7below.

Table 3-6: Top 10 risk areas divided by climate scenarios during 2016-2035 for the human settlement and security sector.

Risk for Human Settlement and Security Sector		Areas
Risk areas to heat stress	RCP 4.5	Bangkok, Nakhon Ratchasima, Samut Prakan, Buri Ram, Chon Buri, Ubon Ratchathani, Songkhla, Nonthaburi, Surin, and Phuket.
	RCP 8.5	Bangkok, Nakhon Ratchasima, Samut Prakan, Buri Ram, Chon Buri, Ubon Ratchathani, Songkhla, Surin, Phuket, and Nonthaburi.
Risk areas to floods	RCP 4.5	Bangkok, Nakhon Ratchasima, Chiang Mai, Nakhon Si Thammarat, Chiang Rai, Nakhon Sawan, Kamphaeng Phet, Phitsanulok, Khon Kaen, and Phra Nakhon Si Ayutthaya.
	RCP 8.5	Bangkok, Nakhon Ratchasima, Khon Kaen, Nakhon Si Thammarat, Chiang Mai, Samut Prakan, Phra Nakhon Si Ayutthaya, Kamphaeng Phet, Songkhla, Nakhon Sawan, and Nakhon Nayok.
Risk areas to drought	RCP 4.5	Bangkok, Nakhon Ratchasima, Khon Kaen, Samut Prakan, Ubon Ratchathani, Roi Et, Buri Ram, Surin, Chaiyaphum, and Udon Thani.
	RCP 8.5	Bangkok, Nakhon Ratchasima, Khon Kaen, Roi Et, Samut Prakan, Ubon Ratchathani, Udon Thani, Buri Ram, Maha Sarakham, and Surin.

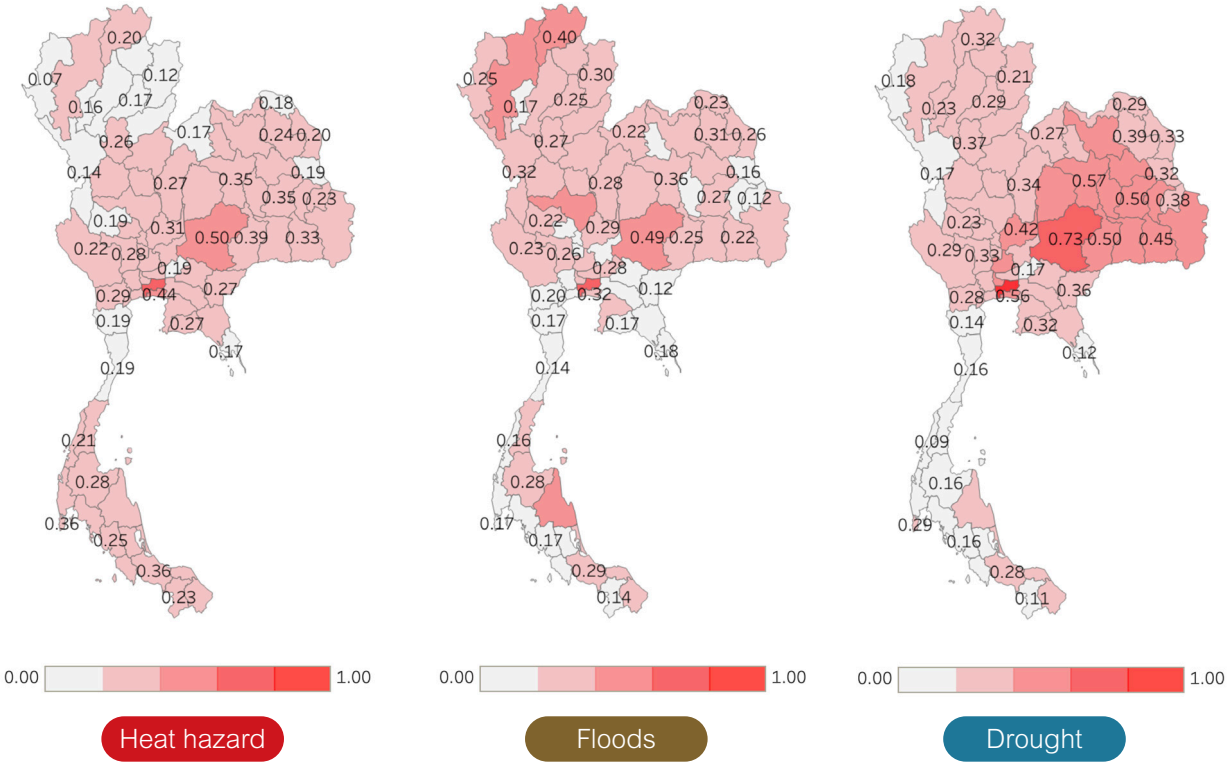


Figure 3-7: Risk areas for the human settlements and security sector under the RCP4.5 with a focus on heat hazard, floods, and drought areas shown in the country map during 2016-2035. The darker color indicates more severely impacted areas.

Source: Office of Natural Resources and Environmental Policy and Planning (2021).

Guidelines and measures for human settlement and security

Climate adaptation guidelines for human settlements and security would focus on mitigating risks and damages from climate-related disasters, as well as strengthening the preparedness and adaptive capacity of individuals, communities, and cities. The guidelines can be categorized and detailed as follows:

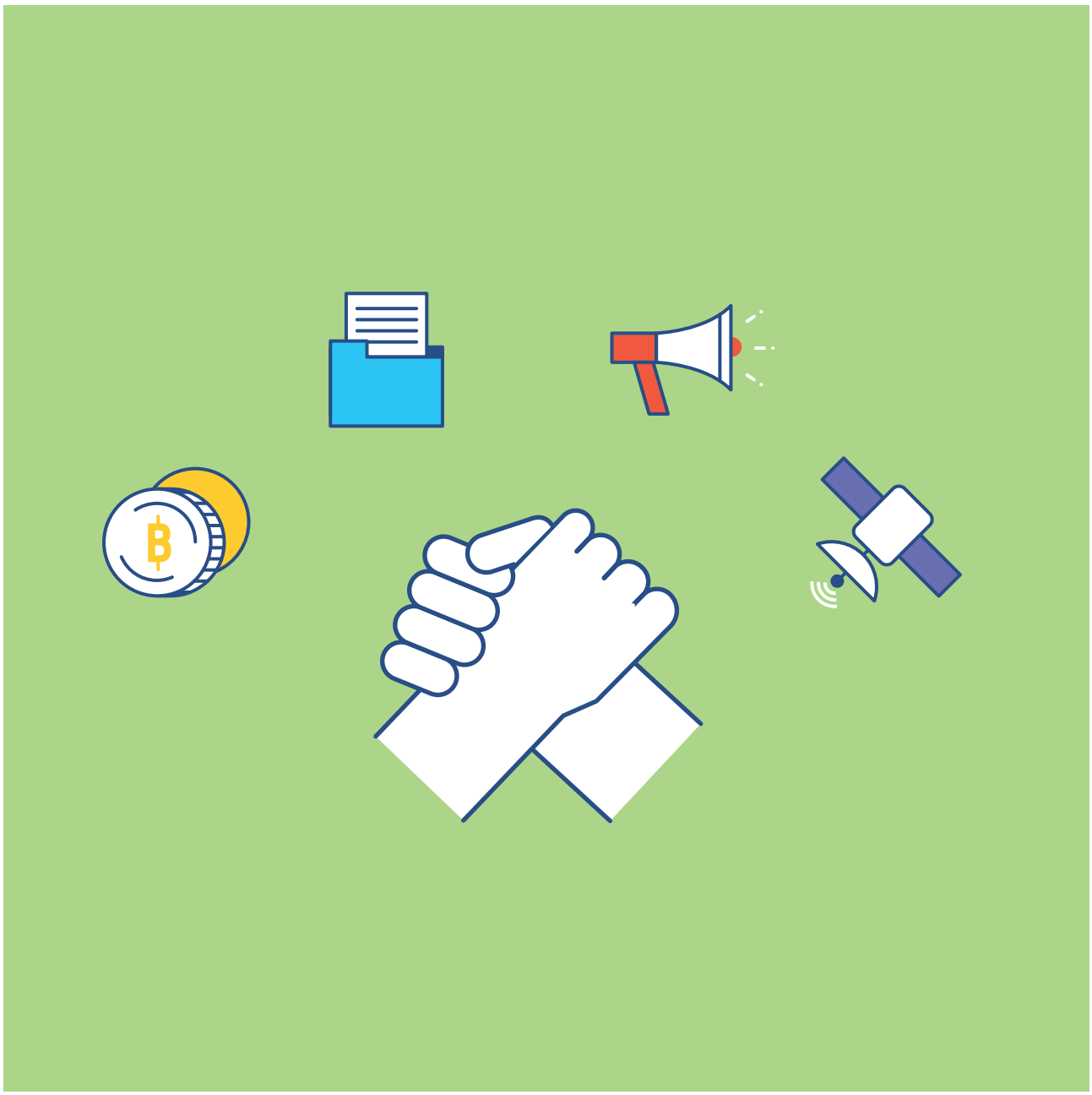
Guidelines/Measures	Output
Guideline 1: Management of metropolitan and large cities	
(1) Develop the essential infrastructure with alternatives to prepare for emergencies caused by natural disasters, and develop emergency response plans through a participatory approach in all risk areas, as well as disseminate the information to the general public, so that they would be aware and able to take action.	Metropolitan and large cities have the essential infrastructure and risk reduction plans to respond to emergencies caused by climate change related natural disasters.
(2) Advocate for town planning regulations or building control laws in potential climate change impact areas to ensure that built structures are stable, secure, and appropriately designed to enhance climate resilience.	Metropolitan and large cities have regulations for specific town planning or building control laws that integrate climate resilience criteria.
(3) Support mixed use developments to encourage non-reliance on long-distance transport.	Metropolitan and large cities have regulations for mixed used development plans.
(4) Develop additional green multi-use spaces that are connected within the city as well as to nearby areas to mitigate the climate-related impact.	Metropolitan and large cities have sufficient green multi-use spaces for their urban population.
(5) Coordinate and prepare backup plans for systems essential for survival during climate-related emergencies or crises.	Backup plans for systems essential for survival at the local level during climate-related emergencies or crises are developed.
(6) Strengthen the capacity of the business and industrial sectors in preparing for and managing the climate change impact and risks through a participatory approach for evaluating the effectiveness of various adaptation options to suit the context of the respective business and industry.	Adaptation options are assessed to find those suitable for each business and industry through a participatory approach.

Guidelines/Measures	Output
(7) Set guidelines for responding to the impact of increased temperature or urban heat islands, especially in large cities.	Guidelines for responding to the impact on urban heat islands in large cities are developed.
Guideline 2: Management of medium and small cities and communities	
(1) Expedite the integration of climate change adaptation issues into development plans and strategies for cities, communities, and local authorities by taking into consideration the climate change conditions and providing adaptation options, which would combine nature-based solutions, local wisdom, and modern technology, and correspond with the communities' way of life in each locality.	Climate change adaptation issues are integrated into development plans and strategies for cities, communities, and local areas in all risk areas.
(2) Develop specific town plans with the objective of climate change adaptation, including regulations for specific town plans and/or building control laws in potential climate change impact areas.	Regulations and/or building control laws for specific town plans in potential climate change impact areas are established.
(3) Adapt land use to be aligned with climate change, and determine the appropriate direction for urban and infrastructure development, such as polycentric cities in cases where existing development is in climate change risk-areas.	Cities, communities, and localities integrate climate change responses and adaptation into land use plans and infrastructure development.
(4) Develop land use plans that preserve areas of high environmental/ecosystem value, including agricultural land, water resources, and green spaces to sustain ecosystems and address floods and drought.	Cities, communities, and localities have land use plans that preserve valuable environmental/ ecosystem areas, agricultural land, water resources, and green spaces.
(5) Develop local disaster prevention and mitigation plans that are connected to national level disaster prevention and mitigation plans, including coordination of government agencies in disaster prevention and mitigation, as well as strengthening the adaptive capacity through exchanging lessons learned between local agencies facing similar issues, for instance.	Cities, communities, and localities have local disaster prevention and mitigation plans connected to national level disaster prevention and mitigation plans.

Guidelines/Measures	Output
(6) Strengthen the capacity of coastal urban areas and communities in the prevention and surveillance of the rise in the sea level through a participatory approach with all the relevant sectors by designating and categorizing areas impacted by the rise in the sea level by severity and urgency or future trends to be used as a guideline for prevention measures or rehabilitation of each type of area.	Integrated plan for coastal urban area and community management, and prevention measures and surveillance are developed to cover all of Thailand's coastal areas.
(7) Create up-to-date information networks, and establish clear roles and practices for quick and efficient community warning and communication reaching all populations, especially risk groups, such as the elderly, low-income groups, and rural communities, for instance.	Networks of climate change related disaster communication and warning to the public and risk groups are established.
(8) Develop backup systems for households and communities in risk areas during seasons of risk, such as reserves of food and water sources, backup power, for instance.	Backup plans for survival during climate-related emergencies or crises are developed for households and communities.
Guideline 3: Supporting mechanisms for human settlements and security	
(1) Develop criteria and indicators to measure the progress of the adaptive capacity and climate resilience in the urban context.	Criteria and indicators are developed for urban climate resilience and adaptive capacity.
(2) Develop accurate, accessible, and up-to-date disaster warning and situation reporting mechanisms covering all types of cities to be comprehensively connected to other warning systems with full accessibility by all population groups.	Disaster warning systems and situation report mechanisms are established that cover all types of cities and enhance accessibility by all population groups.
(3) Expedite the integration of a climate-resilient building approach into the standards and regulations of building designs in the Building Control Act 1979 to be consistent with the changing climatic conditions and degrees of the severity of natural disasters in each area.	A climate-resilient building approach is integrated into the standards and regulations of building designs in the Building Control Act 1979.

Guidelines/Measures	Output
(4) Promote buildings with climate-resilient architecture and adaptive designs to create the flexibility of buildings to accommodate climate uncertainties and to enable communities to respond to natural disasters and climate change with approaches, which are more appropriate to the local context.	Research and development of buildings with climate-resilient architecture and adaptive design are disseminated to the general public for their application.
(5) Advocate for the regulation to undertake climate change benefit analysis (CCBA) in all mega projects under public investment to ensure that they are consistent with the present and future climatic conditions.	CCBA is conducted for all mega projects receiving public investment.
(6) Encourage the roles of the private sector in the responses and management of climate change related risks through financial mechanisms, such as supporting climate insurance businesses as an option for risk management by emphasizing the fairness, accessibility, and benefits for the groups of the population at risk; and providing low-interest loans or tax exemptions for projects related to climate change adaptation.	Criteria and guidelines on financial mechanisms to support the private sector to have roles in the responses and management of climate change related risks are developed.
(7) Strengthen the capacity and awareness of the public by mainstreaming the knowledge and understanding of climate change risk management and responses in basic education.	The general public has knowledge and understanding of climate change risk management and responses.
(8) Enable low-income population and population at-risk to have fair access to various forms of support, such as funding for climate change adaptation and climate risk insurance systems, when affected by climate change.	Low-income population and population at-risk can get access to various forms of support mechanisms that are fair when affected by climate change.

Responsible agencies of the human settlement and security sector: MOI, MNRE, MSDHS and MHESI.



CHAPTER 4

ENABLING CONDITION

4.1 Cross-cutting Issues

To achieve the goals of the Thailand's NAP, not only sectoral measures are to be implemented, but various cross-cutting measures are also required to ensure synergistic and integrated planning approaches. These measures would include the development of databases, research, and technology on climate change adaptation, development of supporting mechanisms, such as regulations, finance, capacity building and incentives, and enhancement of the capacity, knowledge, and awareness of the officials and relevant stakeholders in all sectors, such as youth and the business community to understand the risk and impact of climate change and be capable of undertaking adaptation actions.

OPERATIONAL GUIDELINES AND MEASURES

Guidelines/Measures	Outputs/Targets
Guideline 1: Databases, research, and technology development and transfer	
(1) Undertake research related to climate change adaptation in the six key sectors and sub-sectors, in areas, such as climate change impact assessment, identification of risk areas, loss and damage assessment, and monitoring and evaluation of climate change adaptation actions by the sector and cross-sector.	Availability and applicability of research on climate change adaptation to effectively support the development of guidelines/ measures on climate change adaptation management and impact assessment.
(2) Harmonize the standard of all climate change research databases and promote the exchanges of data and information among domestic and international agencies, including through establishing coordination mechanisms.	Harmonized and coordinated climate change research databases among domestic and international agencies.
(3) Promote networking of academia to exchange and develop knowledge on climate change and between academic communities and sectoral agencies to ensure a translation and communication of research knowledge into policy development and practices and vice versa.	Networks of academia and sectoral agencies working on climate change adaptation and research-supported climate change adaptation policy development.
(4) Establish additional meteorological and climate stations to ensure a network coverage of vulnerable areas in all provinces to monitor weather conditions and link the data with existing stations, including meteorological stations in highland areas of mountain ranges to obtain climate data and information for highland agricultural development and temperate fruit and vegetable crop cultivation, as well as, for early warnings on flash floods and landslides.	Meteorological and climate station networks are established in all provinces, particularly in vulnerable and highland areas.

Guidelines/Measures	Outputs/Targets
(5) Developing climate services for sectors and sub-sectors as well as define suitable climate and non-climate dataset for sectoral stakeholder.	Numbers of climate services and sectoral dataset.
(6) Establish an integrated sectoral-based climate risk and vulnerability database system and enhance its linkage with sectoral warning system, instruments, and mechanisms.	Improved integrated system of climate database and sectoral warning system, instruments, and mechanisms.
(7) Develop a national action plan on climate change technology development and a human resource capacity development plan to support relevant technological advancement.	A national action plan on climate change technology and a human resource capacity development plan are developed.
(8) Improve the accuracy and precision of climate change projection and model simulation, including the forecast of extreme weather events, such as tropical cyclones and climate fluctuation leading to severe floods and droughts in order to improve the efficiency of early warning systems.	More accurate and precise climate change projection and model simulation to enhance the efficiency of early warning systems.
Responsible Agencies: ONEP, MNRE, MHESI, and MOI.	
Guideline 2: Development of supporting mechanisms for climate change adaptation actions	
(1) Amend and/or develop laws and legislation to support climate change adaptation actions, such as the new Climate Change Act, and the amendment of the Town and Country Planning Act 1975, the Disaster Prevention and Mitigation Act 2007, and the Agricultural Economics Act 1979.	Improved or new laws and legislation to support climate change adaptation actions are established.
(2) Ensure sufficient budgetary support to the relevant government agencies in taking climate change adaptation actions by developing an integrated budget for climate change and introducing budget codes on climate change actions in the annual budget appropriation document.	Relevant government agencies receive sufficient budget to take climate change adaptation actions.
(3) Adopt financial mechanisms to support climate change adaptation in various aspects, such as rehabilitation and reparation funds for disaster and climate change impacts, climate insurance systems, and payment for ecosystem services (PES).	Financial mechanisms are established to support climate change adaptation actions.

Guidelines/Measures	Outputs/Targets
(4) Develop a business model in the areas of climate insurance or disaster insurance for disasters due to climate change as an option for risk management in all sectors, especially the agricultural sector, private sector, and populations groups that are at risk.	Insurance business covering climate-induced disasters or climate change impacts are accessible by farmers, the private sector, and populations groups that are at risk.
(5) Add all dimension climate change impact assessment into the Strategic Environmental Assessment (SEA) to understand its impacts on the carrying capacity of natural resources and ecosystems in area-based development planning.	Assessment of dimensions of the impact of climate change is required under the SEA process.
(6) Establish a coordinating mechanism to enable access of national agencies and institutions to financial, academic, and technological support on climate change adaptation from international agencies and funds, such as International Climate Initiative (IKI), Global Environment Facility (GEF), Green Climate Fund (GCF), Adaptation Fund (AF) and Special Climate Change Fund (SCCF).	A coordinating mechanism is established to enable access of national agencies and institutions to financial, academic, and technological support on climate change adaptation from international agencies and funds.
(7) Develop mechanisms to incentivize the private sector to take action or provide support on climate change adaptation, such as economic instruments in the forms of tax or business incentives or establish funds on climate change adaptation or encourage using social measures, such as CSR.	Mechanisms are established to enhance the role of the private sector's action and support on climate change adaptation.
(8) Strengthen the capacity of local governments and communities in accessing public-private partnership finance as well as international finance on adaptation.	Target group based knowledge materials on adaptation finance.

Guidelines/Measures	Outputs/Targets
Guideline 3: Enhancement of the capacity and awareness of the official and relevant stakeholders in all sectors	
(1) Develop and integrate climate change and natural disasters in the school curricula and activities in the primary to tertiary levels, including inside/outside classroom learning and informal educational systems in order to build knowledge, understanding, and capacity of youth in climate change adaptation.	Availability and applicability of research on climate change adaptation to effectively support the development of guidelines/ measures on climate change adaptation management and impact assessment.
(2) Enhance the human resource capacity in all sectors on climate change risk management by focusing on awareness and knowledge building on climate change situations, trends, and adaptation approaches, and enhancing the skills and ability to collaborate with domestic and international agencies on technical cooperation, human resource development, and financial access to international funds.	Harmonized and coordinated climate change research databases among domestic and international agencies.
(3) Build knowledge and awareness of communities and related stakeholders on climate change risks, impact, and adaptation options.	Networks of academia and sectoral agencies working on climate change adaptation and research-supported climate change adaptation policy development.
(4) Enhance the knowledge and awareness of the private sector on climate change to facilitate the development of area-based business disaster management plans and BCP to raise awareness on public safety, and promote the roles of the private sector and local communities in providing financial support and collaboration on addressing climate change impacts.	Hydrometeorological and climate station networks are established in all provinces, particularly in vulnerable and highland areas.

Responsible Agencies: ONEP, MNRE, MOI, MOPH, MOAC, MOTS, MHESI, and FTI.

4.2 Thailand's Needs for Support

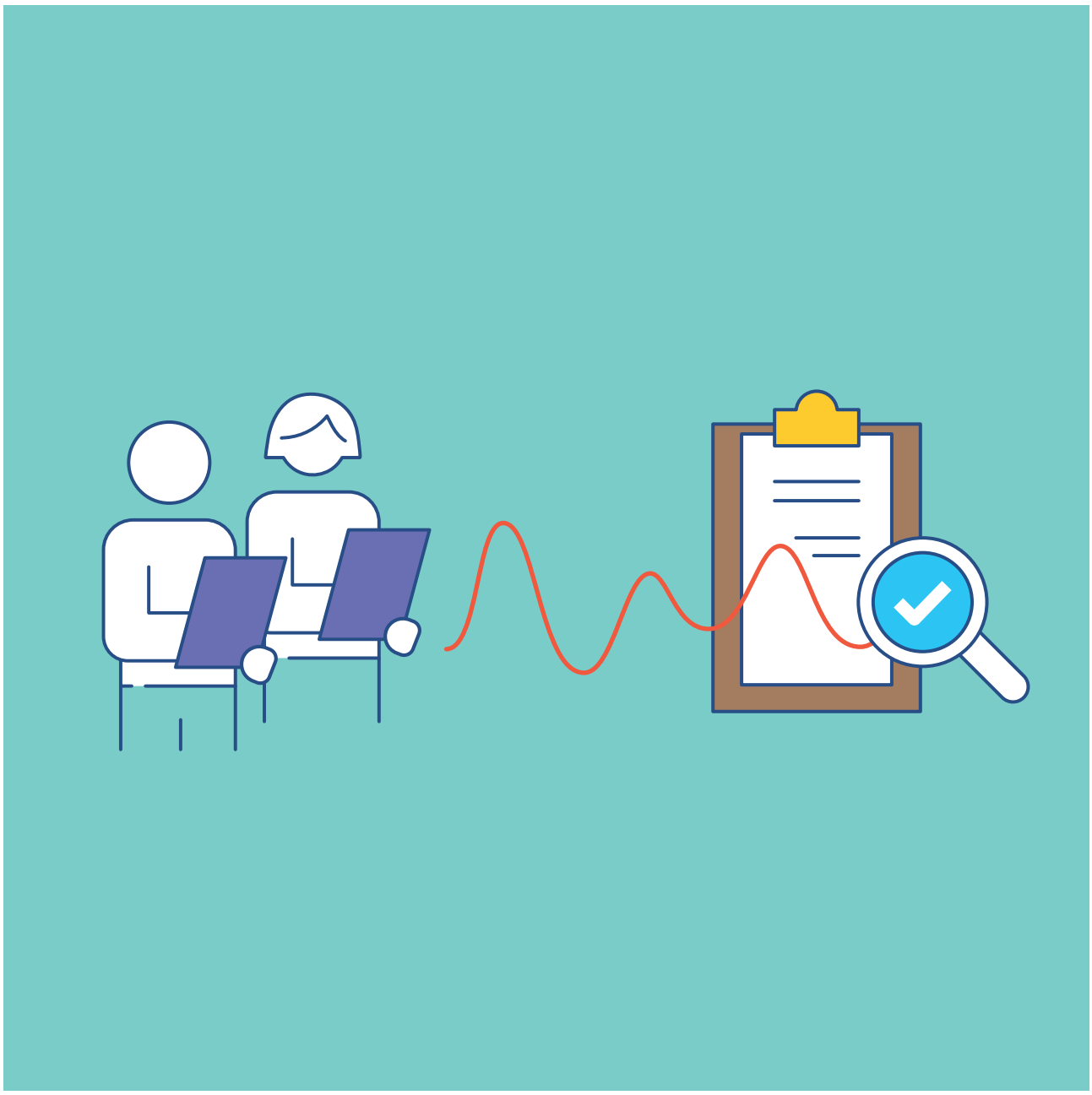
To effectively undertaking the NAP process and successfully implement the adaptation measures and action to achieve climate resilient growth, international support in terms of financing, capacity building, and technological development and transfer is the key to providing the necessary means. International support and partnership would assist Thailand to meet its current and future adaptation challenges, particularly in the following key areas:

Table 4-1: Thailand's needs for support in terms of financing, capacity building, and technological development and transfer for the NAP process and implementation.

Sectors	Support Needs
Water resources management	• Mainstreaming adaptation in the application of Integrated Water Resources Management (IWRM). • Enhancement of the IWRM database and assessment system: Water management database center, Thai Water Plan (TWP), water management budget planning, and Thai Water Assessment (TWA). • Guidelines and pilot implementation of EbA practices, nature-based solutions (NbS) and green infrastructure approaches for climate-resilient water resource management.
Agriculture and food security	• Climate-smart agriculture technologies and techniques, including smart farming, precision farming, digitalization, drought-resistant/flood-resistant crop varieties, heat-resistant livestock, improved livestock feed and manure management, sustainable soil management practices, etc. • Early warning/detection systems for plantation management, such as changing crop calendars, water management strategies, etc.
Natural resources management	• Research on the projection of the rise in the sea level in the Gulf of Thailand with the aim to develop appropriate adaptation measures in response to the rise in the sea level scenarios/seawater intrusion in risk areas, such as the Lower Central Plains. • Knowledge and technology for tracking and managing changes in the sea temperature, coral bleaching, coral diseases, coral reef immunity, and ocean acidification. • Preparation of integrated planning for coastal management across the country covering the management of critical and urgent areas, such as coastal erosion and investments to prevent the rise in the sea level. • Database development for predictions of the impact of climate change on the ecosystem and forest tree species. • Development of a forest map indicating climate vulnerabilities. • Establishment of a market mechanism to incentivize the implementation of community enterprises based on sustainable forest resources. • Sustainable community forest management/sustainable forest management practices.

Sectors	Support Needs
Public health	• Climate-related health surveillance and early warning system. • Guidelines for climate-resilient health infrastructure. • Awareness raising and capacity building of health professionals and relevant networks to monitor climate-related health issues and implement preventive measures. • Strengthening the health system in case of emerging diseases.
Tourism	• Development of climate-integrated sustainable tourism strategies. • Guidelines and capacity building for climate-integrated sustainable tourism management and practices by taking into account ecosystem-based approaches. • Awareness raising and capacity building for local governments and tourism stakeholders on the potential climate impact to the tourism value chain and possible adaptation options. • Development of sustainable tourism destinations, tourist route plans, and smart tourism village design guidelines. • Climate-resilient tourism infrastructure, including preservation of cultural heritage sites.
Human settlement and security	• Guidelines to climate-resilient architecture and adaptive design buildings. • Guidelines to adapt to the impact of increased temperature or urban heat islands. • Guidelines and capacity building for local governments to develop and implement climate-integrated emergency development plans. • Surveillance and emergency response systems and capacity development for cities, municipalities, and communities. • Climate-resilient urban infrastructure, including urban planning and building code standards, and critical urban infrastructure. • Urban ecosystem-based adaptation.

Sectors	Support Needs
Enabling conditions	• Development of a risk map and/or risk profile displaying the areas at risk of the impact of climate change by considering extreme weather events and slow onset events at the local level. • Tools for climate change vulnerability assessment in six sectors of the NAP. • Enhancement of a climate data/information center to provide various climate models and sector-based and user-based climate information services. This includes the enhancement of data in terms of quality, availability, facilities, management, etc., and the uptake/utilization of such data in terms of the capacity to interpret and analyze climate data for planning, programming, and decision-making across the key adaptation sectors. • Assessment of the loss and damage and socio-economic impact of climate change. • Development of Thailand's Climate Resilient Index. • Capacity-building on climate proofing tools and analyses for infrastructure/investments. • Enhancement of adaptation technology, including climate modeling technology. • Enhancement of climate risk insurance. • Enhancement of the capacity of both finance- and climate-related agencies to initiate innovative financing measures to sustainably support future adaptation investments. • Exchange of knowledge and experiences on the integration of climate change adaptation into the national budget system. • Capacity building of national and subnational actors to develop proposals in seeking international support to implement adaptation measures under the NAP. • Development of a national database on climate change adaptation covering different spatial scales and sectors that is reliable, up-to date, publicly available, and accessible by both national and sub-national government and non-government agencies. • Technical support for designing and establishing a national M&E system for climate change adaptation that is in line with the NAP. • Development of the national M&E system of climate finance-related policies.



CHAPTER 5

MONITORING AND EVALUATION

Thailand has recognized that M&E is a crucial part of the adaptation planning process, as it assists the decision makers and planners in keeping track of the benefits of the adaptation interventions by aiming at building a resilient and adaptive society. Therefore, it is important to define the specific objectives of the adaptation of M&E at different stages of the adaptation planning process.

This chapter outlines Thailand's monitoring, evaluation, and reporting system of the NAP, as well as the development of the country's climate resilient indicators.

5.1 Adaptation Monitoring and Evaluation Framework

Adaptation Planning	Adaptation Implementation	Adaptation Outcome
	Goal for Adaptation M&E	
Concrete adaptation plan and long-term/sectoral plans with mainstreamed adaptation.	Adaptation actions and mechanisms to enhance deployed climate resilience.	Sectors and socio- economic system resilience to climate change.
	Approach for M&E	
Quantity and coverage of long term/sectoral plans with mainstreamed adaptation.	**Short-term** • Adaptation project progress as planned, and output/target reached. • Mechanisms to enhance resilience in place. **Long-term** • Effectiveness and efficiency of the adaptation project. • Sustainability of the adaptation project. • Cross sectors effect impact. • Mitigation co-benefits	• Vulnerability to climate hazards (short term) and climate change (long term) reduced . • Adaptive capacity to climate change increased. • Resilience to climate change increased.

Figure 5-1: Thailand's adaptation monitoring and evaluation framework.

To monitor and evaluate the results of the adaptation process effectively and coherently, Thailand has conducted a study to define the M&E framework by considering three aspects of adaptation: Adaptation planning, mobilization of the adaptation implementation, and outcome of adaptation (Figure 4-1). In parallel, Thailand has also initiated a process and system to monitor and evaluate the adaptation outcome of the country. The process of the climate resilience indicators development was initiated in 2020, to define sector-based indicators to monitor the resilience of the country to climate impacts in the medium and long term.

Climate Resilience Indicators

Following Thailand's adaptation of the M&E framework (Figure 4-2), the country is in the process of developing sector-based Climate Resilience Indicators with the aim to understand how resilience and robust the sector is to the weather and climate hazards by considering the vulnerability and the vulnerability trend in each sector. In the development of the sector-based Climate Resilience Indicators, the following three aspects were considered:

1. The exposure of the sectors to climate hazards - The exposure indicators focus on the meteorological factors with the assumption that these factors have a high influence on how the sectors would be exposed to weather and climate hazards.

2. The sensitivity of the sectors to climate risk - To indicate the magnitude of the impacts and risks, caused by weather and climate hazards, to the sector.

3. The coping and adaptative capacity of the sector to climate hazards - To indicate how well the mechanisms and the capacities are in place to confront and recover from climate risk in the short term and build resilience in the long term to continue economic activities. To evaluate the resilience status in each sector in the long term, the identified indicators in the three aspects would be analyzed and evaluated to understand the yearly vulnerability index. Over the years, the policy makers would understand the vulnerability trend in each sector and be able to evaluate the sector's climate resilience status whether it lacked resilience, or had low, medium, and/or high resilience.

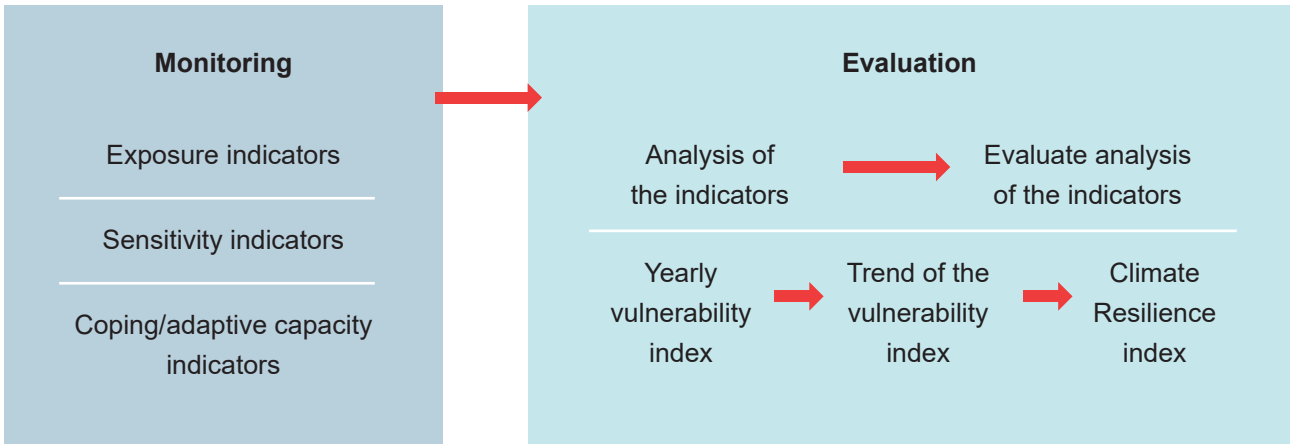


Figure 5-2: Framework to monitor and evaluate Thailand's resilience.

Water resources and agriculture were the first two pilot sectors that Thailand initiated the process to develop the climate resilience indicators. In each sector, the indicators were defined to reflect its vulnerability in different aspects. For water resources, the stability and the disaster caused from a lack or excess of water were considered. For the agricultural sector, agricultural productivity, farmers, and food security were considered.

Table 5-1: Example of Thailand's Climate resillience indicators.

Sectors	Example of the Indicators		
	Exposure	Sensitivity	Adaptive Capacity
Water resource management	- An average annual maximum temperature compared to the average of the baseline year. - Total annual rainfall compared to the baseline year. - The frequency of storms in 30 years compared to the baseline year.	- Total water demand compared to the total amount of water. - Number of total surface water sources with lower than average water quality compared to the total surface water sources. - Ten-year percentile rank of the total economic loss from floods and drought.	-Total amount of water reserved compared to the water demand. -Trends of economic loss in 10 years.
Agriculture and food security	- An average annual maximum temperature compared to the average of the baseline year. - An average annual minimum temperature compared to the average of the baseline year. - Total annual rainfall compared to the baseline year. - The frequency of storms in 30 years compared to the baseline year.	- The annual yield compared to the average of the 10-year yield. - Farmer's household income from the agricultural sector compared to the total farmer's household income. - Rice production per person per year compared to the rice consumption per person per year.	- The agricultural areas that have a water management system compared to the total agricultural areas. - Farmer's household pending outside the agricultural sector compared to the farmer's household income outside the agricultural sector. - Excess rice productivity compared to the total consumption per year.

5.2 Adaptation Reporting

To ensure the effectiveness and consistency of the M&E system, the adaptation data collection and reporting structure was established, and the new DCCE has, since August 2023, taken over this mandate instead of the ONEP. The DCCE would collaborate with the focal agencies in the six key sectors to report on the M&E results of the adaptation planning, implementation, as well as the resilience status in each sector.

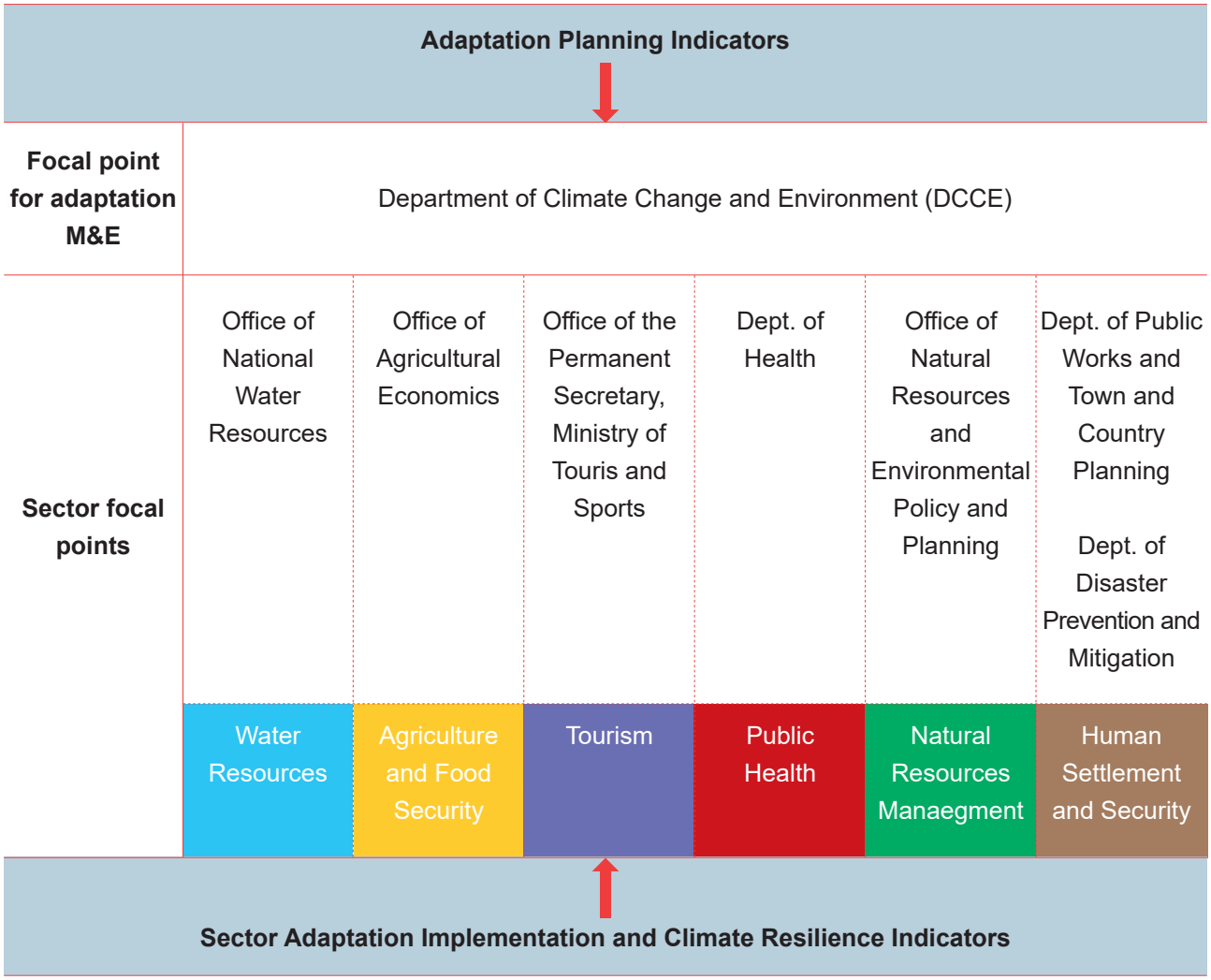


Figure 5-3: Sectoral focal point for Thailand's M&E adaptation actions.

Lastly, the revision process of Thailand's NAP would be planned every five years to monitor and evaluate the results of the adaptation planning, the deployment of the adaptation measures and mechanisms, as well as the outcome of the adaptation efforts. In the first Thailand's NAP, the planning stage of adaptation would be monitored and evaluated.

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Climate Change Adaptation Division
Department of Climate Change and Environment
49 Soi 30, Rama VI Road, Phaya Thai, Bangkok 10400 THAILAND
Tel.: +66-2278-8400, Fax: +66-2298-5606

THE KINGDOM OF THAILAND
MINISTRY OF NATURAL RESOURCES AND ENVIRONMENT
DEPARTMENT OF CLIMATE CHANGE AND ENVIRONMENT
CLIMATE CHANGE ADAPTATION DIVISION

HONORARY ADVISOR
Police General Patcharawat Wongsuwan
Deputy Prime Minister and Minister of Natural Resources and Environment
Mr. Jatuporn Buruspat
Permanent Secretary,
Ministry of Natural Resources and Environment
Dr. Phirun Saiyasitpanich
Director General, Department of Climate Change and Environment
Mr. Pavich Kasavawong
Deputy Director General, Department of Climate Change and Environment
Mr. Jiravat Ratisoontorn
Deputy Secretary-General, Office of Natural Resources and Environmental Policy and Planning
Ms. Nareerat Panmanee
Director of Strategy and International Cooperation Division
Dr. Chongrak Thinagul
Dissemination Technical officer, Expert Level Acting, Director of Climate Change Adaptation Division

DEVELOPMENT TEAM

Ms. Katanchalee Thammakul
Mr. Teerapong Laopongpith
Mr. Eakaraj Khummano
Ms. Chompunut Songkhao
Dr. Anuporn Wanwisede
Dr. Ruchirek Ratchaburi
Mr. Suphat Phengphan
Ms. Benjiraya Boonyapatsirikul
Dr. Angkana Chalermpong
Ms. Pimkarn Kattiyavong
Ms. Chayathorn Thanawattanadamrong
Mr. Supachok Chittapisan
Mr. Shindanai Tansakool
Ms. Netnapa Saelim
Ms. Wasana Thepsanga

CONTRIBUTORS

- Office of Natural Resources and Environmental Policy and Planning
- Budget Bureau
- Office of the National Economic and Social Development Council
- Office of the National Water Resources
- The Thailand Research Fund
- Department of Tourism
- Office of Agricultural Economics
- Department of Marine and Coastal Resources
- Department of Climate Change and Environment
- Department of National parks Wildlife and Plant Conservation
- Department of Disaster Prevention and Mitigation
- Department of Public Works and Town & Country Planning
- Department of Local Administration
- National Science Technology and Innovation Policy Office
- Bureau of Policy and Strategy, Ministry of Education
- Department of Health
- National Research Council of Thailand
- Thailand Greenhouse Gas Management Organization (Public Organization)
- The Joint Standing Committee on Commerce, Industry and Banking
- Good Governance for Social Development and the. Environment Foundation
- Biodiversity Management Division, Office of Natural Resources and Environmental Policy and Planning
- Assoc. Prof. Dr. Noppanan Tapananon
- Mr. Boonlert Archevarahuprok
- Mr. Suppakorn Chinvanno
- Dr. Kannika Thampanichvong

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