

# THAILAND'S FOURTH NATIONAL COMMUNICATION





THAILAND'S **FOURTH** NATIONAL COMMUNICATION



*Empowered lives.  
Resilient nations.*

## THE KINGDOM OF THAILAND

MINISTRY OF NATURAL RESOURCES AND ENVIRONMENT  
OFFICE OF NATURAL RESOURCES AND ENVIRONMENTAL POLICY AND PLANNING  
CLIMATE CHANGE MANAGEMENT AND COORDINATION DIVISION

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# FOREWORD

The international collaboration, with public recognition and awareness of climate change, has significantly increased since the adoption of the Paris Agreement at COP21, which is in accordance with the IPCC comprehensive assessment reports on climate change. In particular, the IPCC Fifth Assessment Report (AR5) revealed the wide-spread and severe climate impacts in the near term, escalating risk from higher temperatures causing irreversible climate change impacts, and increased vulnerability to climate risks due to inequality and development challenges, all of which indicate that the world needs urgent mitigation and adaptation actions to address loss and damages. Thus, a monumental step was made at COP26 when all member states came together with the ambitious decision to put their best efforts into limiting the average temperature increase to less than 1.5°C. To achieve this goal, global net-zero greenhouse gas emissions must be pursued by 2050.

Thailand recognizes the severe impacts of climate change and the significance of holding the increase in global average temperature to well below 2°C and pursuing efforts to limit the increase to 1.5°C under the Paris Agreement. At COP26 World Leaders Summit, Thailand announced the country's new ambitious targets to reach carbon neutrality and net-zero greenhouse gas emissions by 2050 and 2065, respectively, and increase NDC contributions up to 40% upon timely and adequate international support on finance, technology transfer, and capacity building. In terms of actions, Thailand has mainstreamed climate change agenda into its national plans: the 20-Year National Strategy, National Economic and Social Development Plans, Climate Change Master Plan, National Adaptation Plan (NAP), Nationally Appropriate Mitigation Action (NAMA), and Nationally Determined Contribution (NDC). Furthermore, the Long-Term Low Greenhouse Gas Emission Development Strategy (LT-LEDS) and the 2<sup>nd</sup> updated NDC were revised and submitted to UNFCCC by COP27. The revisions focus on the alignment of mitigation measures and 2050 carbon neutrality and 2065 net-zero GHG emissions, just transition, and optimization of socio-economic impacts. In the 2<sup>nd</sup> updated NDC, Thailand elevated the contribution level to 40%, with 30% from our domestic effort and 10% from international support. This target is challenging for the energy, transport, and agriculture sectors. The challenge also includes raising awareness and participation from all relevant sectors, particularly the private sector, which urgently needs to adapt and enhance its capacity for business competition to keep pace with the rapidly changing global circumstances and trends.

Thailand's Fourth National Communication (NC4) has been prepared in accordance with UNFCCC guideline. The NC4 is a medium for Thailand to communicate its commitment to fulfilling the obligations under Article 4.1 and 12.1 of the UNFCCC. It presents updated and more comprehensive information on the national circumstances; institutional arrangements; national greenhouse gas (GHG) inventory; mitigation policies, plans, and measures; achievement of GHG emissions reduction under NAMA; preparation for the implementation of NDC; vulnerability and adaptation; other information and activities relevant to climate actions; and constraints, gaps, support needed, and support received to implement its adaptation and mitigation actions. The chapter on vulnerability and adaptation also serves as Thailand's first adaptation communication.

On behalf of the Office of Natural Resources and Environmental Policy and Planning (ONEP), Ministry of Natural Resources and Environment (MONRE), I would like to express my sincere gratitude to the Global Environment Facility (GEF) for the funding and the United Nations Development Programme (UNDP), a coordinating and implementing agency, for its technical support. My appreciation also extends to representatives of Ministries, sub-national government agencies, academic institutions, private sectors, civil societies, non-governmental organizations, and international agencies for their contributions in the preparation of this report.

Thailand will continue to put the utmost effort into prioritizing and implementing our policies to combat climate change and limit the increase of global average temperature under the Paris Agreement according to the country's vision toward net-zero GHG emissions by the second half of this century.



Dr. Phirun Saiyasitpanich  
Secretary-General  
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## LIST OF ACRONYMS, ABBREVIATIONS, AND UNITS

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### LIST OF ACRONYMS, ABBREVIATIONS, AND UNITS

3Rs	Reduce, Reuse, and Recycle
ACE	Action for Climate Empowerment
AD	Activity data
ADF	Activity data factor
AEDP	Alternative Energy Development Plan
AgWG	Agriculture Working Group
AIMEnduse	Asia-Pacific Integrated Assessment Model
AP-PLAT	Asia-Pacific Adaptation Information Platform
BAU	Business-As-Usual
BECC	Basic Education Core Curriculum
BCG	Bio-Economy, Circular Economy, and Green Economy
BUR	Biennial Update Report
CAPCI	Climate Action Programme for the Chemical Industry
CBD	Convention on Biological Diversity
CCAI	Climate Change Awareness Index
CCF	Corporate Carbon Footprint
CCFF	Climate Change Financing Framework
CCMP	Climate Change Master Plan
CCUS	Carbon Capture Utilization and Storage
CDM	Clean Development Mechanism
CER	Certified emission reduction
CEOS	Committee on Earth Observation Satellite
CFP	Carbon Footprint of Products
CGEOs	Chief Gender Equality Officers
COD	Chemical Oxygen Demand
COP	Conference of the Parties
CORDEX-SEA	Coordinated Regional Climate Downscaling Experiment - Southeast Asia Regional Climate Downscaling
CRADR	Climate-resilient Agriculture for Disaster Risk Reduction

CRI	Global Climate Risk Index
CSR	Corporate Social and Environmental Responsibility
DET	Data Entry Template
DMWG	Disaster Mitigation Working Group
DRR	Disaster Risk Reduction
EE	Estimated Elsewhere
EEC	Eastern Economic Corridor
EEF	Education Equality Fund
EEP	Energy Efficiency Plan
EF	Emission Factor
EI	Energy Intensity
EPR	Extended Producer Responsibility
ESD	Education for Sustainable Development
ESS	Earth System Science
EV	Electric vehicles
F-Gases	Fluorinated Gases
FGRS	Flare Gas Recovery System
FS	Financial Support
FT-IR	Fourier Transform Infrared Spectroscopy
GAW	Global Atmospheric Watch
GBO5	Fifth Global Biodiversity Outlook
GCF	Green Climate Fund
GCMs	General Circulation Models
GDP	Gross Domestic Product
GCF	Green Climate Fund
GCOS	Global Climate Observing System
GEF	Global Environment Facility
GFPs	Gender Focal Points
GOOS	Global Ocean Observing System
GOS	Global Observing System

## LIST OF ACRONYMS, ABBREVIATIONS, AND UNITS

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GSN	GCOS Surface Network
GUAN	GCOS Upper Air Network
CB	Capacity Building
CFR	Carbon Footprint Reduction
GFSI	Global Food Security Index
GHG	Greenhouse Gas
GSI	Gender and Social Inclusion
GWP	Global Warming Potential
HNAP	Health National Adaptation Plan
ICC	International Coastal Cleanup
ICE	Internal Combustion Engine
I&FF	Investment and Financial Flows Assessment
IKI	International Climate Initiative
INDC	Intended Nationally Determined Contribution
IPPU	Industrial Processes and Product Use
iSEE	Information System for Equitable Education
IUU	Illegal, Unreported, and Unregulated Fishing
JCM	Joint Crediting Mechanism
KCA	Key Category Analysis
LCC	Low Carbon Growth in Cities through Sustainable Urban System Management in Thailand Project
LCCP	Low Carbon Cities Programme
LESS	Low Emission Support Scheme
LGBTI	Lesbian, gay, bisexual, transgender, and intersex
LOR	Letter of Recognition
LPG	Liquefied Petroleum Gas
LT-LEDS	Long-Term Low Greenhouse Gas Emission Development Strategy
LULUCF	Land Use, Land-Use Change and Forestry
MCCAI	Municipality Climate Change Action Indicator
M & E	Monitoring and evaluation
MOC	Memorandum of Cooperation

MOU	Memorandum of Understanding
MPI	Multi-Dimension Poverty Index
MPS	Marine Spatial Planning
MRV	Measurement, Reporting and Verification
MSW	Municipal Solid Waste
NA	Not Applicable
NACAG	Nitric Acid Climate Action Group
NAMA	Nationally Appropriate Mitigation Action
NAP	National Adaptation Plan
NbS	Nature-based Solutions
NBSAPs	National Biodiversity Strategies and Action Plans
NC	National Communication
NCCC	National Committee on Climate Change Policy
NDC	Nationally Determined Contribution
NDE	National Designated Entity
NE	Not Estimated
NO	Not Occurring
PCCB	Paris Committee on Capacity-Building
PDP	Power Development Plan
PM	Particulate Matter
PMR	Partnership for Market Readiness
PPP	Polluter Pays Principle
QA	Quality Assurance
QC	Quality Control
RAC	Refrigeration and Air Conditioning
RBCN	Regional Basic Climatological Network
RBSN	Regional Basic Synoptic Network
RCPs	Representative Concentration Pathways
RDF	Refuse Derived Fuel
RE	Renewable Energy

## LIST OF ACRONYMS, ABBREVIATIONS, AND UNITS

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REDD+	Reducing Emissions from Deforestation and Forest Degradation (REDD); and the role of conservation, sustainable management of forests and enhancement of forest carbon stocks in (+)
SARCCIS	Southeast Asia Regional Climate Information System
SDGs	Sustainable Development Goals
SEACLID	Southeast Asia Regional Climate Downscaling
SOU	Statement of Undertaking
TACCC	Transparency, Accuracy, Consistency, Completeness, and Comparability
TAP	Technology Action Plans
TEC	Technology Executive Committee
TGCP	Thai-German Climate Programme
TGEIS	Thailand Greenhouse Gas Emission Inventory System
THEOS-2	Thailand Earth Observation System Phase 2
TNA	Technology Needs Assessment
TOD	Transit-oriented development
T-COP	Thailand Carbon Offsetting Program
T-PLAT	Thailand Climate Change Adaptation Information Platform
TS	Technical Support/Assistance
TT	Technology Development and Transfer
T-VER	Thailand Voluntary Emission Reduction Program
V & A	Vulnerability and Adaptation
WCRP	World Climate Research Programme
WWW	World Weather Watch
<b>GASES</b>	
CH <sub>4</sub>	Methane
CO	Carbon Monoxide
CO <sub>2</sub>	Carbon Dioxide
HFCs	Hydrofluorocarbons
N <sub>2</sub> O	Nitrous Oxide
NMVOCs	Non-Methane Volatile Organic Compounds

NO <sub>2</sub>	Nitrogen Dioxide
NO <sub>x</sub>	Nitrogen Oxides
O <sub>3</sub>	Ozone
PFCs	Perfluorocarbons
PM	Particulate matters
SF <sub>6</sub>	Sulphur Hexafluoride
SO <sub>2</sub>	Sulphur Dioxide
VOCs	Volatile Organic Compounds
<b>UNITS</b>	
\$	United States Dollar (USD)
¥	Japanese Yen
€	Euro (EUR)
°C	Degree Celsius
A\$	Australian Dollar
Bpd	Barrels per day
EUR	Euro
Gg	Giga (represents a factor of 10 <sup>9</sup> )
kg	Kilogram (represents a factor of 10 <sup>3</sup> )
km	Kilometer (represents a factor of 10 <sup>3</sup> )
km <sup>2</sup>	Square kilometer
ktoe	Kilo ton of oil equivalent
M	Million (represents a factor of 10 <sup>6</sup> )
m <sup>2</sup>	Square meter
m <sup>3</sup>	Cubic meter
mm	Millimeter (represents a factor of 10 <sup>-3</sup> )
MMscf	Million standard cubic feet
tCO <sub>2</sub> eq	Ton of Carbon Dioxide Equivalent
THB	Thai Baht
USD	United States Dollar
µg/m <sup>3</sup>	micrograms (one-millionth of a gram) per cubic meter of air

## LIST OF ACRONYMS, ABBREVIATIONS, AND UNITS

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### ORGANIZATIONS

APAN	Asia-Pacific Advanced Network
APN	Asia-Pacific Network for Global Change Research
ARDA	Agricultural Research Development Agency
ASEAN	Association of Southeast Asian Nations
ASEANCOF	ASEAN Climate Outlook Forum
ASEAN-SCMG	ASEAN Subcommittee on Meteorology and Geophysics
ASOEN	ASEAN Senior Official on the Environment
AWGCC	ASEAN Working Group on Climate Change
AWGEE	ASEAN Working Group on Environmental Education
BAAC	Bank for Agriculture and Agricultural Cooperatives
BMA	Bangkok Metropolitan Administration
CAA	Climate Action Academy
CAAT	Civil Aviation Authority of Thailand
CCMC	Climate Change Management and Coordination Division
CITC	Climate Change International Technical and Training Center
CTCN	Climate Technology Centre and Network
DEDE	Department of Alternative Energy Development and Efficiency
DEQP	Department of Environmental Quality Promotion
DIW	Department of Industrial Works
DLA	Department of Local Administration
DLD	Department of Livestock Development
DMCR	Department of Marine and Coastal Resources
DMF	Department of Mineral Fuels
DMR	Department of Mineral Resources
DNP	Department of National Parks, Wildlife and Plant Conservation
DOA	Department of Agriculture
DOAE	Department of Agricultural Extension
DOEB	Department of Energy Business
DOF	Department of Fisheries

DOH	Department of Health
DOT	Department of Tourism
DPIM	Department of Primary Industries and Mines
DWF	Department of Women's Affairs and Family Development
ED	Excise Department
EGAT	Electricity Generating Authority of Thailand
EPPO	Energy Policy and Planning Office
ERCT	Environmental Research and Training Center
EU	European Union
FLMO	Forest Land Management Office
FPO	Fiscal Policy Office
FTI	Federation of Thai Industries
GISTDA	Geo-Informatics and Space Technology Development Agency
GLOBE	Global Learning and Observations to Benefit the Environment
GIZ	Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH
HII	Hydro-Informatics Institute
HDRTN	Hydrographic Department of Royal Thai Navy
IGES	Institute for Global Environmental Strategies
IPCC	Intergovernmental Panel on Climate Change
IPST	Institute for the Promotion of Teaching Science and Technology
ISIT	Iron and Steel Institute of Thailand
IUCN	International Union for the Conservation of Nature
JICA	Japan International Cooperation Agency
LAOs	Local Administrative Organizations
LDD	Land Development Department
MD	Marine Department
MEA	Metropolitan Electricity Authority
MHESI	Ministry of Higher Education, Science, Research, and Innovation
MOAC	Ministry of Agriculture and Cooperatives

## LIST OF ACRONYMS, ABBREVIATIONS, AND UNITS

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MOE	Ministry of Education
MOEJ	Ministry of Environment of Japan
MOI	Ministry of Interior
MONRE	Ministry of Natural Resources and Environment
NASA	National Aeronautics and Space Administration
NCCC	National Committee on Climate Change Policy
NESDC	Office of the National Economic and Social Development Council
NRCT	National Research Council of Thailand
NSO	National Statistical Office
NSTDA	National Science and Technology Development Agency
NXPO	Office of National Higher Education Science Research and Innovation Policy Council
OAE	Office of Agricultural Economics
OBEC	Office of the Basic Education Commission
OCSB	Office of the Cane and Sugar Board
OEC	Office of the Energy Regulatory Commission
OECC	Overseas Environmental Cooperation Center, Japan
OIE	Office of Industrial Economics
ONEP	Office of Natural Resources and Environmental Policy and Planning
ONLB	Office of the National Land Policy Board
ONWR	Office of the National Water Resources
OTP	Office of Transport and Traffic Policy and Planning
PCD	Pollution Control Department
ProSPER.NET	Promotion of Sustainability in Postgraduate Education and Research Network
PTIT	Petroleum Institute of Thailand
PTTEP	PTT Exploration and Production Public Company Limited
RAOT	Rubber Authority of Thailand
RCC	Regional Collaboration Centre
RCEs	Regional Centres of Expertise on Education on Sustainable Development

RD	Rice Department
REO	Regional Environment Office
RFD	Royal Forest Department
RID	Royal Irrigation Department
RU-CORE	Ramkhamhaeng University, Center of Regional Climate Change and Renewable Energy
SDSN	Sustainable Development Solutions Network
SRT	State Railway of Thailand
STI	National Science Technology and Innovation Policy Office
TBA	Thai Banker's Association
TCMA	Thai Cement Manufacturers Association
TCNN	Thailand Carbon Neutral Network
TGO	Thailand Greenhouse Gas Management Organization
TMD	Thai Meteorological Department
TSRI	Thailand Science Research and Innovation
UN	United Nations
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
UNESCO	United Nations Educational, Scientific, and Cultural Organization
UNFCCC	United Nations Framework Convention on Climate Change
UNIDO	United Nations Industrial Development Organization
UNOSSC	United Nations Office for South-South Cooperation
UNU-IAS	United Nations University Institute for the Advanced Study of Sustainability
WMA	Wastewater Management Authority
WMO	World Meteorological Organization

### EXECUTIVE SUMMARY

Thailand, as a Non-Annex I Party to the United Nations Framework Convention on Climate Change (UNFCCC), is obligated to submit National Communications (NCs) every 4 years and Biennial Update Reports (BURs) every 2 years. Thailand submitted its first, second, and third NC on 13 November 2000, 24 March 2011, and 29 August 2018, respectively. This report, the fourth NC (NC4), has demonstrated the country's intention to actively implement climate actions and share the results with UNFCCC and the global community. According to Conference of the Parties (COP) guidelines, the NC4 consists of 6 chapters as follows:

#### NATIONAL CIRCUMSTANCES

The physical context reveals the country's vulnerability to climate impacts as above-average temperatures tend to rise, precipitation has fluctuated over time, population structure is becoming an "aging society," and its long coastal zone faces coastal erosion and sea-level rise. Thailand relies largely on commercial energy production and consumption, but renewable energy shares have continued to increase. The country's natural resources exhibit not only the abundance and absorptive capacity but also the degrading conditions from climate-induced disasters.

The COVID-19 pandemic caused a significant economic contraction during 2019-2020. In particular, the tourism sector, which had always been a significant part of Thailand's economic growth generating approximately 20-22% of GDP, suffered a drastic decline. This resulted in an increase in plastic and infectious wastes and a slight increase in the poverty line and inequality indicators. On the positive side, the COVID-19 controlling measures led to a reduction in energy consumption and production, improvement in overall air quality due to less traffic circulation in the transport sector and economic activities, a general decline of all other diseases, reinforcement of Thailand's healthcare system for coping with newly emerged diseases, and recovery of natural resources in touristic sites.

As a final point, National Committee on Climate Change Policy (NCCC) serves as a national institute overseeing climate policy development and implementation. It was initially composed of 5 Subcommittees, but 2 Subcommittees have been recently instituted to advance Thailand's climate actions—the Subcommittee on the Mobilization of GHG Mitigation with Carbon Sequestration in LULUCF Sector and the Subcommittee on the Mobilization of GHG Mitigation with CCUS Technology Implication.

### NATIONAL GREENHOUSE GAS INVENTORY

The inventory report was prepared using the 2006 IPCC Guidelines for National Greenhouse Gas Inventories and presented Thailand's national GHG emissions from 2000 to 2018 by sources and removals by sinks. The GHG emissions estimated in this report include both direct and indirect emissions: Carbon Dioxide (CO<sub>2</sub>), Methane (CH<sub>4</sub>), Nitrous Oxide (N<sub>2</sub>O), Hydrofluorocarbons (HFCs), Sulphur Hexafluoride (SF<sub>6</sub>), Nitrogen Oxides (NO<sub>x</sub>), Carbon Monoxide (CO), Non-Methane Volatile Organic Compounds (NMVOCs) and Sulphur Dioxide (SO<sub>2</sub>). The GHG emission is calculated by the Thailand Greenhouse Gas Emission Inventory System (TGEIS).

In 2018, total GHG emissions (excluding those from LULUCF) were 372,648.77 GgCO<sub>2</sub>eq. Net GHG emissions were 286,680.47 GgCO<sub>2</sub>eq (including those from LULUCF) resulted from the Energy sector (257,340.89 GgCO<sub>2</sub>eq), Agriculture sector (58,486.02 GgCO<sub>2</sub>eq), IPPU sector (40,118.18 GgCO<sub>2</sub>eq), and Waste sector (16,703.68 GgCO<sub>2</sub>eq). The Energy sector remained the most significant contributor to Thailand's GHG emissions, accounting for 69.06% of the total GHG emissions. The share of emissions from the Agriculture, IPPU, and Waste sectors were 15.69%, 10.77%, and 4.48%, respectively. LULUCF contributed to a net removal of -85,968.30 GgCO<sub>2</sub>eq.

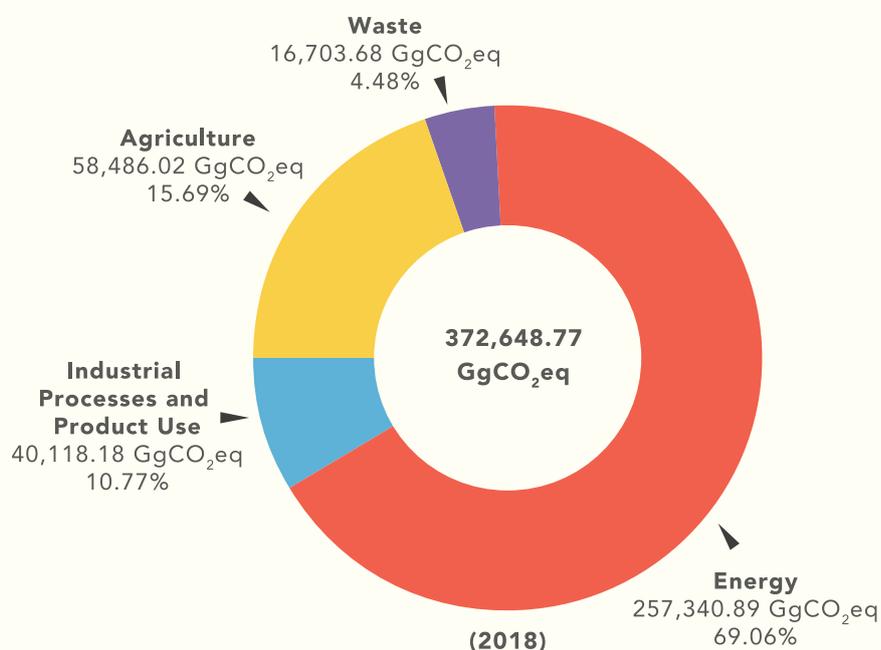


Figure: Total GHG emissions by sector (excluding LULUCF) 2018

## MITIGATION MEASURES

Thailand has made efforts to uphold its commitment under the Convention by integrating climate change mitigation into its national and sectoral policies and plans and implementing mitigating measures in order to achieve the national GHG reduction targets—NAMA’s target to reduce GHG emissions by 7-20% from BAU by 2020 and NDC’s target to reduce GHG emission by 20-25% from BAU by 2030. Thailand submitted the 2<sup>nd</sup> updated NDC, which aligns with an ambitious pledge to reduce GHG emissions by 30% from the BAU level by 2030. The contribution level increases to 40%, subject to adequate and enhanced access to technology development and transfer, financial resources, and capacity-building support. Furthermore, Thailand will continue efforts to meet the long-term goals of carbon neutrality by 2050 and net-zero GHG emissions by 2065.

Thailand implemented NAMA’s mitigation measures and successfully achieved a GHG reduction of 56.54 MtCO<sub>2</sub>eq in 2020 from 10 mitigation measures in the energy and transport sectors which is 15.40% lower than its BAU level. As NAMA ended in 2020, Thailand has transitioned toward NDC, which aims to reduce GHG emissions in the energy, transport, industrial process and product use, and waste management sectors. In addition, Thailand has also increasingly developed supporting measures and voluntary actions to mitigate GHG reduction, such as the carbon market and carbon label schemes.

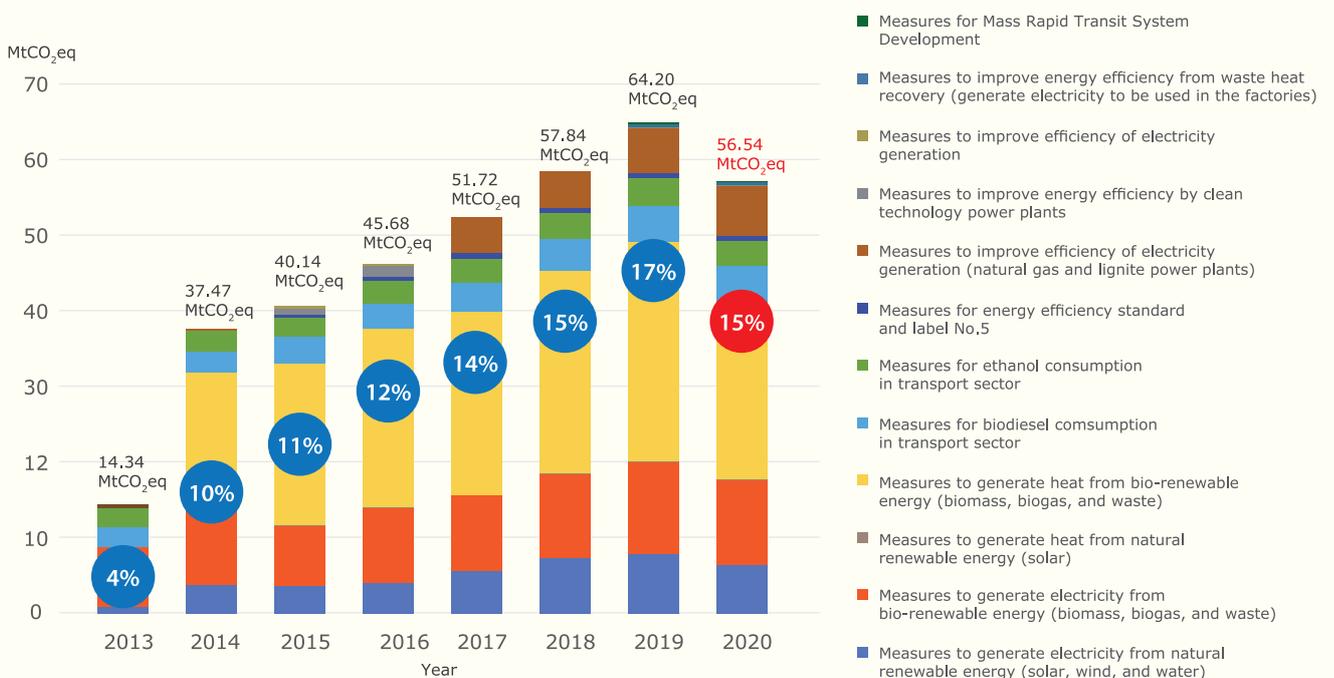


Figure: Thailand’s GHG emission reduction from NAMA implementation 2013-2020

## **VULNERABILITY AND ADAPTATION**

Thailand, a developing country, is ranked 9<sup>th</sup> as the most affected country by climate change impacts in the last 20 years (2000-2019) by Global Climate Risk Index 2021 (CRI), both in terms of human impacts (fatalities) and direct economic losses. Thailand, by ONEP and RU-CORE, has developed a database of geospatial risks from climate change by assessing climate impacts, risks, and vulnerabilities in 6 significant sectors: water management, agriculture and food security, tourism, public health, natural resources management, and human settlement and security. The risk and vulnerability assessments for climate projection are based on the top-down approach using climate scenarios generated through the most updated version of General Circulation Models (GCMs) and RCP models, which are derived from data in the SEACLID/CORDEX SEA Phase II project. For all the 6 sectors, 3 types of climate hazards—heat, drought, and flooding—are considered together with socio-economic factors. The vulnerability assessments show that climate impacts are not homogenous across hazard, type, time, and areas. Different sectors and different regions in Thailand are vulnerable to different climate hazards. In addition to the physical impacts of climate change, Thailand is also vulnerable to changes in socio-economic conditions, particularly the aging population.

## **OTHER RELEVANT INFORMATION AND ACTIVITIES**

Chapter 5 depicts other information and activities of climate actions that complement and empower the implementation of mitigation and adaptation measures enabling Thailand to achieve the objectives of the Convention. The information and activities include technology development and transfer; research and systematic observation; education, training, public awareness, public participation, and public access to climate information; capacity building; and information sharing and networking. First, Thailand has established a mechanism for technology transfer and formulated a climate technology database and roadmap indicating technologies that require further development aligning with key sectors stated in Thailand's NDC and Thailand's NAP. Significant technologies have been developed to reach carbon neutrality and net-zero targets in the energy sector, such as technologies related to electric vehicles and hydrogen fuel. Second, research and systematic observation have been conducted in climate variable sectors: atmospheric, terrestrial (i.e., land and water), and oceanic domains. Third, Thailand has engaged in implementing capacity-building initiatives as well as Actions for Climate Empowerment (ACE) under Article 6 of the UNFCCC, which involves not only climate knowledge dissemination but also the environmental rights of the public to participate and access climate information. Finally, ONEP acts as a primary entity for climate information sharing, and Thailand cooperates with international communities at bilateral, regional, and multilateral levels to address climate change issues.

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## **CONSTRAINTS, GAPS, NEEDS, AND SUPPORT RECEIVED**

Thailand has received support from various international partners to facilitate climate actions in mitigation, adaptation, and enabling environment, including the preparation of Thailand's Fourth National Communication (NC4) and Third Biennial Update Report (BUR3) to the UNFCCC. From 2020-2022, Thailand has received support from multilateral and bilateral partners for a total of 34 projects, entailing 18 mitigation projects with a total amount of 31,438,771 USD, 10 adaptation projects with a total amount of 48,667,056 USD, and 6 enabling environment projects with a total amount of 3,419,548 USD. Most support was a combination of technical support and capacity building.

However, considering remaining constraints and gaps, Thailand still needs international support in terms of finance, technical expertise, technology transfer, and capacity building to ensure the achievement of LT-LEDS in a short-term period (2025-2035), a mid-term period (2040-2050), and a long-term period (2050-2065). More support is needed, particularly for technology development and transfer, which is essential for mitigation and adaptation implementation. For mitigation, Thailand needs support for the energy transition toward renewable sources focusing on renewable energy technologies (such as solar and wind), enhancing the potential use of Carbon Capture Storage (CCS) & Carbon Capture, Utilization, and Storage (CCUS) technologies, and developing other technologies to achieve GHG emission reduction and a net-zero emission. For adaptation, support is needed for developing a data map showing areas at risk of climate change impacts and accessible viable adaptive technology. To enhance the enabling environment, Thailand requires support for developing and strengthening mechanisms, instruments, and policy implementation, such as financial instruments and incentives to engage private sectors in green investment and capacity building for all stakeholders to integrate climate actions into their respective practice and plans.







# CHAPTER 1

## NATIONAL CIRCUMSTANCES



# CHAPTER 1: NATIONAL CIRCUMSTANCES

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Thailand, a developing country, is ranked 9<sup>th</sup> as the most affected country by climate change impacts in the last 20 years (2000–2019) by Global Climate Risk Index 2021 (CRI). Its long coastal zone of 24 provinces with a total area of 101,678 km<sup>2</sup>, a total coastal length of 3,151 km, and an approximately 20 million population are among the most vulnerable to climate risks, particularly coastal erosion. The devastating climate change crisis leads to substantial social and economic loss as coastal communities and economic activities, mainly fishery and tourism, are inevitably affected. Bangkok and its perimeter provinces adjoined to the coast and rivers are ranked as one of the top cities in the world at the highest risk of severe flooding resulting from precipitation change, sea-level rise, and coastal erosion under climate change.

Setting the stage, this chapter lays out Thailand's national circumstances in all climate-related domains displaying the social, environmental, and economic conditions and how they are intertwined with climate change. In addition, the link between the reported information and Thailand's implementation for achieving sustainable development is highlighted as sustainable development goals, and climate change actions are complementary and greatly aligned.

The physical context section reveals the country's vulnerability to climate impacts, whereas the energy section shows the extent to which Thailand relies on fossil fuels as the primary energy source. The natural resources section exhibits not only the abundance and absorptive capacity of natural resources but also the degrading conditions that occurred from economic activities and climate-induced disasters. The state of environment section seeks to report environmental quality and management in three sectors: air quality, water quality, and waste management. The section on national economic and social development sets out the national development objectives, priorities, and outlook as well as the key economic and social sectors vastly affected by and interlinked with climate change—agriculture, tourism, health, poverty and inequality, and gender equality.

As a final point, the chapter illustrates Thailand's establishment of inter-ministerial committees to oversee climate policy development and implementation and comprehensive national systems to monitor, evaluate, and report on progress. Two more subcommittees on carbon sequestration and CCUS have been instituted in the institutional arrangement to advance Thailand's climate actions.

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## 1.1 Physical Context

### 1.1.1 Geography

The Kingdom of Thailand is situated in the tropical zone of the Southeast Asia region between latitudes 5° 37' N and 20° 27' N and longitudes 97° 22' E and 105° 37' E, encompassing a total area of 513,115 km<sup>2</sup>. Thailand has territorial borders with Myanmar and Laos in the North, Laos and Cambodia in the East, Malaysia in the South, and Myanmar in the West. The significant topography of Thailand is a peninsula with a total coastal length of 3,151.02 km, consisting of the Andaman Sea coast of 1,111.04 km in the west and the Gulf of Thailand coast of 2,039.97 km in the east.

Source: 1) Thai Meteorological Department 2) Department of Marine and Coastal Resources



Figure 1-1 Map of the Kingdom of Thailand

Source: Department of Field Support Cartographic Section, United Nations

### 1.1.2 Administrative Area

**Region:** Thailand comprises the Northern high mountains, the Central plains, the Northeast plateau, and the Southern coastal plain. It was officially geographically divided into the six-regions system in 1977, and this continues to be the most well-known and commonly used division for local administration. The six official regions are 1) North, 2) West, 3) East, 4) Northeast, 5) South, and 6) Central.

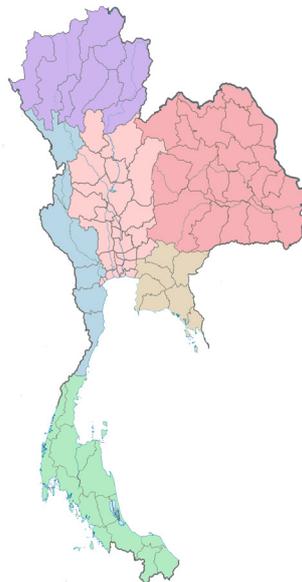


Figure 1-2: Thailand's six regions division

**Province:** Thailand is divided into 76 provinces, excluding the capital, Bangkok. Thailand's public administration is divided into 3 tiers: central, provincial, and local administration. The central administration comprises the ministries, departments, and bureaus. The positions at the field units are from each central department responsible for implementing government policies. The provincial government consists of provinces, and each province is divided into districts. The local administration consists of Provincial Administrative Organization, Municipality, and Sub-district Administrative Organization. There are also 2 special local governments under the local administration: Bangkok and Pattaya. While Pattaya is part of Chonburi Province (and therefore also subject to the provincial organization), Bangkok operates at the provincial level. Unlike the other 76 provinces, Bangkok is a particular administrative area, locally governed by the Bangkok Metropolitan Administration (BMA).

Source: Notification of the Department of Provincial Administration: Subject Administrative Information 2020, Department of Provincial Administration

### 1.1.3 Population

#### 1.1.3.1 Population Density

**Population density:** According to registration records, the total population of Thailand in 2021 was 66,171,439, making it the 20<sup>th</sup> most populated country in the world. Over the past decade, the average annual population growth rate has been around 0.4%.

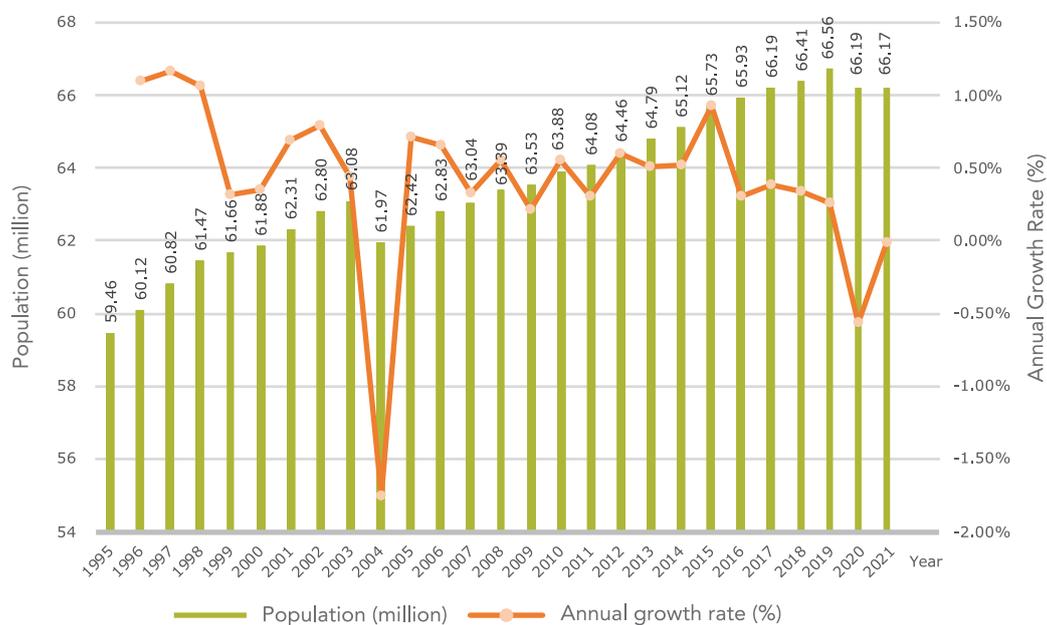


Figure 1-3: Population and Annual Growth Rate 1995-2021

Remark: In 2004, The Department of Provincial Administration reviewed and made necessary corrections to remedy double counting issues in Thailand's total population figures. Accordingly, this chart reflects the accurate, corrected figure of the country's total population.

Source: 1) National Statistical Office 2) Department of Provincial Administration 3) UN World Population Prospects 2019

### 1.1.3.2 Population Projections

**Population projections:** The population’s projection remains relatively the same as reported in the BUR3. It is projected to increase gradually and start to decline after 2030. Thailand’s population structure is becoming an “aging society” as it faces a decline in birth rate but an increase in life expectancy. By 2040, the aging population will be more than double that of the youthful population. This demographic transition translates into two challenges: 1) the development of a mechanism to support aging members of society, and 2) the development of national policies and plans to promote social and health services for mothers and newborns.

Considering this challenge, Thailand has developed the 5-year Quality Births project (2017-2021) and maternal mortality rate reduction plans for local areas and provinces. Research on the causes of maternal mortalities is conducted on a continuous basis. Furthermore, Thailand has advanced the implementation of the 2<sup>nd</sup> National Reproductive Health Development Policy Strategy (2017-2026), with provisions on pregnancy testing and antenatal care, birth costs, financial aid for newborn babies, maternity leave and compensation, provision of tax reductions for costs related to the care of babies, tax reductions for childcare facilities. These implementations also serve as progress relating to Sustainable Development Goal 3 (SDG3)—*Ensure healthy lives and promote well-being for all at all ages*.

Table 1-1: Thailand’s population projections from 2020-2040

Population Projections	2020	2025	2030	2035	2040
<b>1. Population</b>					
0-14 years	11,225,072	10,637,212	9,916,612	9,149,160	8,363,327
15-59 years	43,269,391	41,917,127	40,105,230	38,334,858	36,498,965
60 and over	12,040,221	14,534,657	17,118,697	19,102,768	20,510,045
<b>Total</b>	<b>66,534,684</b>	<b>67,088,996</b>	<b>67,140,539</b>	<b>66,586,786</b>	<b>65,372,337</b>
<b>2. Fertility Rates</b>	1.53	1.47	1.41	1.36	1.30
<b>3. Life Expectancy at Birth (years)</b>					
Men	73.23	74.33	75.27	76.07	76.75
Women	80.35	81.28	82.04	82.66	83.15

Source: 1) Population Projections 2013 and Study Report on Population Projection in Thailand 2019, Office of the National Economic and Social Development Council 2) Department of Provincial Administration

**Urbanization rate:** The urbanization rate remains the same as reported in the BUR3. The projection from 2010-2040 reveals that the population living in urban areas has been steadily increasing. By 2040, 74.3% of the population will live in urban areas.

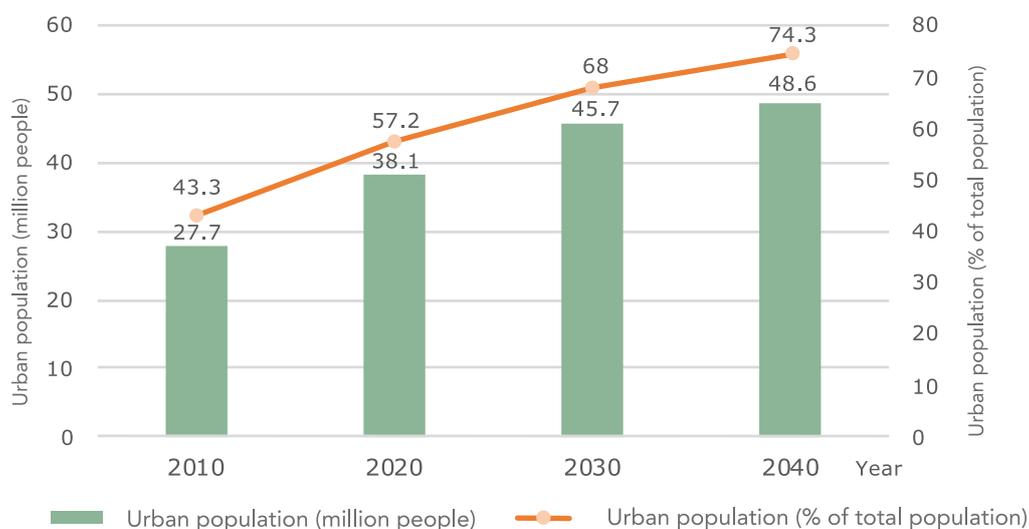


Figure 1-4: Urbanization rate 2010-2040

Source: Office of the National Economic and Social Development Council

## 1.1.4 Climate

### 1.1.4.1 Seasons and Temperature

Thailand’s climate is influenced by two main seasonal monsoon winds: the southwest monsoon and the northeast monsoon. The southwest monsoon starts in May and brings a stream of warm, moist air from the Indian Ocean toward Thailand, causing abundant rain over the country, especially on the windward side of the mountains. The northeast monsoon starts in October and brings cold, dry air from the anticyclone in the Chinese mainland over major parts of Thailand, mainly focused on the north and northeast regions. The climate of Thailand can be broadly divided into 3 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.

Data on temperature fluctuations in Thailand over the ten-year period of 2012-2021 showed the highest temperature period. These high temperatures are likely to continue to rise. In April 2016, Thailand recorded its highest temperature since 1951 at 44.6°C in Mae Hong Son province. 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. The annual mean maximum temperature in 2020-2021 is 33.7°C and 33.0°C. The annual mean minimum temperature in 2020-2021 is 23.5°C and 23.2°C. The annual mean temperature (Dry-Bulb) in 2020-2021 is 28.0°C and 27.5°C.

Source: Thai Meteorological Department

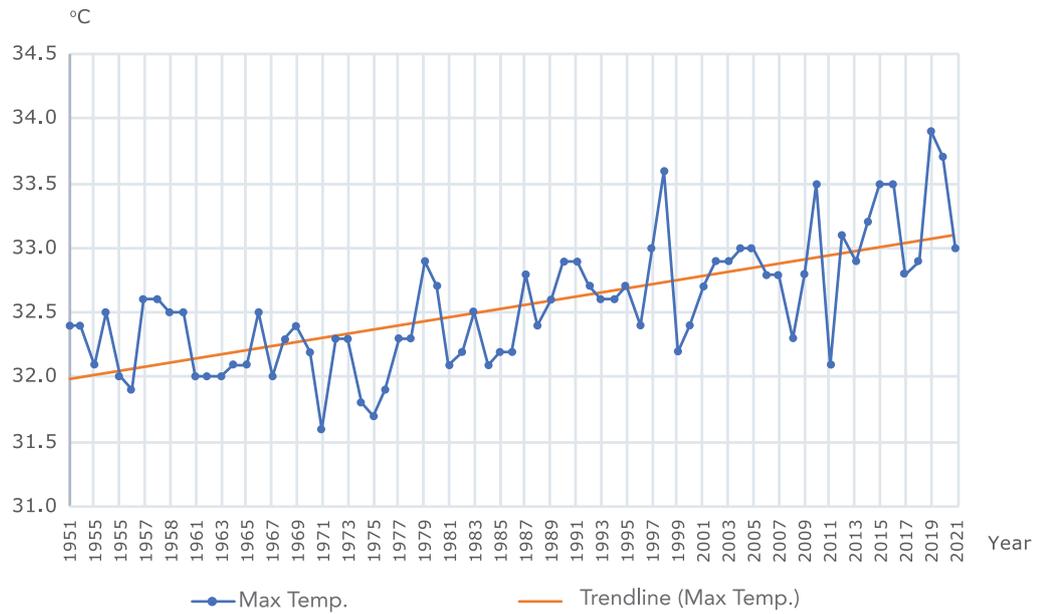


Figure 1-5: Annual Mean Maximum Temperature in Thailand (°C) 1951-2021

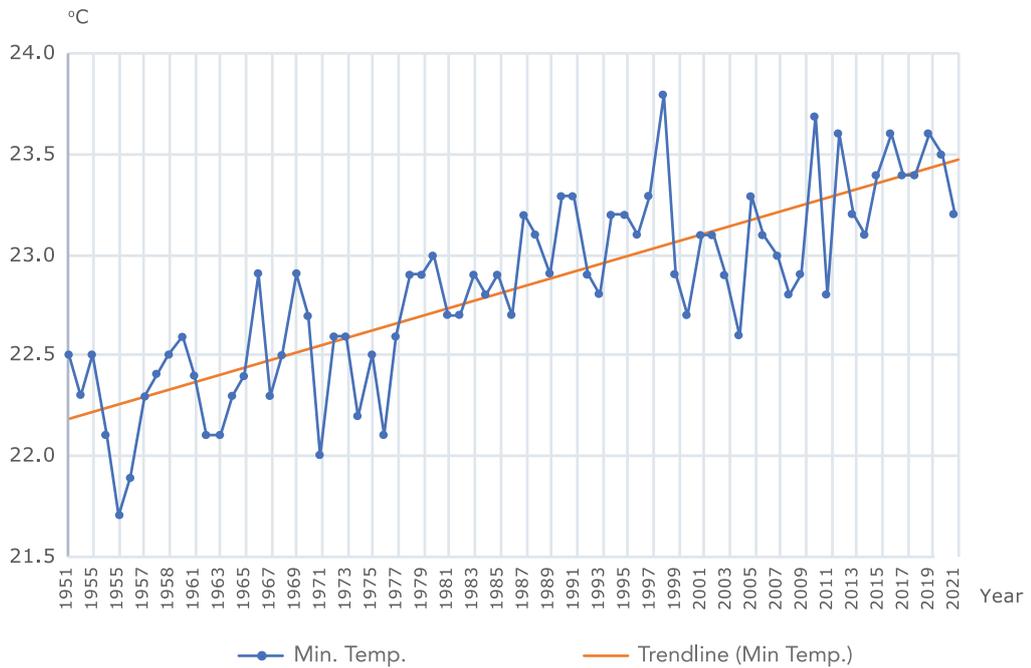


Figure 1-6: Annual Mean Minimum Temperature in Thailand (°C) 1951-2021

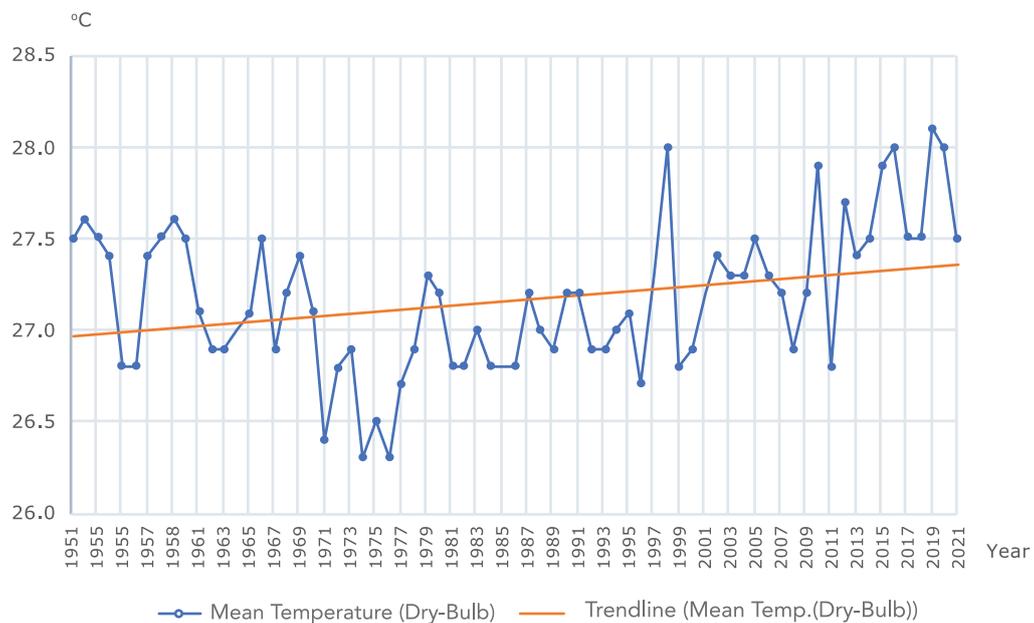


Figure 1-7: Annual Mean Temperature (Dry-Bulb) in Thailand (°C) 1951-2021

Source: Thai Meteorological Department

### 1.1.4.2 Precipitation

Based on the Thai Meteorological Department’s climate change reports, the variation of precipitation and the number of rainy days has oscillated over time. In the last 7 years (2015-2021), the rainfall variation has fluctuated, 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) since the record began in 1951. The annual rainfall in 2020 and 2021 was recorded at 1,528.8 mm and 1,759.3 mm.

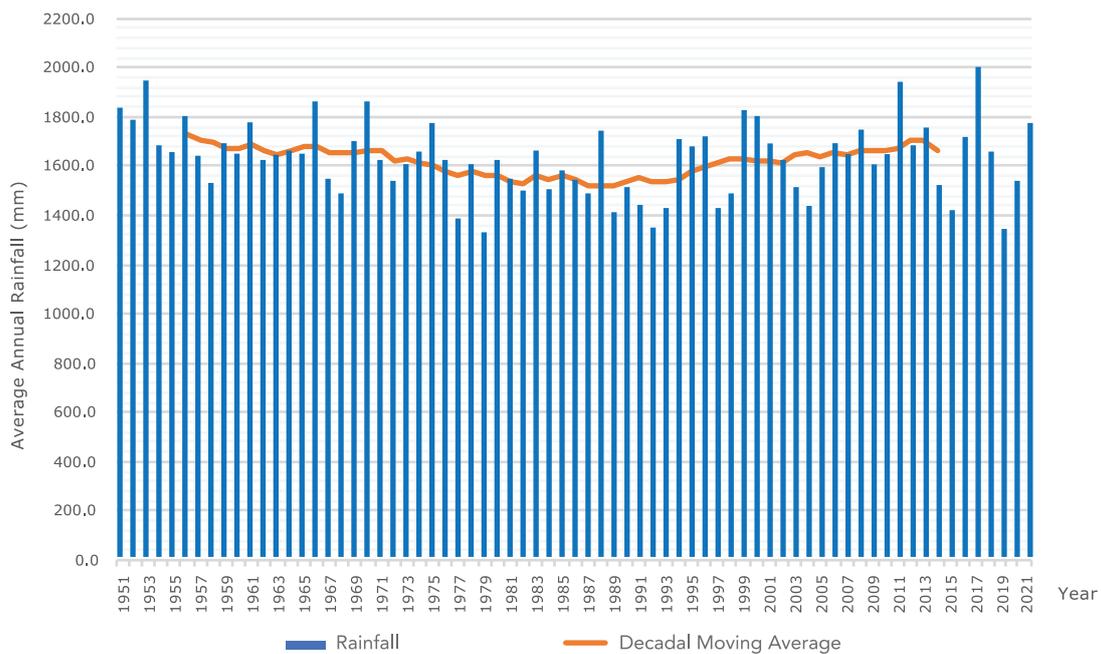


Figure 1-8: Annual Mean Rainfall in Thailand (mm) 1951-2021

Source: Thai Meteorological Department

## 1.2 Energy

### 1.2.1 Energy Consumption

In 2020, Thailand’s energy consumption was 77,340 ktoe, a decrease of 9.8% from the previous year. The total value of final energy consumption was 1,245 billion THB. Commercial energy consumption was 86.4% of the total final energy consumption, while renewable energy was 8.7%, and traditional renewable energy was 4.9%. Total final commercial energy consumption was 66,821 ktoe. Of this amount, petroleum products consumption totaled 37,124 ktoe, electricity 16,761 ktoe, coal and its products 7,983 ktoe, and natural gas 4,953 ktoe. Renewable energy consumption was 6,717 ktoe, including solar, fuelwood, paddy husk, bagasse, agricultural waste, MSW, and biogas. Traditional renewable energy consumption was 3,802 ktoe, including fuelwood, charcoal, paddy husk, and agricultural waste from the previous year. However, consumption of petroleum products played the greatest proportion, 48.0% of the total final energy consumption, followed by electricity, coal and its products, renewable energy, natural gas, and traditional renewable energy shared 21.67%, 10.32%, 8.69%, 6.40%, and 4.92%, respectively.

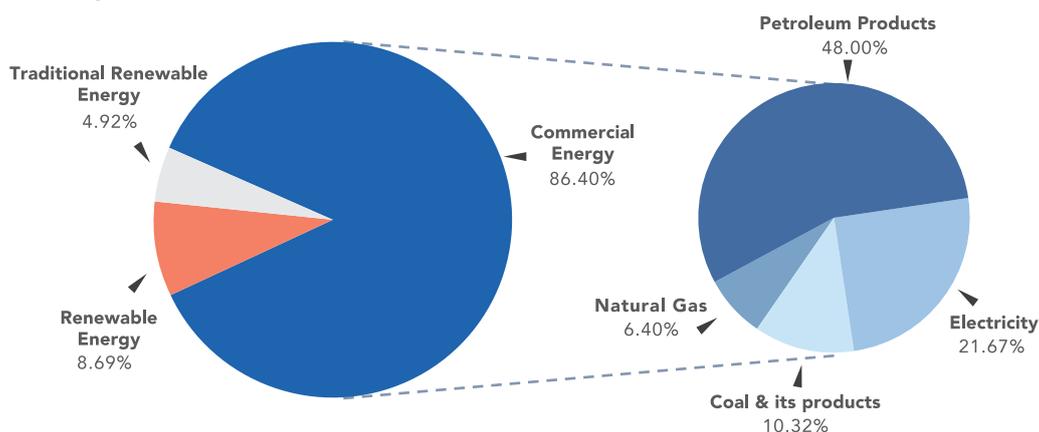


Figure 1-9: Final Energy Consumption by Fuel Type 2020

Source: Energy Balance of Thailand 2020, Department of Alternative Energy Development and Efficiency

Table 1-2: Final energy consumption by fuel type 2018-2020

Final energy consumption by fuel type	Quantity (ktoe)			Growth (%)	
	2018	2019	2020	2019	2020
<b>Final Energy Consumption</b>	83,952	85,708	77,340	2.09	-9.76
<b>Commercial Energy</b>	70,822	72,126	66,821	1.84	-7.36
• Petroleum Products	41,383	42,084	37,124	1.69	-11.79
• Electricity	16,805	17,358	16,761	3.29	-3.44
• Coal and Coal Products	6,865	7,116	7,983	3.66	12.18
• Natural Gas	5,769	5,568	4,953	-3.48	-11.05
<b>Renewable Energy</b>	7,919	8,525	6,717	7.65	-21.21
<b>Traditional Renewable Energy</b>	5,211	5,057	3,802	-2.96	-24.82

Source: Energy Balance of Thailand 2020, Department of Alternative Energy Development and Efficiency

The energy consumption by economic sectors was distributed among the following: the agricultural sector amounted to 2,318 ktoe, the industrial sector (including manufacturing, mining, and construction) amounted to 28,837 ktoe, the residential sector 10,150 ktoe, the commercial sector 6,336 ktoe, and the transport sector 29,699 ktoe. Of this total, the most significant proportion is the energy consumed in the transport sector sharing at 38.4%. The industrial, residential, commercial, and agricultural sectors shared 37.29%, 13.12%, 8.19%, and 3.0%, respectively.

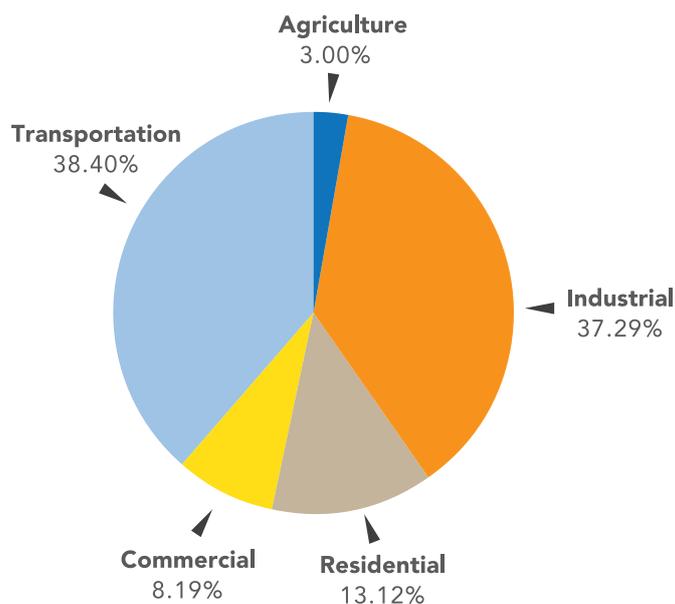


Figure 1-10: Final Energy Consumption by Economic Sectors 2020

Source: Energy Balance of Thailand 2020, Department of Alternative Energy Development and Efficiency

### 1.2.2 Energy Production

**Energy production** was 65,821 ktoe in 2020, a decrease of 11.8% from the previous year. Classified by commercial energy production contributed 63.61% of the total energy production, renewable energy 24.34%, traditional renewable energy 7.87%, biofuel 3.56%, and other energy 0.62%. Total commercial energy production was 41,871 ktoe. This amount consisted of crude oil 5,860 ktoe, lignite 3,282 ktoe, natural gas 28,865 ktoe, and condensate 3,864 ktoe. The proportion of total renewable energy production (i.e., solar, wind, hydro, geothermal, fuelwood, paddy husk, bagasse, agricultural waste, MSW, and biogas) was 16,020 ktoe. Traditional renewable energy, including fuelwood, charcoal, paddy husk, and agricultural waste, was 5,179 ktoe and biofuel was 2,343 ktoe. Other energy (black liquor & residual gas) was 408 ktoe.

Table 1-3: Energy production by fuel type 2020

Energy Production	Quantity (ktoe)			Growth (%)	
	2018	2019	2020	2019	2020
<b>Total Energy Production</b>	72,609	74,592	65,821	2.73	-11.76
<b>Commercial Energy</b>	45,828	46,188	41,871	0.79	-9.35
• Crude Oil	6,453	6,178	5,860	-4.26	-5.15
• Lignite	3,756	3,532	3,282	-5.96	-7.08
• Natural Gas	31,122	31,871	28,865	2.41	-9.43
• Condensate	4,497	4,607	3,864	2.45	-16.13
<b>Renewable Energy*</b>	17,156	18,670	16,020	8.82	-14.19
<b>Traditional Renewable Energy**</b>	7,012	6,842	5,179	-2.42	-24.31
<b>Biofuel</b>	2,113	2,422	2,343	14.62	-3.26
<b>Other Energy***</b>	500	470	408	-6.00	-13.19

\* solar, wind, hydro geothermal, fuelwood, paddy husk, bagasse, agricultural waste, MSW, and biogas

\*\* fuelwood, charcoal, paddy husk, and agricultural waste

\*\*\* black liquor and residual gas

Source: Energy Balance of Thailand 2020, Department of Alternative Energy Development and Efficiency

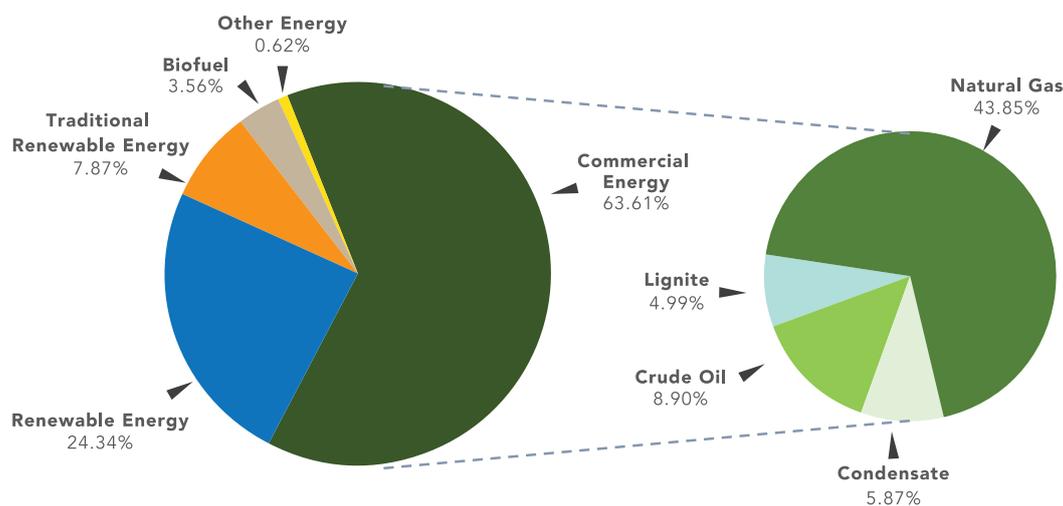


Figure 1-11: Energy Production by Fuel Type 2020

Source: Energy Balance of Thailand 2020, Department of Alternative Energy Development and Efficiency

**Total energy import** in 2020 was 77,199 ktoe, a decrease of 0.6% from the previous year. Nearly all energy import was commercial energy, sharing 99.9% of the total energy import and the rest 0.1% proportion was traditional renewable energy. The commercial energy import was in a total of 77,155 ktoe. This amount consisted of crude oil import 42,291 ktoe, coal import 14,908 ktoe, petroleum products import 1,862 ktoe, natural gas import 14,064 ktoe, condensate import 1,512 ktoe, electricity import 2,518 ktoe, and traditional renewable energy which is fuelwood and charcoal import 44 ktoe.

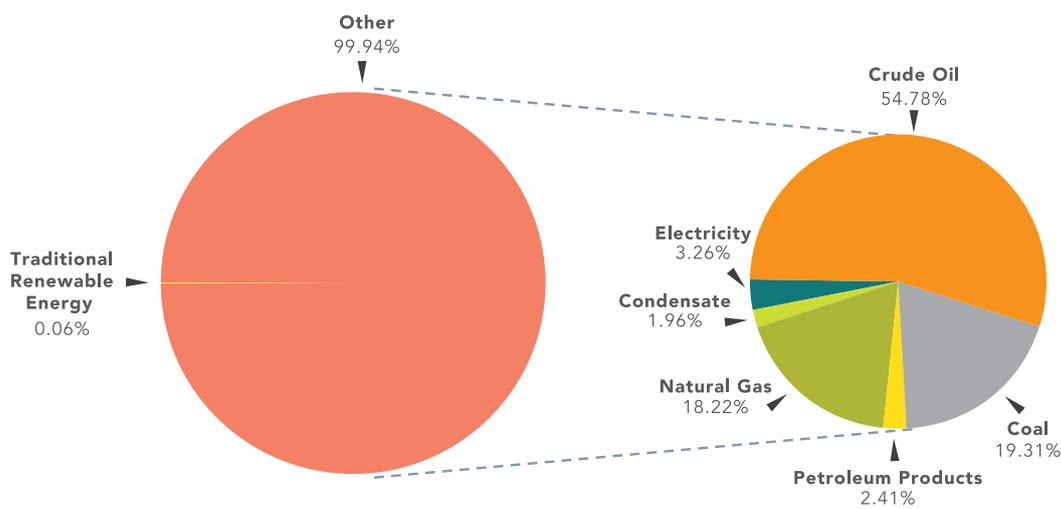


Figure 1-12: Import of Energy by Fuel Type 2020

Source: Energy Balance of Thailand 2020, Department of Alternative Energy Development and Efficiency

**Total energy export** was 10,812 ktoe in 2020, an increase of 6.2% from the previous year. Commercial energy was shared 99.9% of the total energy export, and the rest proportion of 0.1% was the traditional renewable energy and biofuel. The commercial energy export was 10,800 ktoe, consisting of petroleum products as the most considerable amount with a total of 9,253 ktoe, crude oil of 1,230 ktoe, electricity of 222 ktoe, natural gasoline of 51 ktoe, and coal of 44 ktoe. The traditional renewable energy, including fuels wood and charcoal of 12 ktoe, was exported.

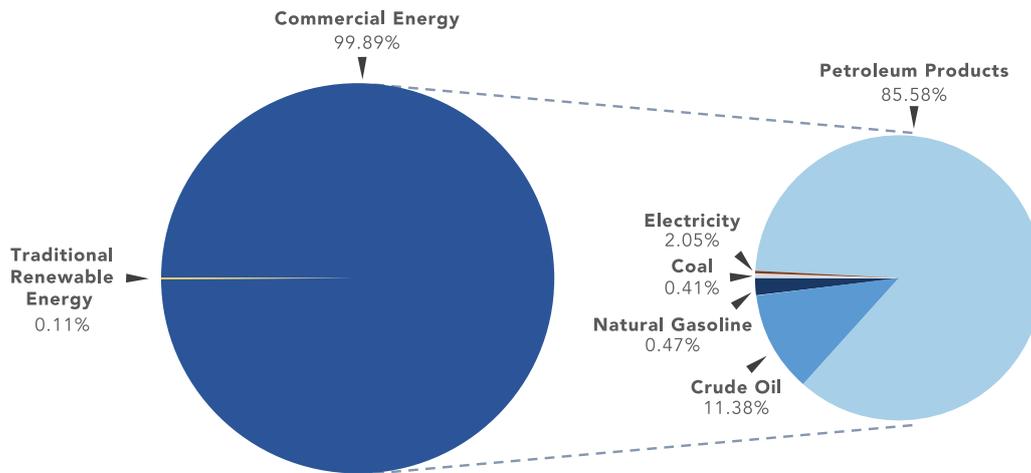


Figure 1-13: Export of Energy by Fuel Type 2020

Source: Energy Balance of Thailand 2020, Department of Alternative Energy Development and Efficiency

In 2020, there were 7 petroleum refinery plants with a total capacity of 1,244,500 barrels per day (bpd), 6 natural gas processing plants totaling 2,870 MMscf per day, and one more small plant for gas processing to produce LPG unit with a total capacity of 163.3 MMscf per day. In 2020, the total petroleum products produced from the petroleum refineries plant comprised diesel oil, gasoline, LPG, fuel oil, jet fuel, and kerosene by 47.8%, 20.7%, 16.2%, 7.5%, 5.2%, and 2.6%, respectively.

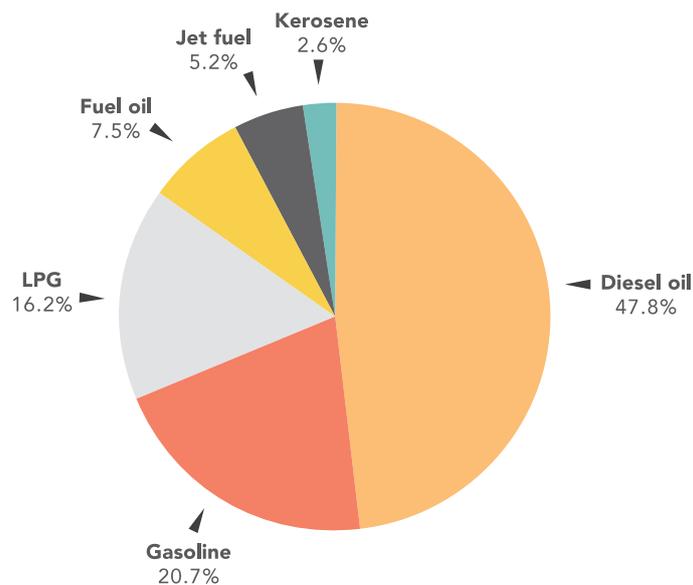


Figure 1-14: The proportion of petroleum products production in 2020

Source: Energy Balance of Thailand 2020, Department of Alternative Energy Development and Efficiency

Natural gas, the primary fuel for electricity generation, was shared 59.1% of the total fuel consumption in electricity generation. The followings were coal/lignite 17.6% and fuel/diesel oil 0.1%. The rest (renewable energy and other energy) was 23.2%.

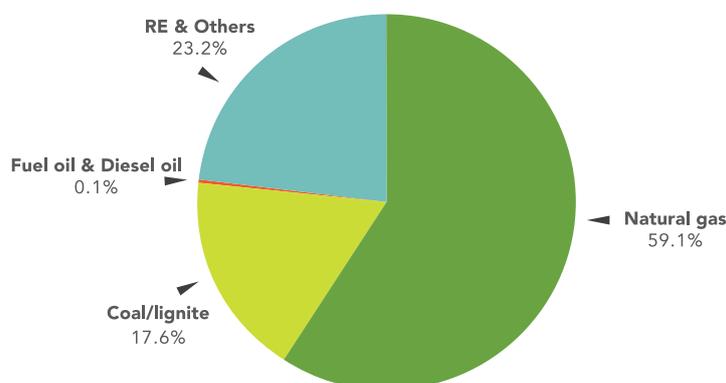


Figure 1-15: The proportion of fuel consumption for electricity generation in 2020

Source: Energy Balance of Thailand 2020, Department of Alternative Energy Development and Efficiency

### 1.2.3 Alternative Energy

**Consumption Situation:** Energy consumption from alternative energy produced in the country comprises solar energy, wind energy, hydro energy, biomass, biogas, MSW, and biofuel (ethanol and biodiesel). In 2020, Thailand’s alternative energy consumption was 11,997 ktoe, a decrease of 15.13% from the previous year. Of this amount, alternative energy consumption in terms of electricity, heat, and biofuel (ethanol and biodiesel) shared 15.5% of the total final energy consumption. The electricity consumption produced from alternative energy was 2,903 ktoe, and heat consumption was 6,717 ktoe. The biofuel consumption from ethanol was 765 ktoe, and that from biodiesel was 1,612 ktoe

Table 1-4: Alternative energy consumption 2020

Alternative Energy Consumption	Quantity (ktoe)			Growth (%)
	2018	2019	2020	2020
<b>1. Electricity* (solar, wind, hydroelectricity, biomass, MSW and biogas)</b>	2,960	3,239	2,903	-10.37
<b>2. Heat** (solar, biomass, MSW and biogas)</b>	7,919	8,525	6,717	-21.21
<b>3. Biofuel</b>				
• Ethanol	781	829	765	-7.72
• Biodiesel	1,336	1,543	1,612	4.47
<b>Total</b>	12,996	14,136	11,997	-15.13

Source: Energy Balance of Thailand 2020, Department of Alternative Energy Development and Efficiency

**Energy Efficiency Situation:** In 2020, energy intensity significantly improved, with a decrease of 7.53% from 2010. A decline resulted from the Government's energy-efficiency policy, particularly Thailand's National Energy Efficiency Plan of 2018–2037 targeting Energy Intensity (EI) reduction in 2037 by 30% from the base year of 2010. The Energy Efficiency Plan provides financial assistance and incentives for energy projects related to energy conservation, renewable energy, research and development, public awareness promotion, and training on energy efficiency.

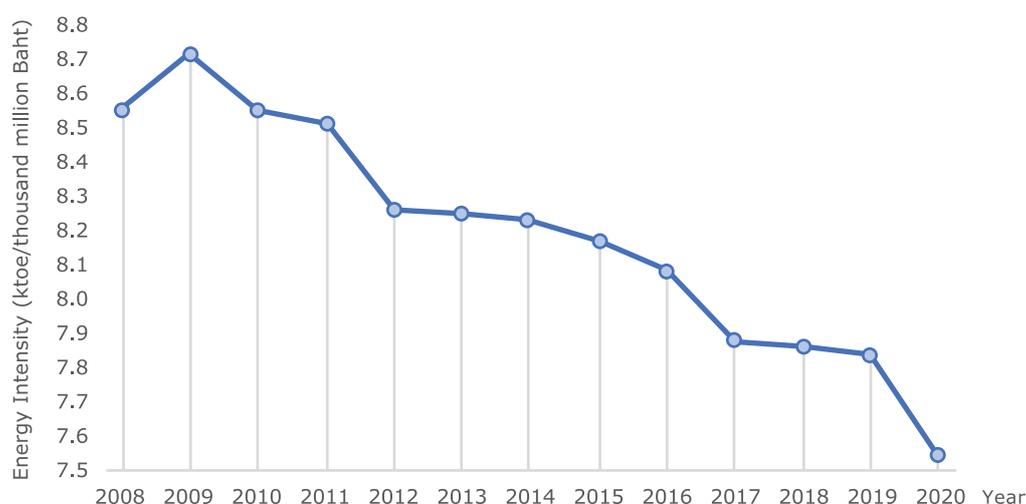


Figure 1-16: Energy Efficiency Situation in 2020

Source: Energy Balance of Thailand 2020, Department of Alternative Energy Development and Efficiency

The main achievements of energy development targeting indicators for SDG 7—*Ensure access to affordable, reliable, sustainable, and modern energy for all*, focused on three areas:

- *Access to energy:* Thailand has made significant progress in access to electricity from 82.1% in 2000 to 99.21% in 2020. This is due to the efforts to promote local energy generation in far-off areas and increase the generation efficiency throughout the energy chain.
- *Uptake in renewable energies:* Thailand aims to increase the percentage of renewable energy in final gross consumption to 24.08% by 2030. In 2020, renewable energy constituted 15.99% of final gross consumption, an increase from 10.9% in 2011.
- *Improve energy efficiency:* Thailand's Government aims to reduce Energy Intensity (EI) by 30% by 2036 compared to levels from 2010. In 2019, EI stood at 7.85%, which was an 8.08% decrease and equaled the saving of 7,541 ktoe.

Source: Thailand's Voluntary National Review on the Implementation of the 2030 Agenda for Sustainable Development 2021, Ministry of Foreign Affairs

1.3 Natural Resources

1.3.1 Land Resources and Forestry

Thailand’s total land area is approximately 513,115 km<sup>2</sup>. Forest land and non-agricultural land comprised 163,975 km<sup>2</sup> and 110,337 km<sup>2</sup> or 31.95% and 21.51%, respectively. Agricultural land accounted for 238,803 km<sup>2</sup> or 46.54% of the total land area. The attribution of agricultural land consisted of paddy land 46.04%, fruit and perennial trees 24.75%, upland field crops 20.59%, and vegetables, cut flowers, and ornamental plants 0.94%.

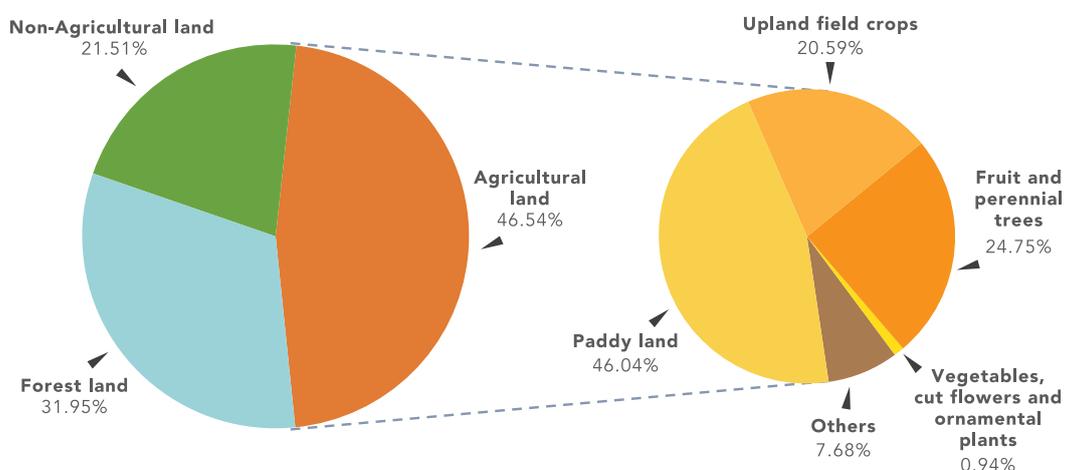


Figure 1-17: Land resources and forestry in 2020

Source: Agricultural Statistics of Thailand 2018, Office of Agricultural Economics

From the 2018-2020 statistic record of the Royal Forest Department, the forest area in Thailand was relatively stable, at an average of 31% of the total land area. The forest types in Thailand can be categorized as follows: Moist Evergreen Forest, Dry Evergreen Forest, Montane Forest, Pine Forest, Peat Swamp Forest, Mangrove Forest, Freshwater Swamp Forest, Beach Forest, Mixed Deciduous Forest, Dry Dipterocarp Forest, Bamboo Forest, Teak Plantation, Other Plantations, Secondary Forest, Savanna, and Vegetation on Pen Rock Platform Areas.

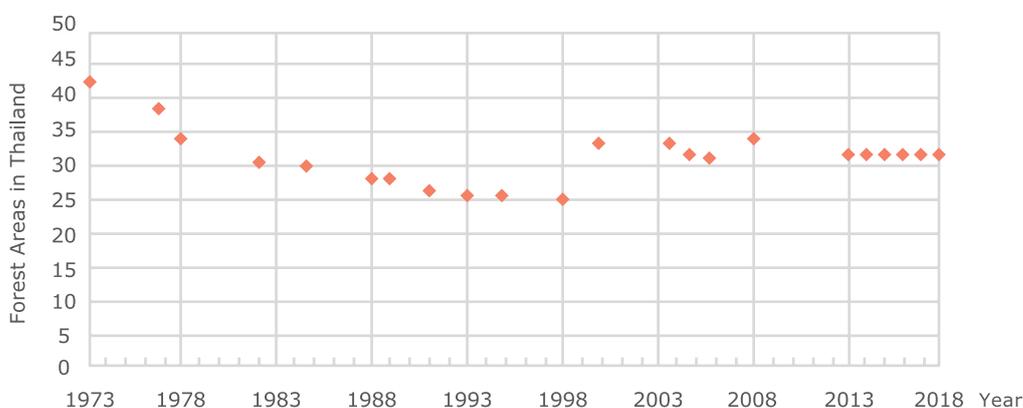


Figure 1-18: Forest area in Thailand in 2020

Source: Office of the Forest Land Management, Royal Forest Department

The forest area deteriorates from deforestation and forest fire, which occur from extreme heat and drought as part of the climate change impacts and agricultural burning. Striving to tackle the problems and achieve SDG goal 15—*Protect, restore, and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification, halt and reverse land degradation and halt biodiversity loss*, Thailand has taken the following steps:

- *Legal instruments*: Thailand enacted laws, regulations, and measures to manage and maintain the richness of the forest and its ecosystem. Key legal instruments include the Forest Act (1941), National Reserved Forest Act (1964), Wild Animal Reservation and Protection Act (1992), Commercial Forest Plantation Act (1992), Chain Saws Act (2002), National Park Act (2019), and the Community Forest Act (2019).

- *Strategic plan*: The 5<sup>th</sup> strategy of the 20-Year National Strategy (2018-2037)—*environmentally growth for sustainable development*—aims to prevent deforestation and increase forest areas to 55% by 2037. The 20-Year Strategic Plan for the Ministry of Natural Resources and Environment (2017-2036) further elaborates in the first strategy that the goal is to protect and conserve forest areas for sustainable development of natural resources and biodiversity, including monitoring and preventing forest fires.

- *Forest conservation*: In 2020, Thailand expanded forest conservation from 105,696 km<sup>2</sup> in 2006 to 116,304 km<sup>2</sup>. This is equivalent to 23% of the total land area, including 22 national parks extending across 6,416 km<sup>2</sup>.

*Source: 1) Office of Agricultural Economics 2) Office of the Forest Land Management, Royal Forest Department 3) Department of National Parks, Wildlife, and Plant Conservation 4) Thailand's Voluntary National Review on the Implementation of the 2030 Agenda for Sustainable Development 2021, Ministry of Foreign Affairs 5) Office of Natural Resources and Environmental Policy and Planning*

### 1.3.2 Water Resources

Thailand has 22 major river basins and 353 sub-basins. There are 27 groundwater sources, contributing around 1,130 billion m<sup>3</sup>. Of this amount, only roughly 45 billion m<sup>3</sup> per year has the potential to be extracted for utilization. In 2020, the natural surface flow was about 199 billion m<sup>3</sup>, a 31.4% increase from the previous year. In 2021, the total demand for water activities was about 100 billion m<sup>3</sup>. The most significant demand was for agriculture, representing 82.50%, followed by the demand for ecosystem conservation, consumption, and industry at 12.81%, 3.73%, and 0.98%, respectively.

Thailand has experienced problems with water resources, such as water shortage, drought, floods, decreased groundwater levels, and saltwater intrusion in groundwater sources. Severe droughts in 1979, 1994, and 1999 affected almost every part of the country. There have been an increasing number of recurring droughts over the last 10 years, which have affected a total area of around 42,280 km<sup>2</sup>. Over the past 30 years, Thailand has experienced flooding in almost all provinces, causing damage to life, property, and the economy. In 2011, Thailand faced severe flooding, which impacted over 13 million people, with economic damage costing more than 1.44 trillion THB.

Therefore, aiming to manage the country's water resources effectively and align with SDG 6—*Ensure availability and sustainable management of water and sanitation for all*, Thailand has set the 20-Year National Strategy (2018-2037) and formulated the 20-Year Master Plan on Water Resources Management (2018-2037) with 6 key focus areas: management of water use, security of water production, inundation control, water quality conservation, afforestation in watershed areas and soil protection, and managing approach. Thailand has made overall achievements as follows:

- *Access to clean water*: Thai people have been able to sufficiently access drinking water, with the proportion of household members able to access clean drinking water rising from 97% in 2012 to 98% by 2016 and 99.5% in 2019. Government efforts to provide clean water for villages without existing plumbing systems have been successful, with the number of such villages reduced from 7,321 to 169.

- *Water quantity*: In 2019, the Royal Irrigation Department increased water storage capacity by 16.7 million m<sup>2</sup> and increased the amount of irrigated land by 188,296 rai. The Department of Water Resources and the Department of Groundwater Resources excavated an additional 2,228 pools and developed a plan to renovate 3,400 km of water pipes in order to reduce the amount of water lost in Bangkok, Nonthaburi, and Samutprakan. A target was set to reduce the amount of water lost from 25% to 20%.

- *Water quality*: In 2019, the Ministry of Interior, as the responsible agency for developing the water consumption system, installed water systems in 1,197 villages across the country and expanded water systems in all provinces and the Bangkok Metropolis to over 26,000 additional households.

- *Ecosystem*: The Government has advanced the protection and revival of ecosystems linked to water sources. During 2018-2019, Thailand implemented measures to revive 110,921 rai of upwater forest areas, which represents 15% of the target set in the Water Management Masterplan.

*Source: 1) 22 Basins and Designated River Basin Decree 2021, Report on Water Resource Management Plan 2021, and the 20-Year Master plan on Water Resources Management 2018-2037, Office of National Water Resources 2) Department of Groundwater Resources 4) Department of Water Resources 5) Thailand's Environmental Circumstance 2021, Office of Natural Resources and Environmental Policy and Planning 6) Thailand's Voluntary National Review on the Implementation of the 2030 Agenda for Sustainable Development 2021, Ministry of Foreign Affairs*

### 1.3.3 Marine Resources

Thailand has 24 coastal provinces, with a total area of 101,678 km<sup>2</sup> and a coastal length of 3,151.02 km. The total maritime territory is 321,247 km<sup>2</sup>, consisting of Internal Waters 61,023 km<sup>2</sup>, Territorial Sea 52,216 km<sup>2</sup>, Contiguous Zone 37,185 km<sup>2</sup>, Exclusive Economic Zone 163,644 km<sup>2</sup>, and Thai-Malaysia Joint Development Area 7,179 km<sup>2</sup>.

Marine and coastal resources entail 2,779 km<sup>2</sup> of mangroves, 256 km<sup>2</sup> of seagrass, 238 km<sup>2</sup> of coral reefs, 971 islands, and 609 beaches. The coastal area and marine resources have been adversely affected by climate change impacts and the expanding economic activities, causing many critical problems such as coastal erosion, coral bleaching, acidification of seawater, degradation of coral reefs and seagrass, depletion of marine animals, and increased marine plastic litter.

Thailand has acknowledged the degradation of marine environmental resources and the severe impacts of climate change; thus, it seeks to address the problems and implement SDG 14—*Conserve and sustainably use the oceans, seas, and marine resources for sustainable development*. Thailand has accomplished the following:

- *Legal ground:* The Department of Marine and Coastal Resources (DMCR) is the key government agency in enforcing management and conservation measures under the Marine and Coastal Resource Management Promotion Act 2015. The Act is a policy-based legal tool that sets out the principles and methodologies for responsible government agencies to manage coastal and marine resources efficiently and effectively. It also stresses the significance of public participation in the management process.

- *Implementations:* From 2017 to 2020, key initiatives and implementations for resources conservation and restoration include research on coral bleaching and acidification of seawater, planting coral and seagrass, establishing a marine life rescue center for rare species, and enforcing preventive measures for Illegal, Unreported, and Unregulated fishing (IUU). Spatial ecosystem management has been promoted by growing and restoring over 263,008 m<sup>2</sup> of coral reefs and 96,000 m<sup>2</sup> of seagrass and installing 4,710 artificial reefs in 8 sites across 7 provinces.

- *Protected areas:* Thailand has designated 35 marine protected areas extending across 15,336 km<sup>2</sup>, or 4.74% of the country's total maritime zone. Six other areas totaling 11,865.29 km<sup>2</sup>, or 3.67% of the total maritime zone, are currently being reviewed. By 2030, Thailand aims to declare 10% of its total maritime zone as marine protected areas according to the National Reform Plan.

- *Marine plastic pollution:* Thailand set out its policies and measures to reduce single-use plastic production and consumption, particularly to address plastic pollution in coastal and marine areas. Aligning with Waste Management Master Plan (2016-2022) and Plastic Waste Management Road Map (2018-2030), DMCR has implemented many projects and activities with the Marine and Coastal Resources Research & Development Institute to reduce plastic marine litter. The activities include researching the effects of marine plastic litter on the marine environment and animals, collecting marine plastic litter data, analyzing microplastics in the marine environment with Fourier Transform Infrared Spectroscopy (FT-IR), organizing International Coastal Cleanup (ICC), collecting plastic litters using SCG-DMCR Litter Trap and the Ocean Cleanup Interception BV (on-going importation process). As a result, as of 2020, Thailand eliminated 199 tons of marine plastic litter.

## CHAPTER 1

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- *Technology*: The government advanced the application of satellite remote sensing for marine pollution and ships investigations using satellite images from TERRA/AQUA, which allows for seawater quality monitoring, the development of a seawater quality database through the SNAPP and NOAA-20 satellites, and the development of PyGNOME, a system to provide area-specific water direction and speed forecasts.

Source: 1) Department of Marine and Coastal Resources 2) *From Pollution to Solution: A Global Assessment of Marine Litter and Plastic Pollution 2021*, UNEP

### 1.3.4 Biodiversity

Thailand is one of the most biodiverse countries in Southeast Asia. According to the ONEP's report on Thailand's biodiversity status in 2020, national biodiversity can be classified into four groups:

1. Ecosystems: 7 types of Thailand's ecosystems are forest, mountain, agriculture, marine and coastal, island, inland water, and dry and semi-humid.

2. Plant species: From the publication of *Flora of Thailand* in 2015, Thailand hosted around 12,050 plant species. Later, various national and international botany journals on plant taxonomy published from 2014 to 2020 revealed 239 new plant species in Thailand.

3. Animal species: There are more than classifiable 6,928 invertebrate species and 5,005 vertebrate species in 2021, an increase of 274 species from 2015. Of all the vertebrate species, 676 are listed as threatened species, with 141 critically endangered, 191 endangered, and 344 vulnerable.

4. Microorganism species: There are over 200,000 species that are diverse in terms of species, genetic, and ecological contexts.

Biodiversity condition in Thailand is threatened by the increased socio-economic activities and climate change impacts which may cause severe biodiversity loss and degraded ecosystems. ONEP, as a national focal point of the Convention on Biological Diversity (CBD), has initiated many implementations to fulfill the commitments under the CBD, such as developing the World Biodiversity Framework 2020, organizing activities for the International Day for Biological Diversity 2020, formulating the Fifth Global Biodiversity Outlook: GBO5, and organizing the Summit on Biodiversity and other related meetings.

For domestic operations, ONEP has worked as a secretary in the National Biodiversity Conservation and Exploitation Committee, responsible for proposing guidelines, policies, measures, and plans for the conservation and exploitation of the country's biodiversity to the Cabinet, including providing policy recommendations for integrating and linking

strategic operations under the plan to achieve goals and maneuvering the Integrated Biodiversity Management Master Plan 2015-2021. The Master Plan adopted the Strategic Plan for Biodiversity 2011-2020 as a framework for the operation's direction, focusing on conservation, restoration, protection, and exploitation of biodiversity and ecosystem services. The implementation of the Master Plan is in line with the Sustainable Development Goals 2, 6, 14, and 15, which focus on 1) maintaining, protecting, and restoring biodiversity, 2) stopping biodiversity threats, 3) promoting access and benefit-sharing of genetic resources and local wisdom in an equitable and justifiable manner, and 4) promoting the sustainable management and exploitation of terrestrial and marine ecosystems. In addition, ONEP has drafted the Biodiversity Bill, a harmonized law for unifying biodiversity management that promotes and supports the conservation and sustainable exploitation of biodiversity. The Bill aims to eliminate the disparities of legal enforcement on biodiversity issues and serves as an effective mechanism for integrating biodiversity into policies of relevant sectors.

According to the 2030 Agenda for Sustainable Development, maintaining biodiversity richness by supporting sustainable use within regenerating capacity of its components is the key mission to ensure the equilibrium between economic development and environmental protection, as indicated in SDG 15—*Protect, restore and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification and halt and reverse land degradation and halt biodiversity loss*. Thailand's overall achievements include:

- *Financial support*: the Government has increased environmental budgets every year. In 2021, the budget increased from 2019 by 88.32% (from 8.572 billion THB in 2019 to 16.143 billion THB in 2021). An additional 13.267 billion THB has been allocated to conserve biodiversity from 2017 to 2022.
- *Conservation*: Thailand has designated wetlands of importance to natural ecosystems, registered under the Ramsar Convention on Wetlands of International Importance. Thailand also designated biosphere reserves (limited to terrestrial ecosystem) extending across 2,672 km<sup>2</sup> in 2020.
- *Operation center*: The Government has preserved and promoted a healthy forest ecosystem by establishing Forest Protecting Operation Centers. The Centers provide an integrated platform and serve as the headquarters for anti-deforestation operations, the reclamation of forest areas from illegal ownership, the management of national parks in accordance with IUCN Green List Standards, and efforts to promote patrolling standards reform in reserved forest areas.
- *Biodiversity loss prevention*: Natural habitat loss, including forest and coastal ecosystems, has decreased. In 2019, forest areas in the country extended over 163,984 km<sup>2</sup>, or 31.68% of the country's total land area. This amount increased slightly from 2017. In 2018, the mangrove area extended 4,576 km<sup>2</sup>, increasing by 86.37% from 2014. Overall, grass resource areas remain at the same level and are in better health. Coral reefs now extend across 238.44 km<sup>2</sup>, increasing by 0.05% from 2015. Compared

to 2015, the growth rate for coral reefs looks set to continue at the same rate. From 2017-2018, the wetlands area extended to 5,792.3296 km<sup>2</sup>, increasing from 2015-2016 by 5.06%.

*Source: 1) Report on Thailand's Biodiversity Status in 2020 and Thailand's Environmental Circumstance 2021, Office of Natural Resources and Environmental Policy and Planning 2) Thailand's Voluntary National Review on the Implementation of the 2030 Agenda for Sustainable Development 2021, Ministry of Foreign Affairs 3) United Nations Global SDG Indicators Database 4) Office of Natural Resources and Environmental Policy and Planning*

### 1.4 State of the Environment

#### 1.4.1 Air Quality

Six major air pollutants in Thailand are Sulphur Dioxide (SO<sub>2</sub>), Nitrogen Dioxide (NO<sub>2</sub>), Carbon Monoxide (CO), Ozone (O<sub>3</sub>), Volatile Organic Compounds (VOCs), and particulate matters (i.e., particulate matter <10 microns: PM<sub>10</sub>, and <2.5 microns: PM<sub>2.5</sub>). Overall air quality in 2020 was relatively improved compared to the previous year. In particular, the yearly average amount of PM<sub>2.5</sub> was 23 micrograms per cubic meter (µg/m<sup>3</sup>), 8% decreased from 2019, and PM<sub>10</sub> was 43 µg/m<sup>3</sup>, 9% decreased from 2019. The highest 8-hour average amount of ozone was 81 µg/m<sup>3</sup>, 11% decreased from 2019.

**Critical areas Bangkok and its vicinity:** The PM<sub>2.5</sub> problem in 2020 was around 20-25 µg/m<sup>3</sup> (decreased from 2019). The decreased pollution was due to the implementation of the Action Plan for Driving National Agenda "Addressing Pollution Problem (Particulate Matter)" of Pollution Control Department under the Ministry of Natural Resources and Environment and the COVID-19 pandemic causing less industrial production capacities, travel activities, and energy consumption.

**Haze in Northern provinces:** The situation was slightly more violent than in 2019. There were 112 days in which particulate matter exceeded the standard. The accumulated number of hotspots was 88,855 (a 2% decrease from 2019). The highest 24-hour average amount of PM<sub>2.5</sub> was 366 µg/m<sup>3</sup> (a 4% increase from 2019). The primary cause was a large number of agricultural burnings in combination with dry weather, which caused the rapid spread of forest fires. Measures addressing the Northern haze problem were implemented under the mechanism of the Disaster Prevention and Mitigation Act 2007 by determining 4 areas (forest, agricultural, roadside, and community areas) and 5 measures (command system, fuel reduction, awareness raising, network/volunteer building, and law enforcement). These included the upgrade of 12 measures following the Ad-hoc Action Plan in Addressing Pollution Problem (Particulate Matter), the use of aircraft for supporting forest fire mitigation missions, the determination of a strict burning ban period, and the setting up of the Forest Fire Mitigation Center.

**Na Phra Lan Subdistrict, Saraburi Province:** There were 92 days in which PM<sub>10</sub> exceeded the standard (39% decreased from 2019). The yearly average amount of PM<sub>10</sub> was 107 µg/m<sup>3</sup> (9% decreased from 2019). In collaboration with the Committee on Prevention and Mitigation of Particulate Matter Problem in the Pollution Control Area,

various action plans and public participation are implemented, such as monitoring of PM<sub>10</sub> both in ambient air and from pollution release from sources, spot checking of vehicles which did not follow the law, and road cleaning to reduce the amount of dispersed particulate matter.

**The area of Map Ta Phut, Rayong Province:** Benzene and 1,3-butadiene increased, while 1,2-dichloroethane decreased from the previous year. The objectives of measures addressing volatile organic compounds (VOCs) are as follows: 1) to find causes and control the leakage, 2) to prepare the industrial plants and related organizations to implement new regulations on the standard for controlling exhaust ventilation from petroleum refineries to control benzene ventilation in terms of surveillance around the fence, and 3) to monitor the situation by various committees in Rayong Province.

Source: Thailand State of Pollution Report 2020, Pollution Control Department

### 1.4.2 Water Quality

**Surface water:** The water quality of 59 water sources and 6 still water resources: 2% was of excellent quality (equal to 2019), 37% was of good quality (9% increased from 2019), 43% was of fair quality (7% decreased from 2019), and 18% was of poor quality (equal to 2019). There were 8 from 59 water sources found to be the same quality as their types of use. In the past 10-year period (2011-2020), the quality of water sources tended to be better, and most of them were of fair to good quality and none was of very poor quality.

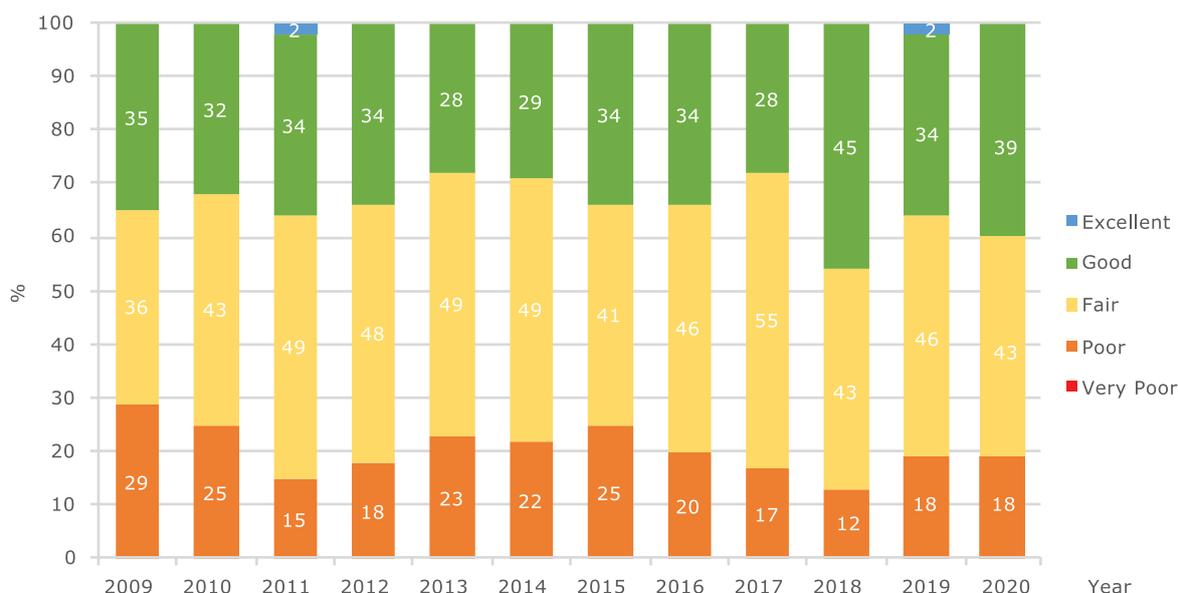


Figure 1-19: State of surface water quality 2009-2020

Source: Thailand State of Pollution Report 2020, Pollution Control Department

**Coastal water:** The coastal water quality: 4% was of excellent quality (100% increased from 2019), 60% was of good quality (2% increased from 2019), 27% was of fair quality (21% decreased from 2019), 7% was of poor quality (133% increased from 2019), and 2% was of very poor quality (equal to 2019). The overall coastal water quality was improved. The changing trend of coastal water quality in the past 10-year period was mostly good, except in the Gulf of Thailand with continuing poor quality.

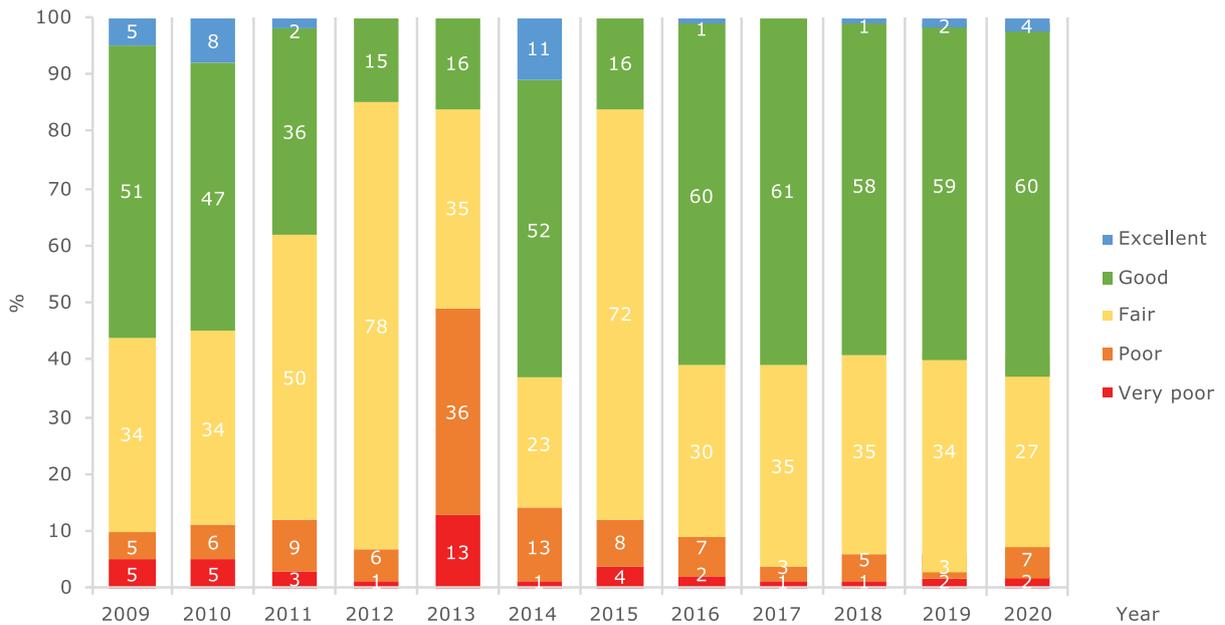


Figure 1-20: State of coastal water quality 2009-2020

Source: Thailand State of Pollution Report 2020, Pollution Control Department

**Groundwater:** According to the monitoring system of groundwater quality and groundwater level from 2,716 observation wells, and 1,724 stations scattered in 27 groundwater basins, the groundwater was generally of good quality under the groundwater standards for consumption according to the Groundwater Act 1977. Some areas had high iron and manganese, resulting from geological and hydrogeological conditions. In 2020, some sites of shallow groundwater layers were contaminated with heavy metals and volatile organic compounds from landfills and waste disposal sites of industries and some industrial estates.

The major causes of deteriorated surface water and coastal water quality were the discharge of effluents from the municipal sector, households, tourist places, industrial sector, and agricultural sector. The municipal wastewater treatment systems were insufficient, and some were still ineffective. Wastewater management in the industrial and agricultural sectors was still ineffective. There were still obstacles to implementation, such as the complexity of wastewater treatment technology, the lack of competent personnel in wastewater management, and the use of large areas in applying uncomplicated wastewater treatment technology because most productions still depend on community ways and seasons.

Source: Thailand State of Pollution Report 2020, Pollution Control Department

### 1.4.3 Waste Management

**Solid waste:** In 2020, the amount of solid waste was 25.37 million tons (12% decrease from 2019). The municipal solid waste was sorted at the sources and recycled as 8.36 million tons (33% decrease from 2019), properly disposed of as 9.13 million tons (7% decrease from 2019), and improperly disposed of as 7.88 million tons (24% increase from 2019). The top five clean cities in 2020 were Bangkok, Phuket, Lamphun, Rayong, and Nonthaburi, respectively. In 2020, the amount of municipal solid waste in Bangkok and its vicinity and some Local Administration Organizations was reduced, partly due to the COVID-19 pandemic. However, the “Work from Home” measure led to the increased amount of Single-Use plastic, especially in urban areas, due to product and food purchase services via an online system. The amount of plastic waste generated during the pandemic was approximately 6,300 tons per day, which was a 15% increase from the normal period of approximately 5,500 tons per day. Since 1 January 2020, Thailand has implemented “Everyday Say No to Plastic Bags” policy with the announcement of measures banning plastic bags provided in department stores, supermarkets, and convenience stores.

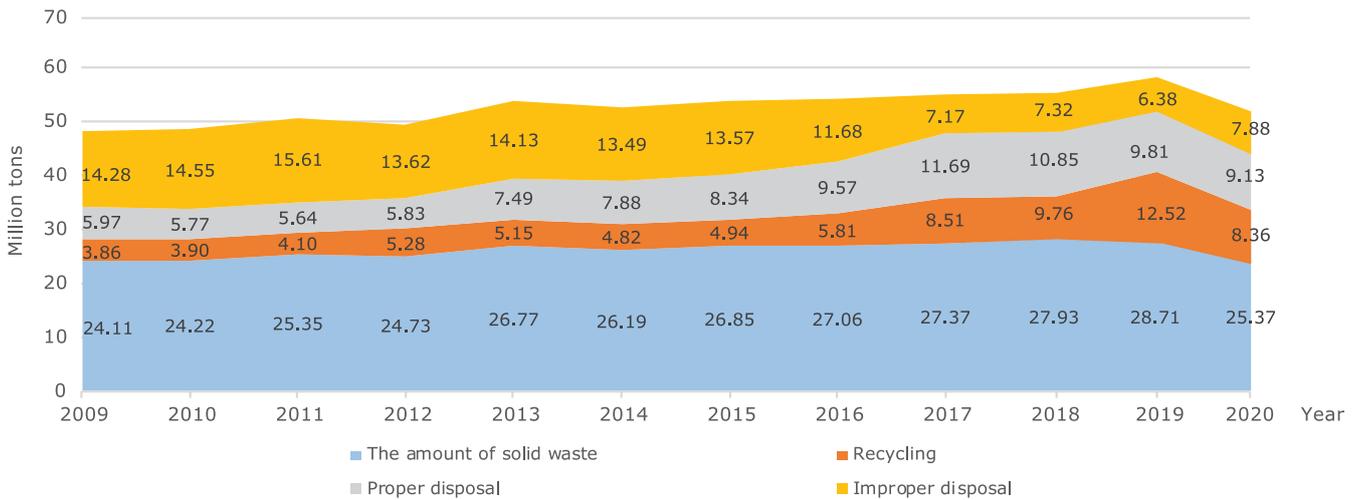


Figure 1-21: The amount of solid waste generated, recycled, properly disposed, and improperly disposed 2009-2020

Source: Thailand State of Pollution Report 2020, Pollution Control Department

**Household hazardous waste:** In 2020, household hazardous waste was approximately 658,651 tons (a 1.6% increase from 2019). Most of them were wastes from electrical and electronic equipment, with 428,113 tons (65%). Other types of hazardous waste were batteries, dry cell batteries, chemical containers, and aerosol spray cans with 230,538 tons (35%). From the government policies supporting the household hazardous waste management system, Local Administration Organizations and related organizations had to provide the collection points of household hazardous waste in the community and their collection centers at provincial levels. As a result, the household hazardous waste were properly managed at 121,695 tons (18.48% of generated household hazardous waste), which increased from the previous year but still represented an insignificant proportion. The mismanagement of household hazardous waste was caused by the lack of awareness, non-separation of hazardous waste from general wastes, no regulations to enforce household hazardous waste management, and no law to oversee the management of waste from electric and electronic equipment. However, the guideline for household hazardous waste management aimed to increase the Drop Points of household hazardous waste at community and provincial levels, enhance cooperation networks among the public, private, and people sectors on household hazardous waste management, and encourage the launching of the Wastes from Electric and Electronic Equipment Management Bill.

**Infectious waste:** In 2020, the amount of infectious waste was 47,962 tons (a 10% decrease from 2019). However, in 2021, the amount of infectious waste increased to 90,009 tons (87% increase from 2020) caused by hospitals under the Ministry of Public Health, hospitals under the Department of Academic Affairs of the Ministry of Public Health, sub-district health promotion hospitals, hospitals affiliated with other ministries, private hospitals, private clinics, animal hospitals, dangerous infection laboratories and other sources of COVID-19 infected wastes such as field hospitals, state quarantine facilities, community isolation. Most of the infected wastes, approximately 81,773 tons or 90.85%, were properly disposed. The Pollution Control Department has published the preliminary guideline on managing used masks to prevent the epidemic for the local authorities and the public. In addition, a survey on the number of used masks was conducted by coordinating with the local authorities to report the number of used masks via QR Code monthly. Between 1 April and 31 December 2020, 17.89 tons of used masks were managed by disposing in landfills (25.01%), burning in the incinerators of local authorities (9.40%) and local authorities nearby (5.60%), eliminating by a private company who must get rid of infectious waste (8.52%). Others (51.47%) were collected and sent to the sub-district health promotion hospitals and the hospitals in the area or the Sub-district Administrative Organization to dispose by soaking in disinfectant and burning or sent to the public health in the area to dispose properly.

*Source: 1) Thailand State of Pollution Report 2020, Pollution Control Department 2) Department of Health*

## 1.5 State of National Economic and Social Development

### 1.5.1 Development Objectives and Priorities

Thailand's past development followed the 12<sup>th</sup> National Economic and Social Development Plan (2017-2021) with its core principles of sustainable development, sufficiency economy, and people-centered development. The plan adhered to the 20-Year National Strategy Framework (2017-2036) and commitments to the Sustainable Development Goals (SDGs). It sets out to achieve "Security, Prosperity, and Sustainability." The 13<sup>th</sup> National Economic and Social Development Plan (2023-2027) will be implemented for future development. Its objective is to transform Thailand into a progressive society with a high-valued and sustainable economy. To achieve the objective, the development will prioritize five key targets: 1) transforming the production structure toward innovation to enhance competition capacity in production and service sectors and respond to modern environmentally friendly technology development; 2) equipping Thai people with skills and capacities adjusting to the modern world norms and market; 3) reducing poverty and inequality gaps by providing opportunities for business competition, enabling social mobility for vulnerable and underprivileged groups, and providing impartial and high-quality public service; 4) moving toward sustainable production and consumption aligning with the absorptive level of the ecosystem and mitigating climate change impacts by reducing GHG emissions and reaching carbon neutrality; 5) building Thailand's capacity to handle risk and change in the modern world context such as climate change impacts, pandemics, and cyber threats.

*Source: 12<sup>th</sup> National Economic and Social Development Plan (2017-2021) and 13<sup>th</sup> National Economic and Social Development Plan (2023-2027), Office of the National Economic and Social Development Council*

### 1.5.2 Profile and Outlook

#### **Economic Profile and Outlook**

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%, recovering from a decline of 6.2% in 2020. GDP value at current prices was 16.2 trillion THB (505.6 billion USD). GDP per capita was 232,176 THB per person per annum (7,255.5 USD). For economic stability, the headline inflation was at 1.2%, and the current account registered a deficit of 2.2% of GDP. On the production side, agriculture, manufacturing, and wholesale and retail trade sectors grew by 1.4%, 4.9%, and 1.7%, respectively. On the other hand, the accommodation and food services sector and transport and storage services sector declined by 14.4% and 2.9%, respectively. On the expenditure side, the export of goods, private consumption, and investments expanded by 18.8%, 0.3%, and 3.4%, respectively. Export value was recorded at 70.5 billion USD, significantly increasing by 21.3%. The export volume and price indices expanded by 16.8% and 3.8%, respectively.

## CHAPTER 1

The Thai economy in 2022 is projected to expand in the range of 3.5–4.5%, mainly supported by: (i) the regaining in domestic demand; (ii) the recovery of domestic tourism; (iii) the continual expansion of the export of goods; and (iv) the support from public investment. The export value of goods in US dollar terms is anticipated to expand by 4.9%. Meanwhile, private consumption expenditure and private investment are expected to increase by 4.5% and 3.8%, respectively. Public investment is projected to increase by 4.6%. Headline inflation is estimated to be in the range of 1.5 – 2.5% and the current account is projected to record a surplus of 1.5% of GDP

Table 1-5: Thailand’s economic projection for 2022

Indicators	Actual data			Projection for 2022	
	2019	2020	2021	Nov 15 <sup>th</sup> ,2021	Feb 21 <sup>st</sup> ,2022
Growth in real GDP (CVM, %)	2.2	-6.2	1.6	3.5-4.5	3.5-4.5
Investment (CVM, %)	2.0	-4.8	3.4	4.3	4.0
• Private	2.6	-8.2	3.2	4.2	3.8
• Public	0.1	5.1	3.8	4.6	4.6
Private Consumption	4.0	-1.0	0.3	4.3	4.5
Government Consumption	1.6	1.4	3.2	0.3	-0.2
Export of Goods	-3.0	-19.7	10.4	9.0	8.9
Volume	-3.7	-5.8	15.0	4.4	3.9
Import of Goods	-5.2	-14.4	17.9	4.3	4.0
Volume	-5.8	-10.5	18.3	4.7	4.4
<b>Current Account to GDP (%)</b>	7.0	4.2	-2.2	1.0	1.5
<b>Inflation (%)</b>	1.0	-1.3	1.9	0.6-1.6	1.2-2.2

Source: NESDC Report on Economic and Social Profile and Outlook 2019-2021, Office of the National Economic and Social Development Council

### Social Profile and Outlook

National Economic and Social Development Council analyzed five key social indicators for assessing Thailand’s social situation and movement—employment, household debt, health and illness, the safety of life and property, and consumer protection. The 2021 report reveals that measures to control the spread of COVID-19 had a significant impact on the labor market. As a result, the number of unemployed persons and the unemployment rate reached their highest levels in the third quarter of 2021 but began to recover in the fourth quarter of 2021. Prime issues to be followed include the implementation of economic measures supporting an economic recovery while containing the outbreak, the significant increase of the informal workforce, the increased cost of living, and the promotion of skill development and modification in response to enterprise and local needs.

Source: NESDC Report on Economic and Social Profile and Outlook 2019-2021, Office of the National Economic and Social Development Council

### 1.5.3 Agricultural Sector

In 2021, total agricultural production increased by 1.4%, recovering from a decline of 3.5% in 2020. The production increased by 0.7% in the fourth quarter, slowing down from 2.2% growth in the previous quarter, following declines in livestock, fisheries, and paddy production.

The agricultural sector is highly vulnerable to climate change impacts causing temperature rise and rainfall fluctuation. The Office of Agricultural Economics estimates national economic loss due to severe climate impacts in the agricultural sector to be up to 1.8 billion THB. From 2011 to 2045, climate change impacts can cause cumulative damage up to 17,912–83,826 million THB per year. Thus, Thailand aims to strengthen sustainable farming and agricultural management, employing both mitigation and adaptation measures to increase resilience, minimize economic-environment loss, and secure sufficient food production for the increased population growth and quality of life. These goals are aligned with SDG 2—*End hunger, achieve food security and improved nutrition, and promote sustainable agriculture*. Thailand's primary achievements include:

- *Food poverty reduction*: Thailand has reduced the number of people living in food poverty. This is in line with Thailand's improved standing in the World Food Security Index and the overall reduction in the number of people per capita who have been unable to access sufficient food in the last 3-5 years. Moreover, Thais have enjoyed greater access to food. In 2019, the number of those under the food poverty line was 0.37%, a reduction from 0.54% in 2016. Furthermore, Thailand's ranking in the Global Food Security Index (GFSI) has improved, with an average score of 65.1 out of 100 in 2019, compared to 58.3 in 2017 and 58.9 in 2018.

- *Increasing agricultural productivity*: Thailand has experienced good progress in increasing the value of productivity per labor unit and the gross income of small-scale agricultural producers. In 2019, the gross agricultural product was valued at 673 billion THB, compared to 609 billion THB in 2016. Employment in the agricultural sector increased from 12.57 million in 2016 to 12.69 million in 2019.

- *Increasing sustainable agriculture*: Thailand has increased the amount of sustainable agricultural land in the past 3-4 years, with increased investment in the sector from the Government. This aims to support mixed agriculture, New Theory Agriculture, organic farming, and natural farming. This enabled Thailand to increase the amount of land used in sustainable farming from 1.08 million rai in 2017 to 1.15 million rai in 2020.

Source: 1) Thailand's Voluntary National Review on the Implementation of the 2030 Agenda for Sustainable Development 2021, Ministry of Foreign Affairs 2) NESDC Report on Economic and Social Profile and Outlook 2019-2021, Office of the National Economic and Social Development Council

### 1.5.4 Tourism Sector

Tourism has always been a significant part of Thailand's economic growth, generating approximately 20-22% of GDP. In 2019, though affected by global economic stagnation, the number of tourist visitors slightly expanded by 1.36% (307,141,990 persons). The annual revenue from the tourism sector increased by 1.10% (2,727,903.84 million THB) from the previous year. The expansion was partly supported by the Government's continual measures to promote the tourism sector, especially an extension of waiving visa-on-arrival fees for citizens of 21 nations.

However, the sector suffered a drastic decline in 2020 due to the COVID-19 pandemic and a nationwide lock-down measure, resulting in decreased tourists by 54.72% (139,067,291 persons) and annual revenue by 69.85% (822,578.62 million THB). Thailand imposed a flight ban from 4 April 2020 to 30 June 2020 to close all borders, leading to a record of zero foreign tourists in the second and third quarters of the year, contracted by 100%. Phuket, Bangkok, and Chonburi were the most affected provinces because their economic growth heavily depended on foreign tourists. In 2021, the situation began to improve in the fourth quarter because of the subsided domestic outbreak situation, the relaxation of control measures, the progress on vaccine distribution, and the domestic traveling stimulus scheme. The number of foreign tourists increased from the low base last year, mainly owing to the implementation of the Test and Go program for international visitors and the easing of international travel restrictions in tourist-origin countries.

In contrast with the economic decline during the pandemic, Thailand's natural resources and ecosystems have recovered from degrading conditions caused by intensive tourism-related activities and swarming tourists in major ecological visiting sights exceeding the environment's carrying capacity. Particularly in the coastal and marine areas, the study shows that seawater condition has improved, and coral bleaching has decreased. Keystone species indicating the abundance of marine ecosystems have also increased, such as Irrawaddy dolphins (*Orcaella brevirostris*), leatherback sea turtle (*Dermochelys coriacea*), sea cows (*Dugong dugon*), false killer whales (*Pseudorca crassidens*), and blacktip reef sharks (*Carcharhinus melanopterus*). Similarly, after the natural parks were closed with no tourism activities, plant species flourished, and rarely appeared animal species were frequently detected.

With the lesson learned from the pandemic and aligning with SDG 8—*Promote sustained, inclusive, and sustainable economic growth, full and productive employment, and decent work for all*—Thailand seeks to strengthen sustainable tourism and enhance diverse socio-cultural identities as cultures, traditions, and community livelihood. Thailand aims for quality and green tourism, environmentally friendly tourism that enhances natural conservation and sustainable exploitation of natural resources.

source: 1) NESDC Report on Economic and Social Profile and Outlook 2019-2021, Office of the National Economic and Social Development Council 2) Analysis Report on Thailand Tourism 2019-2021, Department of Tourism 3) Thailand's Voluntary National Review on the Implementation of the 2030 Agenda for Sustainable Development 2021, Ministry of Foreign Affairs 4) COVID-19 Pandemic: The sea has recuperated into sustainable tourism, the extract from the study project of the marine and coastal resources recovery during the COVID-19 crisis and its policies for sustainable tourism, National Research Council of Thailand (NRCT), Knowledge Network Institution of Thailand (KHNIT), and Thailand Development Research Institute (TDRI)

### 1.5.5 Health

Since 2019, Thailand has suffered from the COVID-19 epidemic. As of 16 March 2022, Thailand has 3,250,642 infected patients, 23,918 deceased, and 126,267,971 vaccine recipients. In contrast, the NESDC report shows a general decline of 67.9% across all other diseases. Surveillance diseases (i.e., Measles, Meningococcal Fever, Encephalitis, Cholera, Hands, Feet, and Mouth, Dysentery, Pneumonia, Leptospirosis, Dengue Fever, Influenza, and Rabies) decreased by 54.5% from 2020. The most significant fall was the Hands, Feet, and Mouth disease, with a drop of more than 95.8%. The decline in other diseases was due to the reduced social interaction under social distancing measures.

For coping with and adapting to climate change impacts on health, the Department of Health (DOH) has initiated Health National Adaptation Plan (HNAP), Phase 1 (2021–2030). It functions as a crucial guideline enabling the multisectoral partnership to strengthen and build health resilience from climate change. The objective is to reduce illness, lessen health impacts, and become a center for health and climate change in Asia in climate change-induced health risk management. HNAP focuses on 4 strategies: i) strengthening the community and their skills in adaptation and health literacy to cope with health risks from climate change; ii) integrating the resources of all sectors to drive public health implementation of climate change proficiently; iii) strengthening public health preparedness for climate change to support economic and social development and security; and iv) developing the national public health system in response to climate change on an international standard. With the support of WHO Thailand, the DOH developed a monitoring standard and publication on health risks from the heat by using information from medical diagnoses and death investigations. It also gathered information from the public during the summer season by using a health poll. The information received was used for planning and producing educational tools on health care and prevention for the public. From 2020 to 2022, the health care system has been strengthened to reach the standard of “Green and Clean Hospital” and “Low Carbon and Resilient Smart Health Care.”

Thailand has also made progress with Sustainable Development Goal 3 (SDG 3)—*Ensure healthy lives and promote well-being for all at all ages*. Lesson learned from the COVID-19 pandemic: The Ministry of Public Health has strengthened the readiness and capacity of health service systems to monitor and evaluate the situation and infection risk and provide early warning and control transmissions through sufficient diagnostic and investigation tracking and quarantine systems. Strengthening the healthcare systems goes hand in hand with the HNAP for climate resilience to prepare for climate change-induced health risks.

*Source: 1) NESDC Report on Economic and Social Profile and Outlook 2019-2021, Office of the National Economic and Social Development Council 2) Department of Health 3) Thailand's Voluntary National Review on the Implementation of the 2030 Agenda for Sustainable Development 2021, Ministry of Foreign Affairs*

### 1.5.6 Poverty and Inequality

#### Poverty

From 2017 to 2020, Thailand’s poverty line increased from 2,686 to 2,762 THB per person per month. The strict measures to control the outbreak of COVID-19 have led to an economic contraction. The number of poor people in 2020 totaled 4.8 million, representing a poverty rate of 6.84%, up from 6.24% in 2019, or only 0.5 million up from the previous year.

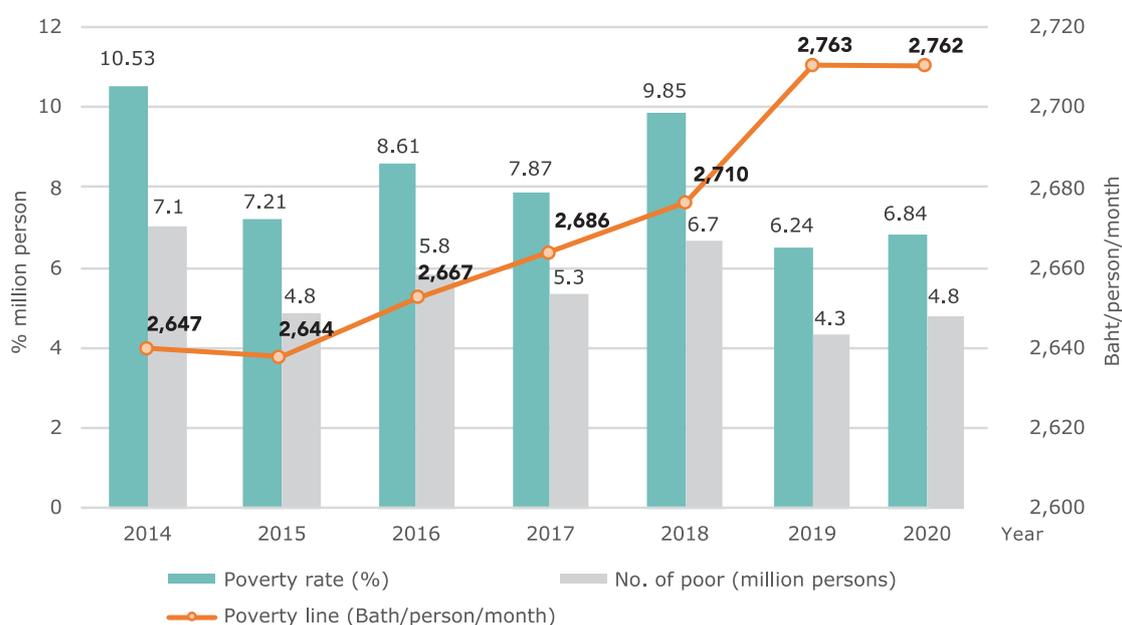


Figure 1-22: Poverty line, poverty rate and number of poor 2014-2020

Source: Office of the National Economic and Social Development Council

Thailand has also implemented several measures to assist those affected by the COVID-19 pandemic. These measures prioritize providing a financial remedy of 5,000 THB per month for 3 months for workers in the informal sector and agricultural producers. A remedy of 1,000 THB per person per month has also been provided for other vulnerable groups. The Government has also initiated the “50:50 Co-Payment Scheme” to assist people with the cost of living in tandem with reducing prices for essential goods. To revive the economy and alleviate the socio-economic effects on vulnerable groups, Thailand has passed an emergency decree allowing the Ministry of Finance to take out a loan of 1 trillion THB to resolve various problems, provide a financial remedy for those affected, and boost socio-economic recovery from the COVID-19 crisis. A strategy has also been developed to support increased employment, boost income generation, and develop training to assist workers who

have recently returned to hometowns and communities because of the pandemic to improve their livelihoods. Thailand is committed to creating a learning system to “upskill” workers according to the needs of the labor market in the post-COVID era, which will help workers adapt to the New Normal.

### Inequality

In 2020, inequality slightly increased from the previous year. The Gini coefficient on consumption expenditure in 2020 was 0.350, up from 0.348 in 2019. As the Government maintains an average income of 13,473 THB per person per year or about 1,123 THB per month, low-income earners can temporarily maintain their living costs.

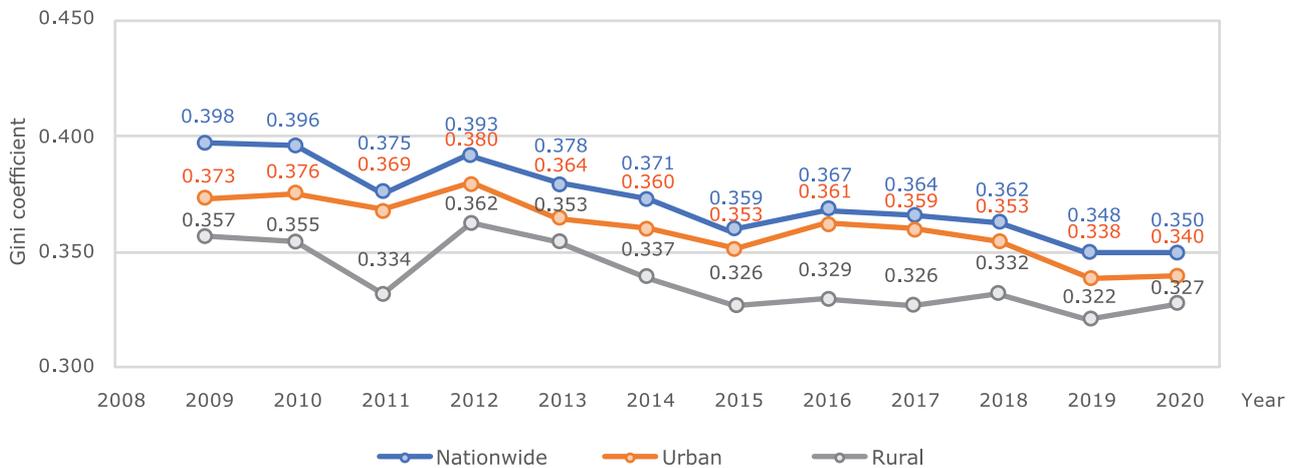


Figure 1-23: Gini coefficient in Thailand, showing urban, rural and national levels 2009-2020

Remark: The Gini coefficient is a tool for measuring inequality, where the value is between 0 and 1. The closer the value is to 1, the greater the income inequality.

Source: Office of the National Economic and Social Development Council

Although poverty and inequality did not drastically increase, they are still issues that need to be realized and given importance. If the Government’s aid runs out before the economy and employment recover, poverty and inequality will become more severe. In the case of poverty, it is estimated that without assistance, the number of poor people in 2020 will total 11.02 million, representing 15.9% of the country’s population, meaning that there will be 6 million more poor people. In the case of inequality, if there is no government assistance, the Gini inequality coefficient is expected to increase from 0.350 to 0.383, equal to the inequality situation in 2014. Thailand has made progress with SDG 1—End poverty in all its forms everywhere and SDG 10—Reduce inequalities within and among countries, with the following improvements:

- *Worker's vulnerability reduction*: Thailand amended relevant legislation to provide increased benefits and rights to assistance for social protection covering workers in the informal sector, self-employed persons, agricultural producers, informal sellers, and freelance workers.

- *Social welfare*: In 2019, 46.05% of eligible persons were given a state welfare card to support consumption costs for low-income groups, including transport costs, rent, and household internet costs. The number of vulnerable groups with access to social welfare was at a good level. In 2018, 84.5% of children from poor backgrounds and disabled persons received financial assistance. In 2019, 81.7% of elderly persons received state financial assistance.

- *Multi-Dimension Poverty Index (MPI)*: The MPI for Thailand in 2019 was 0.051 improved from 0.068 in 2017.

Source: 1) *Poverty and Inequality Report 2020*, Office of the National Economic and Social Development Council  
2) *Thailand's Voluntary National Review on the Implementation of the 2030 Agenda for Sustainable Development 2021*, Ministry of Foreign Affairs

### 1.5.7 Gender Equality

Gender equality is a fundamental human right and a necessary foundation for a peaceful, prosperous, and sustainable world, according to the UN Sustainable Development Goals (SDG 5). Thailand has performed relatively well in SDG achievements. In July 2019, the Sustainable Development Solutions Network (SDSN) and Bertelsmann Stiftung Foundation placed Thailand as the top country among ASEAN members for its overall SDG achievements and the 40<sup>th</sup> rank in the world. The Gender Equality Act was passed in 2015 after a legislative process that included a comprehensive consultative process between officials from the Department of Women's Affairs and Family Development, women's civil society organizations, and LGBTI civil society organizations before the National Legislative Assembly approved it. It is currently the most robust legal instrument advocating for legal gender recognition in Thailand. This law intends to protect people from unjust discrimination and provide access to legal processes equally, whether the person is male, female, or a member of a "sexual diversity group." Section 3 of the Act explicitly defines "gender discrimination" while clarifying that it is not limited to men and women but also applies to persons who have "a different appearance from his/her own sex by birth."

Though Thailand has not yet ascertained the climate change impacts on gender inequality in the national context, Thailand acknowledges the significance of integrating the gender equality dimension into climate change policy, planning, and administrative structure to fully achieve climate resilience and create an enabling environment for social participation in climate change action. Thailand seeks to integrate the concept of Gender and Social Inclusion (GSI) into the climate change context to ensure that 1) climate approaches are more inclusive, efficient, responsive, and provide broader and equitable benefits to all groups of people, especially the most vulnerable, 2) all population groups have equal opportunities to participate and act as active agents of change in decision-making and

implementation at the national, regional, and local levels of adaptation and mitigation, 3) where gender and social equity gaps exist in the distribution of power, resources, services, and participation, disadvantaged groups are supported and empowered to overcome social, cultural, or institutional constraints and barriers to meaningful engagement.

The GSI integration in Thailand is at the initial stage. Notable initiatives can be illustrated as follows:

- The Department of Women's Affairs and Family Development (DWF), as a principal national mechanism for the promotion of gender equality and women's empowerment in Thailand, ONEP, and the Sustainable Development Foundation jointly organize a gender equality course for executive administrators to build capacity for Chief Gender Equality Officers (CGEOs) and Gender Focal Points (GFPs) on a gender approach to climate change adaptation.

- The DWF conducts a study, formulates a report, and holds workshop sessions on GSI integration in climate change mitigation, focusing on the connection between the commitments under the UNFCCC and gender dimensions and Thailand's policies related to climate change and gender. The objective is to provide guidelines and recommendations on climate change implementation equitable for all and social and gender-inclusive.

- The Office of Natural Resources and Environmental Policy and Planning (ONEP) and the Office of Agriculture Economics (OAE) have initiated pilot activities to conduct and collaborate on GSI-climate vulnerability and impact assessment on a small scale and to develop an effective model to integrate GSI into climate-related project formulation, management, and budgeting. These projects were conducted in two provinces, Maha Sarakham and Uthai Thani which are vulnerable to repeated droughts and floods, relying on agriculture as the only source of income, and diverse in terms of demography. The projects aimed to conduct participatory action research and GSI-CC data collection with community engagement and multi-stakeholder consultations. The projects revealed critical challenges in three areas: 1) improve researchers' understanding of GSI perspective to conduct participatory action research and data collection; 2) enhance institutional capacity building to improve government officials' understanding of how GSI relates to climate change impacts and actions; 3) obtain leadership support to mobilize various governmental agencies and key stakeholders.

*Source: 1) Policy Brief: Gender Responsive and Socially Inclusive Public Climate Finance, Office of Natural Resources and Environmental Policy and Planning and UNDP Thailand 2) Legal Gender Recognition in Thailand a Legal and Policy Review 2018, Office of the National and Social Development Council and UNDP Thailand 3) Training Module on Gender and Climate Change: Overview of linkages between gender and climate change, UNDP 4) Department of Women's Affairs and Family Development*

### 1.6 Institutional Arrangement

#### 1.6.1 National Committee on Climate Change Policy (NCCC)

Thailand established the National Committee on Climate Change Policy (NCCC). 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 conventions and protocols on climate change, including supporting and evaluating domestic relevant agencies to be in accordance with the national established policies and plans. The NCCC is composed of 7 subcommittees: 1) Subcommittee on Climate Change Policy and Planning Integration, 2) Subcommittee on Climate Change Knowledge and Database, 3) Subcommittee on Climate Change Negotiation and International Cooperation, 4) Subcommittee on Public Relations and Actions for Climate Empowerment, 5) Subcommittee on Climate Law, 6) Subcommittee on the Mobilization of GHG Mitigation with Carbon Sequestration in LULUCF Sector, and 7) Subcommittee on the Mobilization of GHG Mitigation with CCUS Technology Implication. Figure 1-24 shows the institutional arrangements of Thailand's NCCC.

National Committee on Climate Change Policy (NCCC)	
Chairperson	Prime Minister
1st Vice-Chairperson	Minister of National Resources and Environment (MONRE)
2nd Vice-Chairperson	Minister of Foreign Affairs
<b>Committee members:</b> <i>Permanent Secretary of;</i> 1. Prime Minister's Office 2. Ministry of Finance 3. Ministry of Foreign Affairs 4. Ministry of Tourism and Sports 5. Ministry of Transport 6. Ministry of Digital Economy and Society 7. Ministry of Energy 8. Ministry of Commerce 9. Ministry of Interior 10. Ministry of Labor 11. Ministry of Education	12. Ministry of Public Health 13. Ministry of Industry 14. Ministry of Agriculture and Cooperatives 15. Ministry of Higher Education, Science, Research and Innovation 16. Bangkok Metropolitan Administration 17. Office of the National Economic and Social Development Council 18. Office of the National Water Resources 19. Bureau of Budget 20. 5-9 Experts on law, economics, environment, science and technology, energy or climate change 21. One expert from the private sector



Subcommittee on Climate Change Policy and Planning Integration	Subcommittee on Climate Change Knowledge and Database	Subcommittee on Climate Change Negotiation and International Cooperation	Subcommittee on Action for Climate Empowerments and Public Relations	Subcommittee on Climate Law	Subcommittee on the Mobilization of GHG Mitigation with Carbon Sequestration in LULUCF Sector	Subcommittee on the Mobilization of GHG Mitigation with CCUS Technology Implication
Working Group on GHG Mitigation Policy and Planning	Working Group on GHG Inventory and Mitigation Measures	Working Group on Climate Change Conference and Negotiation				
Working Group on National Climate Change Adaptation Implementation integration	Working Group on Climate Change Data and Modeling					
Ad-Hoc Working Group on REDD-Plus						

Figure 1-24: Structure of the National Committee on Climate Change Policy

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

**The Subcommittee on Climate Change Policy and Planning Integration** is responsible for providing input on policy integration, strategy, and planning linked with climate mitigation and adaptation; providing suggestions on mechanisms and measures, legal regulations, and financial measures; and pushing forward an integrated budget allocation system on climate change. Recently, three working groups were assembled within the subcommittee: 1) **Working Group on GHG Mitigation Policy and Planning** to provide comments on and recommendations for making and integrating mitigation policy, strategy, and plans, aligning with national targets, and mobilizing and advancing GHG mitigation actions to achieve the targets; 2) **Working Group on National Climate Change Adaptation Implementation Integration** to provide comments on and recommendations for forming national adaptation plan and supporting the integration of the adaptation plan into sectoral plans in all areas; 3) **Ad-Hoc Working Group on REDD-Plus** to form a strategy, action plan, and implementation measures on climate actions in the forest sector and REDD-Plus and to establish mitigation and carbon storage targets for the forest sector in Thailand.

**The Subcommittee on Climate Change Knowledge and Database** is responsible for providing comments on the country report under the agreement of UNFCCC; supporting the development of the GHG inventory; providing suggestions on the development of databases and climate change knowledge in the areas of mitigation, adaptation, and Measurement, Reporting and Verification (MRV) systems. Recently, two working groups were assembled within the subcommittee: 1) **Working Group on GHG Inventory and Mitigation Measures** to provide recommendations on the data used for the preparation of GHG inventory in each sector, MRV direction, and assessment of GHG reduction from the mitigation measures; 2) **Working Group on Climate Change Data and Modeling** to build networks for collecting, sharing, processing, and analyzing data and mobilizing and coordinating the operation relating to climate change data and modeling.

**The Subcommittee on Climate Change Negotiation and International Cooperation** is responsible for providing recommendations on Thailand's positions for negotiations on climate change under multilateral agreements and other international frameworks; preparing and developing knowledge and data concerning international negotiations on climate change; providing guidance in international aspects of climate change implementation and the composition of Thailand's delegation for international negotiation on climate change. **The Working Group on Climate Change Convention Conference and Negotiation** was recently assembled to analyze, suggest, and prepare detailed information for the negotiation and conference under UNFCCC.

**The Subcommittee on Action for Climate Empowerments and Public Relations** is responsible for publicizing news and knowledge on the causes, impacts, and solutions related to climate change under the Paris Agreement, Thailand's NDC targets, and the SDGs. This committee also promotes and supports activities related to climate change by conducting training, raising awareness, and implementing capacity building across all sectors.

**The Subcommittee on Climate Law** is responsible for providing comments on policies for the development, improvement, cancellation, or amendment of laws related to climate change according to the NCCC; arranging and proposing draft laws, rules, regulations, or notifications; providing legal opinions on tackling issues related to climate change; and finally, providing advice on the enforcement of laws related to national climate change.

**The Subcommittee on the Mobilization of GHG Mitigation with Carbon Sequestration in LULUCF Sector** is responsible for providing suggestions and recommendations on guidelines, mechanisms, and measures supporting reforestation and conservation and expansion of green areas for public and private stakeholders to push forward long-term strategy for GHG removal. The subcommittee has the Minister of Natural Resources and Environment as the president and consists of representatives from public and private sectors such as the Office of the National Land Policy Board (ONLB), Land Development Department (LDD), Department of Lands, Royal Forest Department (RFD), Department of Natural Parks, Wildlife and Plant Conservation (DNP), Thai Banker's Association (TBA), and Bank for Agriculture and Agriculture Cooperatives (BAAC).

**The Subcommittee on the Mobilization of GHG Mitigation with CCUS Technology Implication** is responsible for providing suggestions and recommendations on GHG mitigating capacity of Carbon Capture and Storage technology and carbon storage and utilization. The subcommittee also has the authority to suggest mechanisms or measures (e.g., legal, economic, and other related measures) for incentivizing, developing, and applying such technology. The subcommittee has the Minister of Energy as the president and consists of representatives from public and private sectors such as the Department of Alternative Energy Development and Efficiency (DEDE), Department of Mineral Resources (DMR), Department of Mineral Fuels (DMF), Department of Industrial Works, Electricity Generating Authority of Thailand (EGAT), PTT Exploration and Production Public Company Limited (PTTEP), Petroleum Institute of Thailand (PTIT), and the Federation of Thai Industries (FTI).

*Source: Office of Natural Resources and Environmental Policy and Planning (ONEP)*

### 1.6.2 Institutional Arrangements of National Greenhouse Gas Inventory

Calculations of the national GHG inventory to report in the Fourth National Communication (NC4) have been made in accordance with the 2006 IPCC Guidelines for National Greenhouse Gas Inventories. The key components in estimating GHG emissions are activity data and emission factors. Activity data is sourced from a collaboration between the Office of Natural Resources and Environmental Policy and Planning (ONEP) and lead agencies of the following 5 sectors.

1. Energy: led by the Energy Policy and Planning Office (EPPO) and the Office of Transport and Traffic Policy and Planning (OTP)
2. IPPU: led by the Department of Industrial Works (DIW)
3. IPPU: led by the Department of Industrial Works (DIW)

4. LULUCF: led by the Department of National Parks, Wildlife and Plant Conservation (DNP)

5. Waste: led by the Pollution Control Department (PCD).

After these lead agencies have collected activity data according to ONEP's required template from relevant agencies responsible for data collection (e.g., agencies under their supervisions, local governments, and the private sector), the GHG emission is calculated by the Thailand Greenhouse Gas Emission Inventory System (TGEIS). Results will then be interpreted into graphs and tables according to reporting format laid out by UNFCCC. Results from TGEIS will then be submitted to 5 working groups, comprising appointed representatives of the 5 sectors outlined above. Each working group then reviews the methodology of the GHG emission estimation as part of quality control (QC) to ensure that GHG emission estimates for their sectors are valid, accurate, and complete. Following this, the GHG inventories of the 5 sectors are submitted to the Climate Change Knowledge and Database Subcommittee for verification.

Finally, as the Secretariat of the NCCC, ONEP will submit the final GHG inventories as part of the BUR to the NCCC for approval before submission to UNFCCC. For a complete list of the sub-sectoral support agencies under each leading sector (see Figure 1-25).

The lead agencies and their responsibility in reporting data activity are as follows:

**Energy:** EPPO and OTP are the 2 lead agencies responsible for gathering the data from relevant agencies within the Ministry of Energy, the Ministry of Transport, and others. The activity data used for GHG emissions calculations are derived from fossil fuel/ electricity consumption used in different activities.

**Industrial Processes and Product Use (IPPU):** DIW is the lead agency responsible for gathering the data from relevant agencies within the Ministry of Industry and others. The activity data used for GHG emissions calculations are each industry group's production volume, import volume, and export volume.

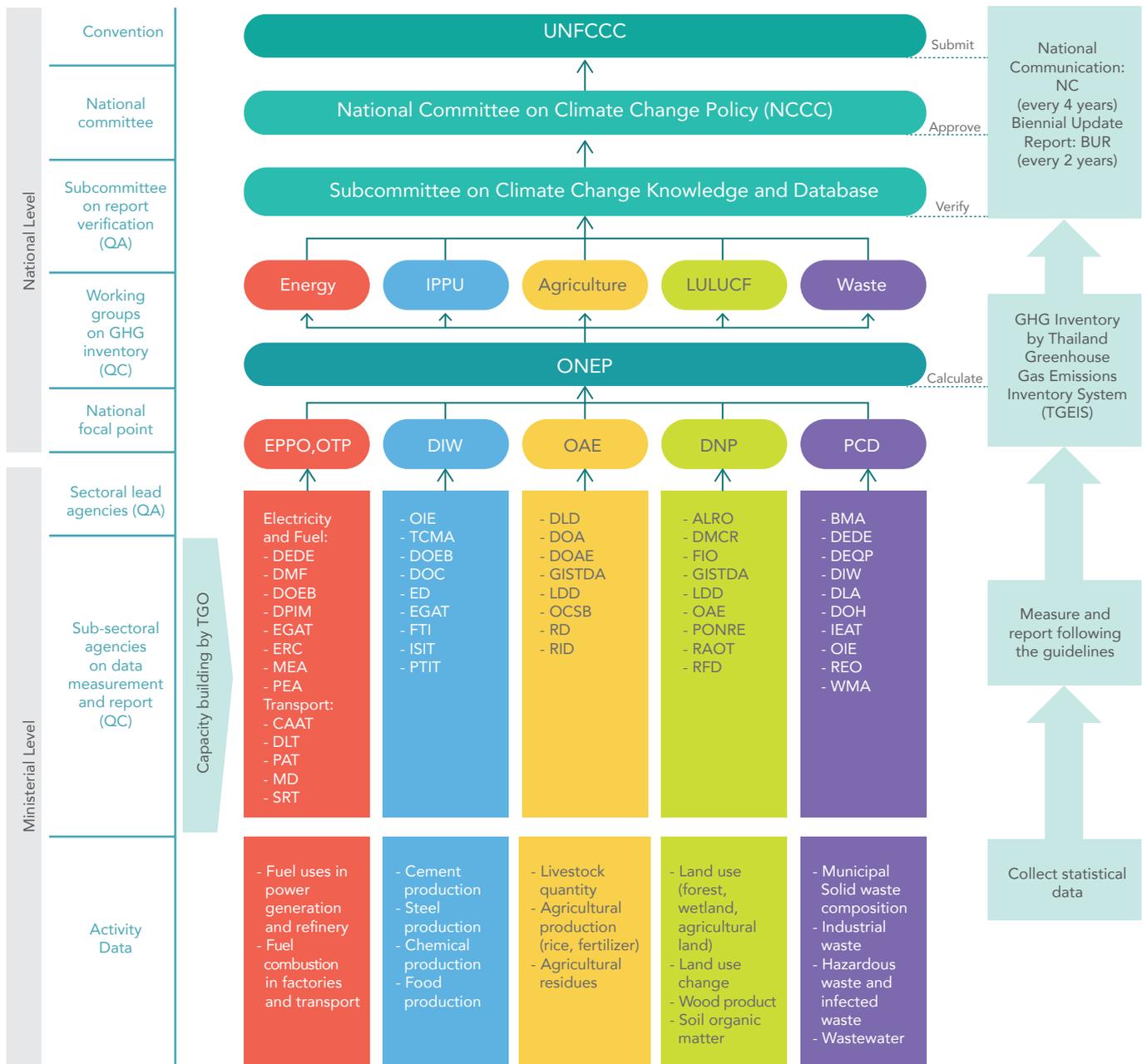
**Agriculture:** OAE is the lead agency responsible for gathering the data from relevant agencies within the Ministry of Agriculture and Cooperatives and others. The activity data used for GHG emissions calculations are derived from livestock farming, rice cultivation, agricultural soils, field burning, and the open burning of agricultural residues.

**Land Use, Land-Use Change, and Forestry (LULUCF):** DNP is the lead agency responsible for gathering the data from relevant agencies within the Ministry of Natural Resources and Environment (MONRE) and others. The activity data used for GHG emissions calculations are derived from land use, land-use change, and wood product.

**Waste:** PCD is the lead agency responsible for gathering the data from relevant agencies within the MONRE and others. The activity data used for GHG emissions calculations are derived from sources of waste, waste production rate, waste composition, and wastewater volume, including Emission Factors.

*Source: Office of Natural Resources and Environmental Policy and Planning (ONEP)*

# THAILAND'S FOURTH NATIONAL COMMUNICATION



- |      |   |        |   |
|------|---|--------|---|
| ALRO | = Agricultural Land Reform Office                               | GISTDA | = Geo-Informatics and Space Technology Development Agency |
| BMA  | = Bangkok Metropolitan Administration                           | ISIT   | = Iron and Steel Institute of Thailand                    |
| CAAT | = The Civil Aviation Authority of Thailand                      | LDD    | = Land Development Department                             |
| DEDE | = Department of Alternative Energy Development and Efficiency   | MD     | = Marine Department                                       |
| DEQP | = Department of Environmental Quality Promotion                 | MEA    | = Metropolitan Electricity Authority                      |
| DIW  | = Department of Industrial Works                                | OAE    | = Office of Agricultural Economics                        |
| DLD  | = Department of Livestock Development                           | OCSB   | = Office of the Cane and Sugar Board                      |
| DLA  | = Department of Local Administration                            | OIE    | = The Office of Industrial Economics                      |
| DLT  | = Department of Land Transport                                  | OTP    | = The Office of Transport and Traffic Policy and Planning |
| DMCR | = Department of Marine and Coastal Resources                    | PAT    | = Port Authority of Thailand                              |
| DMF  | = Department of Mineral Fuels                                   | PCD    | = Pollution Control Department                            |
| DNP  | = Department of National Parks, Wildlife and Plant Conservation | PEA    | = Provincial Electricity Authority                        |
| DOA  | = Department of Agriculture                                     | PONRE  | = Provincial Offices of Natural Resources and Environment |
| DOC  | = Department of Customs   | PTIT   | = Petroleum Institute of Thailand                         |
| DOAE | = Department of Agricultural Extension                          | RAOT   | = Rubber Authority of Thailand                            |
| DOEB | = Department of Energy Business                                 | RD     | = Rice Department   |
| DOH  | = Department of Health  | REO    | = Regional Environment Office                             |
| ED   | = The Excise Department   | RID    | = Royal Irrigation Department                             |
| EGAT | = Electricity Generating Authority of Thailand                  | RFD    | = Royal Forest Department                                 |
| EPPO | = Energy Policy and Planning Office                             | SRT    | = State Railway of Thailand                               |
| ERC  | = Energy Regulatory Commission                                  | TCMA   | = Thai Cement Manufacturers Association                   |
| FIO  | = Forest Industry Organization                                  | WMA    | = Wastewater Management Authority                         |
| FTI  | = The Federation of Thai Industries                             |        |   |

Figure 1-25: Office of Natural Resources and Environmental Policy and Planning (ONEP)

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

### 1.6.3 Institutional Arrangements of Domestic Measurement Reporting and Verification (MRV) System

To monitor the implementation progress of the NAMA Roadmap, Thailand has developed a domestic MRV system, which operates according to the following structure:

#### **National level:**

- *The Working Group on GHG Inventory and Mitigation Measures* is responsible for 1) selecting appropriate measures/policies for monitoring and evaluation (M&E) of GHG emissions reduction, identifying Coefficient/Emission Factors, and implementing MRV processes for activity data, and 2) reviewing and providing feedback on the GHG emissions reduction report.

- *Subcommittee on Climate Change Knowledge and Database* is responsible for further approval of the pre-approved report submitted the sectoral level.

- *National Committee on Climate Change Policy (NCCC)* is responsible for the final approval of the GHG emissions reduction report, which will later be included in national reports, the Biennial Update Report (BUR) and National Communication (NC).

#### **Sectoral level:**

- *The main agencies at the sectoral level* are responsible for the verification of the following key data and approaches after the finalization by the working groups on GHG inventory and mitigation measures as follows: 1) the appropriate measures/policies for M&E of GHG emissions reduction, 2) the methodology for calculating GHG emissions reduction, 3) MRV process for activity data, and 4) the final results and GHG emissions reduction report.

The structure of the domestic MRV system is shown in Figure 1-26.

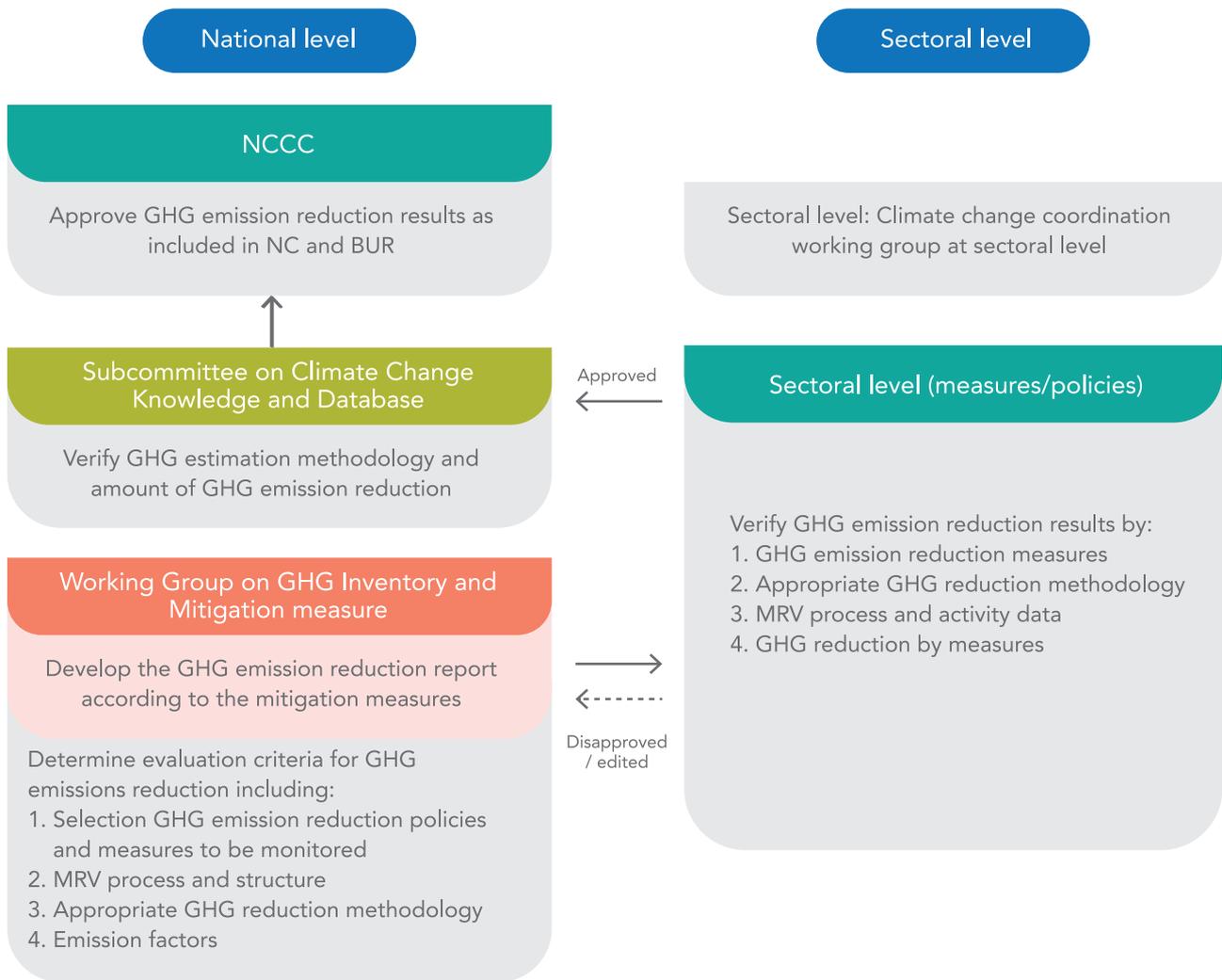


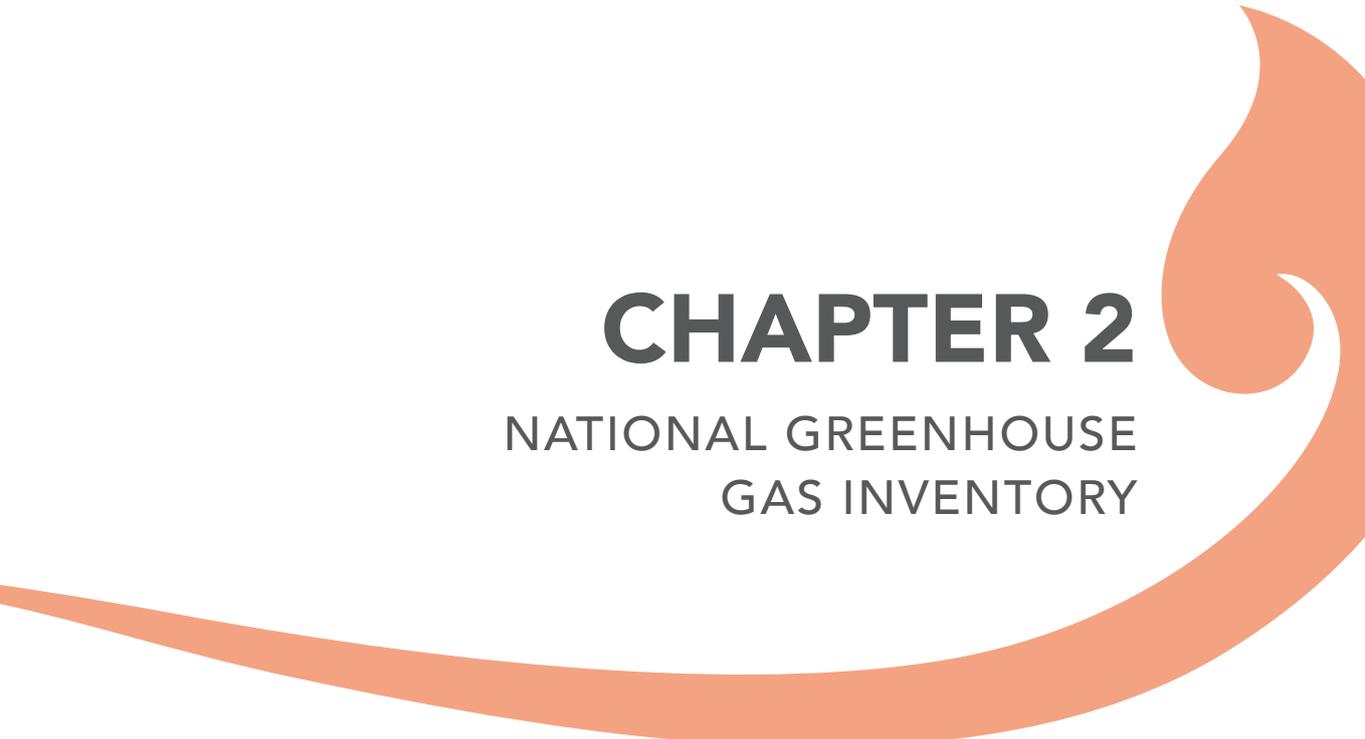
Figure 1-26: The structure of domestic MRV system





# CHAPTER 2

## NATIONAL GREENHOUSE GAS INVENTORY



# CHAPTER 2: NATIONAL GREENHOUSE GAS INVENTORY

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*Thailand National Greenhouse Gas Inventory reported in this NC4 was prepared using the 2006 IPCC Guidelines for National Greenhouse Gas Inventories.*

*In 2018, total GHG emissions (excluding those from LULUCF) were 372,648.77 GgCO<sub>2</sub>eq and Net GHG emissions were 286,680.47 GgCO<sub>2</sub>eq (including those from LULUCF). The Energy sector remained the most significant contributor to Thailand's GHG emissions, accounting for 69.06 % of the total GHG emissions. The share of emissions from the Agriculture, IPPU, and Waste sectors were 15.69%, 10.77 %, and 4.48%, respectively. LULUCF contributed to a net removal of -85,968.30 GgCO<sub>2</sub>eq.*

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## 2.1 Inventory Process in Thailand

### 2.1.1 Scope of Thailand National Greenhouse Gas Inventory

Thailand's GHG inventory was developed and submitted according to Article 4.1(a) of the Convention that requires a party to develop, periodically update, publish, and make available to the Conference of the Parties, in accordance with Article 12, national inventories of anthropogenic emissions by sources and removals by sinks of all greenhouse gases not controlled by the Montreal Protocol.

The inventory report was prepared using the 2006 IPCC Guidelines for National Greenhouse Gas Inventories and presented Thailand's national GHG emissions from 2000 to 2018 by sources and removals by sinks. The GHG emissions estimated in this report include both direct emissions Carbon Dioxide (CO<sub>2</sub>), Methane (CH<sub>4</sub>), Nitrous Oxide (N<sub>2</sub>O), Hydrofluorocarbons (HFCs) and Sulphur Hexafluoride (SF<sub>6</sub>) and indirect emissions Nitrogen Oxides (NO<sub>x</sub>), Carbon Monoxide (CO), Non-Methane Volatile Organic Compounds (NMVOCs) and Sulphur Dioxide (SO<sub>2</sub>).

### 2.1.2 Methodology for GHG Emissions and Removals Calculation

Overall, this GHG inventory report has improved on the previous submission. All the methodologies and tools used for GHG inventory reporting followed the 2006 IPCC Guidelines, LULUCF Good practice guidance for Land Use, Land-Use Change, and Forestry (referred to as GPG 2003), as well as the IPCC's 2000 Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories (referred to as GPG 2000).

Either Tier 1 or Tier 2 methodologies were applied wherever activity data and country-specific emission factors were available. Tier 1 methodologies were employed for all activity data in the Energy sector and almost all in Industrial Processes and Product Use (IPPU) sector. Tier 2 was adopted in most categories under the Agriculture, Land Use, Land-Use Change, and Forestry, and Waste sectors and some categories under the IPPU sector. GHG emissions from the Energy and IPPU sectors were calculated using default emission factors provided in the 2006 IPCC Guidelines. When available, country-specific emission factors were used for some sub-sectors of the LULUCF, Agriculture, and Waste sectors.

The Global Warming Potential (GWP), as recommended by the IPCC, was used to convert GHG<sub>s</sub> other than CO<sub>2</sub> to CO<sub>2</sub>eq. The use of GWP was provided by the IPCC in its Fourth Assessment Report based on the effects of GHGs over a 100-year time horizon. The values were applied for the 5 direct GHG gases: CO<sub>2</sub>, CH<sub>4</sub>, N<sub>2</sub>O, HFCs, and SF<sub>6</sub>. The indirect gases, including NO<sub>x</sub>, CO, NMVOCs, and SO<sub>2</sub>, have been calculated and reported.

### 2.1.3 Uncertainty Analysis

The inventories are prepared in accordance with the 2006 IPCC Guidelines for National Greenhouse Gas Inventories. Thus, they typically contain a wide range of emission calculations. Results of the uncertainty analysis of the data showed that the uncertainties of Thailand's national GHG inventory when including data on LULUCF for 2000 and 2018 are approximately 9.36 and 19.53, respectively. When the LULUCF was excluded from the analysis, uncertainties were approximately 3.67 for 2000 and 7.32 for 2018.

**Table 2-1:** Uncertainties of Thailand's national GHG inventory

Unit: %

Trend uncertainty	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Included LULUCF	9.36	9.72	10.60	11.21	12.28	14.77	14.05	14.32	14.99	15.34
Excluded LULUCF	3.67	3.83	4.18	4.45	4.94	5.24	5.31	5.50	5.88	5.75

Trend uncertainty	2010	2011	2012	2013	2014	2015	2016	2017	2018
Included LULUCF	16.14	16.41	17.58	18.51	19.78	19.56	19.48	19.98	19.53
Excluded LULUCF	5.69	5.75	6.20	6.26	6.53	6.70	7.41	7.58	7.32

## CHAPTER 2

### 2.1.4 Key Category Analysis

Key category analysis presents the importance of emission sources and sinks. The “key categories” are defined as the emission sources and sinks that constitute 95% of total annual emissions when ranked from greatest to lowest contribution. A “key source” has a significant influence on the national inventory of direct GHG emissions in terms of the absolute emissions level. The KCA reported in this inventory follows the 2006 IPCC Guidelines for National Greenhouse Gas Inventories and is estimated for both level and trend assessments. The results of the 2018 level assessment are presented in Table 2-2, and those of the 2018 trend assessment are available in Table 2-3. There are 17 key categories in the level assessment, among which main activity electricity and heat production led the KCA, followed by road transportation, cropland remaining cropland, manufacturing industries and construction, and rice cultivation. Results of the KCA changed slightly under trend assessment, where land converted to cropland, forest land remaining forest land, cropland remaining cropland, main activity electricity and heat production and rice cultivation.

Table 2-2: Key category analysis for the year 2018: Approach 1 – Level assessment

Category code	IPCC source category	GHG	Base year estimate 2000 (GgCO <sub>2</sub> eq)	Current year estimate 2018 (GgCO <sub>2</sub> eq)	Lx,t	Cumulative total of Level assessment
1A1a	Main Activity Electricity and Heat Production	CO <sub>2</sub>	58,182.12	91,664.56	0.19	0.19
1A3b	Road Transportation	CO <sub>2</sub>	45,479.14	69,914.38	0.15	0.34
4B	Cropland Remaining Cropland	CO <sub>2</sub>	36,665.42	68,806.14	0.14	0.48
1A2	Manufacturing Industries and Construction	CO <sub>2</sub>	31,940.86	51,226.49	0.11	0.59
3I	Rice Cultivation	CH <sub>4</sub>	26,553.26	29,990.25	0.06	0.65
4A	Forest Land Remaining Forest Land	CO <sub>2</sub>	34,311.02	26,803.34	0.06	0.71
2A1	Cement Production	CO <sub>2</sub>	16,450.25	19,361.06	0.04	0.75
1A4	Other Sectors	CO <sub>2</sub>	11,044.67	15,057.02	0.03	0.78
2B8	Petrochemical and Carbon Black Production	CO <sub>2</sub>	5,089.85	12,354.17	0.03	0.81
1A1b	Petroleum Refining	CO <sub>2</sub>	7,022.73	10,610.77	0.02	0.83
3A	Enteric Fermentation	CH <sub>4</sub>	9,386.19	10,052.24	0.02	0.85
1B2	Oil and Natural Gas	CH <sub>4</sub>	6,186.22	9,742.60	0.02	0.87
4C	Land Converted to Cropland	CO <sub>2</sub>	23,236.24	9,502.20	0.02	0.89
5A	Solid Waste Disposal	CH <sub>4</sub>	3,447.59	8,774.67	0.02	0.91
3F	Direct N <sub>2</sub> O Emission from Managed Soils	N <sub>2</sub> O	6,285.53	8,715.01	0.02	0.93
5D	Wastewater Treatment and Discharge	CH <sub>4</sub>	6,408.21	6,915.26	0.01	0.94
3G	Indirect N <sub>2</sub> O Emission from Managed Soils	N <sub>2</sub> O	2,379.55	3,259.34	0.01	0.95

Table 2-3: Key category analysis for the year 2018: Approach 2 – Trend assessment

Category code	IPCC source category	GHG	Base year estimate 2000 (GgCO <sub>2</sub> eq)	Current year estimate 2018 (GgCO <sub>2</sub> eq)	Tx,t	% Contribution to trend	Cumulative total of % Contribution to trend
4C	Land Converted to Cropland	CO <sub>2</sub>	23,236.24	9,502.20	0.07	18.44	18.44
4A	Forest Land Remaining Forest Land	CO <sub>2</sub>	34,311.02	26,803.34	0.06	16.96	35.40
4B	Cropland Remaining Cropland	CO <sub>2</sub>	36,665.42	68,806.14	0.05	14.18	49.58
1A1a	Main Activity Electricity and Heat Production	CO <sub>2</sub>	58,182.12	91,664.56	0.03	8.41	58.00
3I	Rice Cultivation	CH <sub>4</sub>	26,553.26	29,990.25	0.02	5.69	63.68
1A2	Manufacturing Industries and Construction	CO <sub>2</sub>	31,940.86	51,226.49	0.02	5.35	69.03
1A3b	Road Transportation	CO <sub>2</sub>	45,479.14	69,914.38	0.02	5.18	74.21
2B8	Petrochemical and Carbon Black Production	CO <sub>2</sub>	5,089.85	12,354.17	0.02	4.22	78.43
5A	Solid Waste Disposal	CH <sub>4</sub>	3,447.59	8,774.67	0.01	3.19	81.62
3A	Enteric Fermentation	CH <sub>4</sub>	9,386.19	10,052.24	0.01	2.45	84.07
2F1	Refrigeration and Air Conditioning	HFC-125	0.70	2,854.17	0.01	2.29	86.37
5D	Wastewater Treatment and Discharge	CH <sub>4</sub>	6408.21	6915.26	0.01	1.63	88.00
4E2	Biomass Burning (Cropland)	CH <sub>4</sub>	1,408.27	4.95	0.01	1.58	89.58
1A3a	Civil Aviation	CO <sub>2</sub>	948.90	2,636.56	0.00	1.06	90.63
2F1	Refrigeration and Air Conditioning	HFC-134a	42.49	1,271.75	0.00	0.98	91.61
1B2	Oil and Natural Gas	CH <sub>4</sub>	6,186.22	9,742.60	0.00	0.89	92.50
2A1	Cement Production	CO <sub>2</sub>	16,450.25	19,361.06	0.01	0.85	93.35
2F1	Refrigeration and Air Conditioning	HFC-32	0.00	951.80	0.00	0.77	94.12
1A1b	Petroleum Refining	CO <sub>2</sub>	7,022.73	10,610.77	0.00	0.73	94.84
4E2	Biomass Burning (Cropland)	N <sub>2</sub> O	493.72	1.74	0.00	0.55	95.40

## CHAPTER 2

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### 2.1.5 Time Series Consistency

Activity data for each source category presented in this inventory was based on the same sources as the national statistics for all years (2000-2018). The same emission factors were also used, in line with the 2006 IPCC Guidelines. Thus, this inventory allows for consistent comparison of data points across time, with good confidence in the emission trends.

### 2.1.6 Quality Assurance and Quality Control

As dictated by the 2006 IPCC Guidelines, quality control (QC) and quality assurance (QA) procedures were implemented during the preparation of this inventory. In addition, Thailand has utilized its own national system for quality control of data collection among ministerial agencies (Chapter 1, Figure 1 -28). Data was controlled at each stage of the data collection process by each respective institute and further underwent a final quality assurance process conducted by the lead agency for each sector.

To fulfill transparency, accuracy, comparability, consistency, and completeness of national GHG inventory, the Energy, IPPU, Agriculture, and Waste sectors have developed and implemented the Quality Control (QC) procedure for verifying activity data (AD) and activity data factor (ADF) in the recent Thailand's GHG inventory system. The developed QC procedure followed the recommendations from the 2006 IPCC Guidelines and was modified with relevant agencies' suggestions. The QC-AD list consists of 1) completeness of data, 2) data fluctuation based on historical data, 3) availability of data for the entire time series, 4) comparable information from other sources, and 5) correction of data structure. The QC-ADF list contains 1) check an applicable value as recommended in IPCC 2006 Guidelines and 2) refer to international and/or national references. The QC templates, simply operated on MS Excel, are used to support the relevant agencies for inspecting the activity data.

## 2.2 Key Findings from the National Greenhouse Gas Inventory

In this report, the trends of Thailand's GHG emissions for the period 2000 to 2018, from all emission sources and removals, were conducted according to the 2006 IPCC Guidelines. The GHG emissions are estimated from the Energy, IPPU, Agriculture, LULUCF, and Waste sectors which include both direct and indirect emissions. Direct GHGs consist of Carbon Dioxide (CO<sub>2</sub>), Methane (CH<sub>4</sub>), Nitrous Oxide (N<sub>2</sub>O), Hydrofluorocarbons (HFCs), and Sulphur Hexafluoride (SF<sub>6</sub>) whereas indirect GHGs consist of Nitrogen Oxides (NO<sub>x</sub>), Carbon Monoxide (CO), Non-Methane Volatile Organic Compounds (NMVOCs) and Sulfur Dioxide (SO<sub>2</sub>). Table 2-4 shows Thailand's national GHG inventory from 2000 to 2018.

### 2.2.1 The Trend of Thailand's GHG Emissions and Removals by Sector 2000-2018

Total GHG emissions (excluding those from LULUCF) increased from 245,899.56 GgCO<sub>2</sub>eq in 2000 to 372,648.77 GgCO<sub>2</sub>eq in 2018, with an average annual increase of 2.34%. The net removal of CO<sub>2</sub> increased from -45,443.60 GgCO<sub>2</sub>eq in 2000 to -85,968.30 GgCO<sub>2</sub>eq in 2018. Net GHG emissions therefore increased overall from 200,455.96 GgCO<sub>2</sub>eq in 2000 to 286,680.47 GgCO<sub>2</sub>eq in 2018, with an average annual increase of 2.01% (Table 2-4, Figure 2-1). Between 2000-2018, the main source of GHG emissions was the Energy sector, which saw an increase of 55.88% from 165,092.40 GgCO<sub>2</sub>eq in 2000 to 257,340.89 GgCO<sub>2</sub>eq in 2018. The proportion of GHG emissions in the Energy sector accounted for 67.14% of total emission sources in 2000, increasing to comprise 69.06% of total emission sources in 2018. In the same period, the share of emissions from the Agriculture sector decreased from 19.95% in 2000 to 15.69% in 2018, the IPPU sector increased from 8.65% in 2000 to 10.77% in 2018 and the shares of emissions from the Waste sectors slightly increased from 4.26% in 2000 to 4.48% in 2018. (Figure 2-2).

Table 2-4: National GHG emissions/removals by sector 2000-2018

Unit: GgCO<sub>2</sub>eq

Year	Source category					Net emissions (Include LULUCF)	Total emissions (Exclude LULUCF)
	Energy	Industrial process and Product Use	Agriculture	LULUCF	Waste		
2000	165,092.40	21,274.82	49,065.40	-45,443.60	10,466.94	200,455.96	245,899.56
2001	172,906.76	22,873.13	50,019.89	-54,436.91	11,281.28	202,644.15	257,081.06
2002	182,317.06	24,944.60	48,691.69	-44,126.05	12,813.68	224,640.98	268,767.03
2003	191,305.31	24,217.55	52,265.60	-45,887.41	14,281.85	236,182.90	282,070.31
2004	208,180.48	26,041.51	51,958.87	-54,146.05	14,844.36	246,879.17	301,025.22
2005	212,318.12	27,883.81	51,413.70	-58,340.43	15,167.72	248,442.92	306,783.35
2006	213,020.12	28,771.00	53,870.52	-61,390.87	16,188.61	250,459.38	311,850.25
2007	219,378.63	30,424.56	57,161.74	-68,396.37	16,569.69	255,138.25	323,534.62
2008	221,716.62	28,897.09	59,059.43	-69,184.97	17,652.74	258,140.91	327,325.88
2009	221,351.88	28,344.22	61,137.46	-71,197.04	17,455.59	257,092.11	328,289.15
2010	233,105.75	29,961.53	60,694.70	-65,827.73	15,778.55	273,712.80	339,540.53
2011	229,859.44	31,290.10	61,220.57	-74,636.18	14,900.97	262,634.90	337,271.08
2012	242,867.49	33,484.60	64,250.78	-80,695.94	11,866.89	271,773.82	352,469.76
2013	241,717.77	33,299.85	59,080.05	-83,110.84	13,978.13	264,964.96	348,075.80
2014	239,724.21	34,819.39	57,995.56	-100,508.25	14,237.77	246,268.68	346,776.93
2015	241,918.80	35,675.42	52,324.55	-87,337.57	15,998.67	258,579.87	345,917.44
2016	254,540.07	37,189.17	52,303.38	-87,054.60	16,771.89	273,749.91	360,804.51
2017	255,244.90	38,054.69	57,052.83	-85,380.82	17,666.21	282,637.93	368,018.75
2018	257,340.89	40,118.18	58,486.02	-85,968.30	16,703.68	286,680.47	372,648.77

## CHAPTER 2

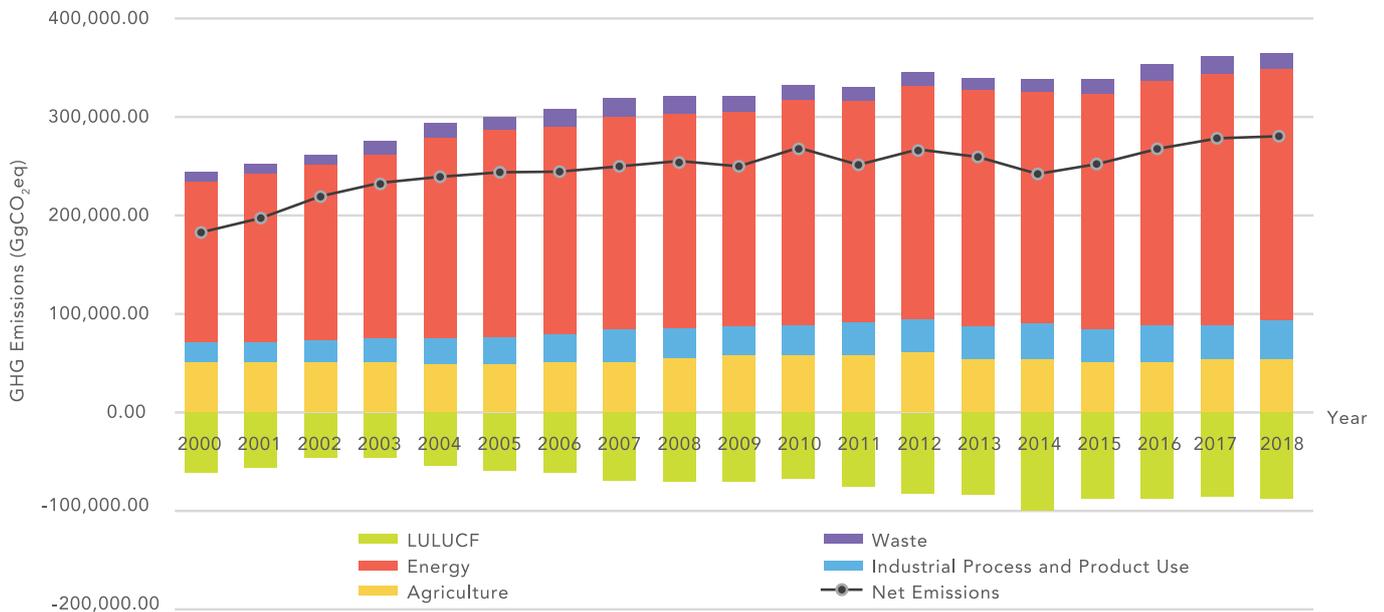


Figure 2-1: National GHG emissions/removals by sector 2000-2018

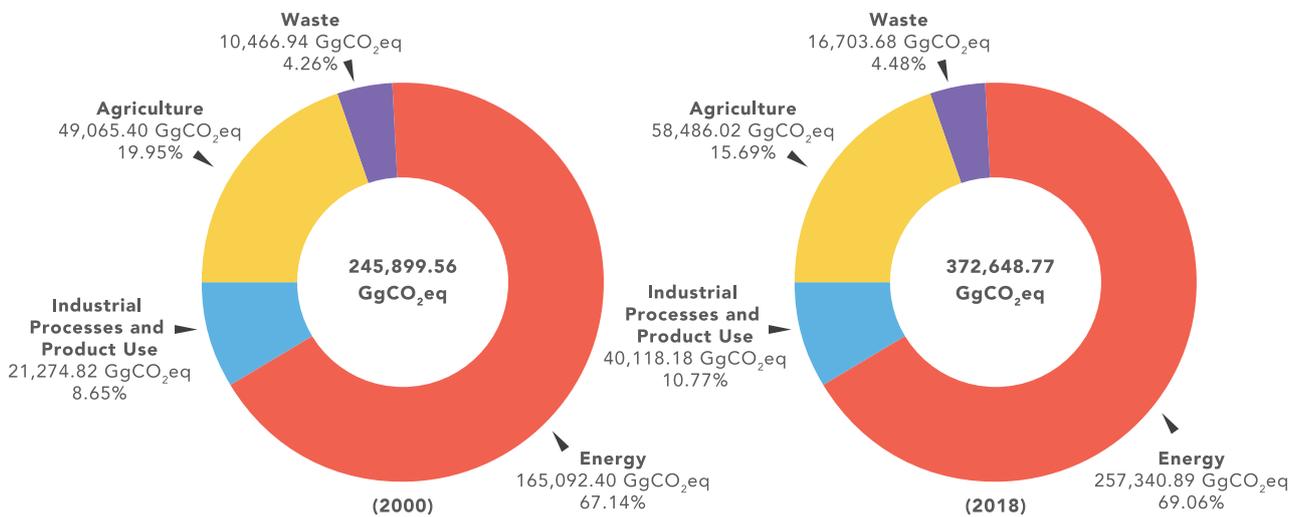


Figure 2-2: Total GHG emissions by sector (excluding LULUCF) 2000 and 2018

## 2.2.2 The Trend of Indirect GHG Emissions

The indirect GHG emissions include NO<sub>x</sub>, CO, NMVOCs, and SO<sub>2</sub>. The trends of indirect GHG emissions for the period from 2000 to 2018 are shown in Table 2-5. The estimated indirect GHG emissions are as follows:

- NO<sub>x</sub>: 942.32 Gg (2000) to 1,451.13Gg (2018) – an average annual increase of 2.43%
- CO: 6,022.22 Gg (2000) to 7,798.65 Gg (2018) – an average annual increase of 1.45%
- NMVOCs: 731.44 Gg (2000) to 1,057.87Gg (2018) – an average annual increase of 2.07%
- SO<sub>2</sub>: 594.96 Gg (2000) to 497.24 Gg (2018) – an average annual decrease of 0.99%

Table 2-5: Indirect GHG emissions by gases 2000-2018

Unit: Gg

Year	Indirect Gases			
	NO <sub>x</sub>	CO	NMVOCs	SO <sub>2</sub>
2000	942.32	6,022.22	731.44	594.96
2001	983.03	5,795.26	746.09	643.74
2002	1,037.23	6,144.15	828.22	688.52
2003	1,107.07	6,435.12	878.37	617.62
2004	1,191.62	6,347.04	895.95	719.97
2005	1,196.23	6,004.78	828.46	756.02
2006	1,190.50	6,459.84	853.77	692.78
2007	1,224.74	6,596.80	868.27	627.18
2008	1,217.36	6,736.72	834.29	631.14
2009	1,246.51	6,845.08	856.75	600.83
2010	1,282.31	6,999.10	865.80	633.92
2011	1,303.60	7,253.58	900.58	607.29
2012	1,356.38	7,408.01	896.69	564.75
2013	1,361.24	7,555.26	926.30	505.64
2014	1,330.04	7,130.69	980.53	447.45
2015	1,351.97	7,153.17	1,033.65	416.77
2016	1,383.96	7,253.94	971.01	452.08
2017	1,420.95	7,398.05	1,009.70	425.62
2018	1,451.13	7,798.65	1,057.87	497.24
Average Annual Growth Rate	2.43%	1.45%	2.07%	-0.99%

### 2.2.3 Recalculation of Total GHG Emissions

Previous inventories submitted in the BUR3 were calculated using the 2006 IPCC Guidelines. To provide a consistent data series, recalculations were performed for past inventories (2000-2016). As part of this current inventory submission, emissions for the period 2000-2016 were recalculated using updated activity data, revised emission factors, and subsectors according to the 2006 IPCC Guidelines. Results of the recalculated national GHG emissions data for 2000-2016 are presented in Figure 2-3. The newly calculated emissions for 2000-2016 were higher than those in the previous inventories submitted in the BUR3, in the range of an additional 0.06% to 1.82%.

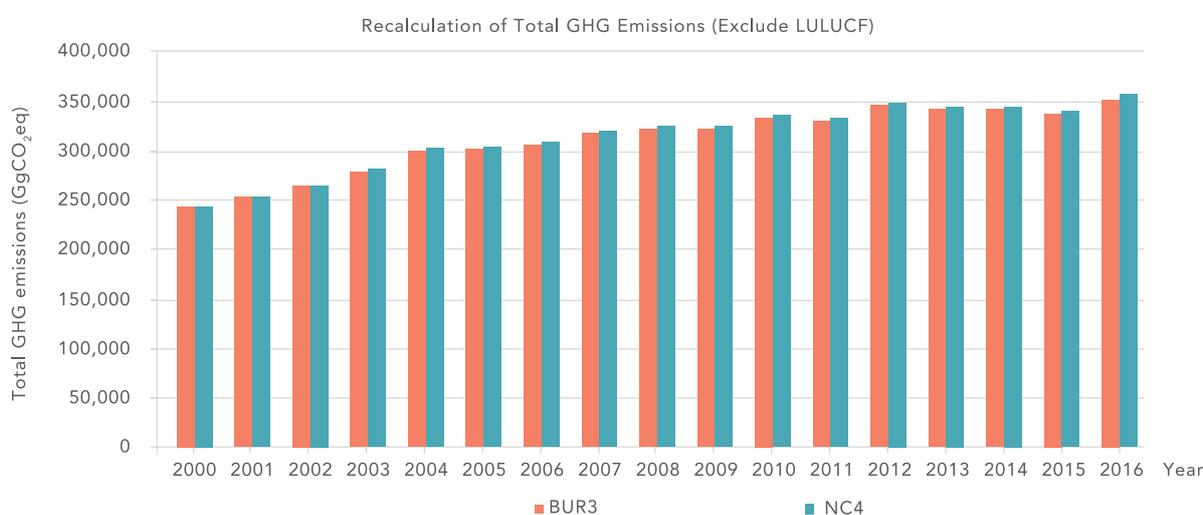


Figure 2-3: Comparison of Thailand’s GHG emissions between BUR3 and NC4

## 2.3 Greenhouse Gas Emissions by Sector

### 2.3.1 Energy

#### 2.3.1.1 Methodology

The method used in the calculation of Thailand’s greenhouse gas emissions is mainly based on the 2006 IPCC Guidelines of National Greenhouse Gas Inventories in compliance with the IPCC Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories 2000 (GPG 2000). The method of emissions calculation in the energy sector is Tier 1.

**2.3.1.2 Greenhouse Gas Emissions 2018**

Total direct GHG emissions from the Energy sector in 2018 were estimated to be 257,340.89 GgCO<sub>2</sub>eq. The majority of GHG emissions in the Energy sector were generated by fuel combustion, consisting mostly of 1A1 Energy industries at around 103,055.20 GgCO<sub>2</sub>eq (40.05%). GHG emissions from Transport, Manufacturing Industries and Construction, and other sectors were 75,029.65 GgCO<sub>2</sub>eq (29.16%), 52,078.20 GgCO<sub>2</sub>eq (20.24%), and 16,884.56 GgCO<sub>2</sub>eq (6.56%).

Fugitive Emissions from fuel comprised only 10,293.28 GgCO<sub>2</sub>eq or a little over 4.00% of total GHG emissions from the Energy sector. Details of GHG emissions in the Energy sector by gas type and source in 2018 are presented in Figure 2-4 and Table 2-6.

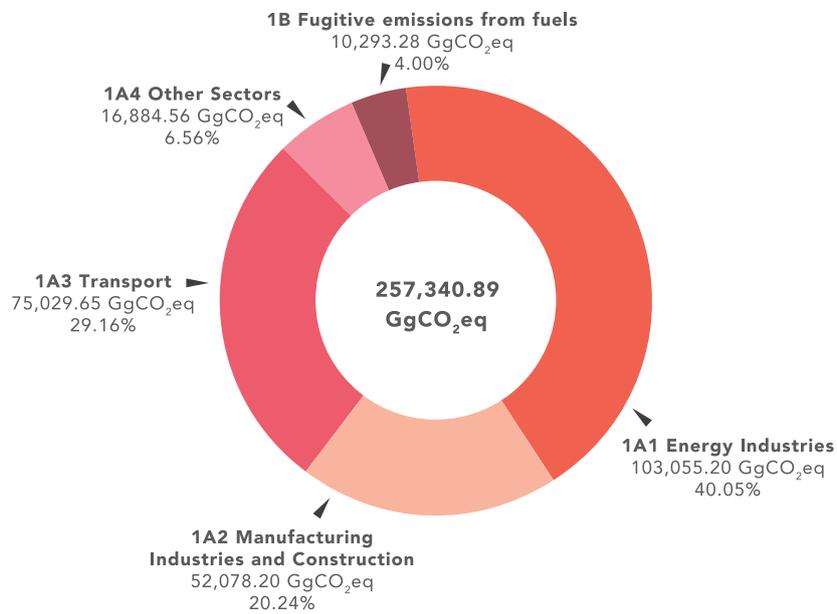


Figure 2-4: GHG emissions in Energy sector in 2018

Table 2-6: GHG emissions from various sources relative to total GHG emissions in the Energy sector 2018

Greenhouse gas source and sink categories	CO <sub>2</sub> emissions GgCO <sub>2</sub> e <sub>q</sub>	CO <sub>2</sub> removals GgCO <sub>2</sub> e <sub>q</sub>	CH <sub>4</sub>		N <sub>2</sub> O		HFCs GgCO <sub>2</sub> e <sub>q</sub>	PFCs GgCO <sub>2</sub> e <sub>q</sub>	SF <sub>6</sub> GgCO <sub>2</sub> e <sub>q</sub>	NO <sub>x</sub> Gg	CO Gg	NMVOCs Gg	SO <sub>2</sub> Gg	Total GgCO <sub>2</sub> e <sub>q</sub>
			Gg	GgCO <sub>2</sub> e <sub>q</sub>	Gg	GgCO <sub>2</sub> e <sub>q</sub>								
1 Energy														
1A Fuel combustion activities	241,833.74	NO	523.25	13,081.15	8.14	2,426.00				1,401.05	6,007.32	884.26	490.54	257,340.89
1A1 Energy industries	241,830.35	NO	111.66	2,791.26	8.14	2,426.00				1,401.05	6,007.32	776.43	490.54	247,047.61
1A2 Manufacturing industries and construction	102,197.05	NO	11.31	282.64	1.93	575.51				319.94	369.93	24.7	50.52	103,055.20
1A3 Transport	51,226.49	NO	12.82	320.38	1.78	531.34				183.00	1,362.84	24.23	393.26	52,078.20
1A4 Other sectors	73,349.79	NO	24.28	607.09	3.60	1,072.77				730.72	3,059.46	572.43	8.61	75,029.65
1A5 Non-specified	15,057.02	NO	63.25	1,581.15	0.83	246.38				167.39	1,215.09	155.07	38.15	16,884.56
1B Fugitive emissions from fuels	NO	NO	NO	NO	NO	NO				NO	NO	NO	NO	NO
1B1 Solid fuels	3.39	NO	411.59	10,289.89	NO	NO				NO	NO	107.83	NO	10,293.28
1B2 Oil and natural gas	NO	NO	21.89	547.29	NO	NO				NO	NO	NO	NO	547.29
1B3 Other emissions from energy production	3.39	NO	389.70	9,742.60	NO	NO				NO	NO	107.83	NO	9,745.98
1C Carbon dioxide transport and storage	NO	NO	NO	NO	NO	NO				NO	NO	NO	NO	NO
1C1 Transport of CO2	NO	NO	NO	NO	NO	NO				NO	NO	NO	NO	NO
1C2 Injection and storage	NO	NO	NO	NO	NO	NO				NO	NO	NO	NO	NO
1C3 Other	NO	NO	NO	NO	NO	NO				NO	NO	NO	NO	NO

Note: NO= Not Occurring

## 2.3.2 Industrial Process and Product Use (IPPU)

### 2.3.2.1 Methodology

The methodologies and tools used for IPPU GHG inventory reporting followed the 2006 IPCC Guidelines for National Greenhouse Gas Inventories (IPCC, 2006), Good Practice Guidance, and Uncertainty Management in National Greenhouse Gas Inventories (IPCC, 2000). The GHG emission calculation for IPPU Sector was Tier 1 approach as the primary basis and Tier 1,2 for Cement Production.

### 2.3.2.2 Greenhouse Gas Emissions 2018

Total direct GHG emissions from the IPPU sector in 2018 were estimated at 40,118.18 GgCO<sub>2</sub>eq. The majority of GHG emissions in the IPPU sector were generated by the Mineral Industry (2A) at around 20,574.46 GgCO<sub>2</sub>eq (51.28%), mainly consisting of Cement Production at around 19,361.06 GgCO<sub>2</sub>eq. The followings were GHG emissions from the Chemical Industry (2B) and Product Uses as Substitutes for Ozone Depleting Substances (2F) at 13,307.30 GgCO<sub>2</sub>eq (33.17%) and 5,347.09 GgCO<sub>2</sub>eq (13.33%), respectively. GHG emissions from the Metal Production (2C), Non-Energy Products from Fuels and Solvent Us (2D), and Other Product Manufacture and Use (2G) accounted for only 2% of total GHG emissions from the IPPU sector.

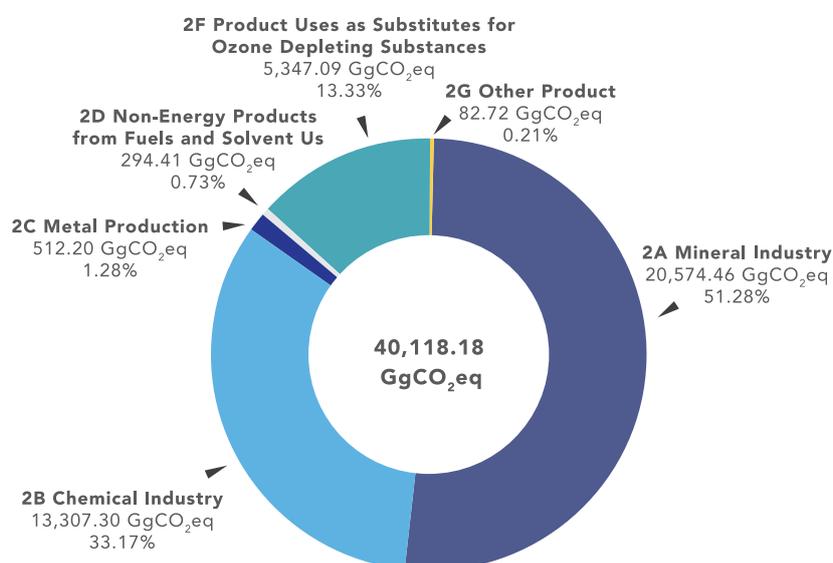


Figure 2-5: GHG emissions in **Industrial Process and Product Use Sector** 2018

Table 2-7: GHG emissions from various sources relative to total GHG emissions in the Industrial Process and Product Use Sector 2018

Greenhouse gas source and sink categories		CO <sub>2</sub>	CH <sub>4</sub>	CH <sub>4</sub>	N <sub>2</sub> O	N <sub>2</sub> O	HFCs	SF <sub>6</sub>	CO	NO <sub>x</sub>	NM VOC	SO <sub>2</sub>	Total
Unit	GgCO <sub>2</sub> eq	Gg	GgCO <sub>2</sub> eq	GgCO <sub>2</sub> eq	Gg	GgCO <sub>2</sub> eq	GgCO <sub>2</sub> eq	GgCO <sub>2</sub> eq	GgCO <sub>2</sub> eq	Gg	Gg	Gg	GgCO <sub>2</sub> eq
2. Industrial Process and Product Use	33,735.24	14,486	362.32	1.98	590.81	82.72	5,347.09	82.72	5.35	1.43	173.6	6.69	40,118.18
<b>2A Mineral Industry</b>													
2A1 Cement Production	19,361.06	NE	NE	NO	NO	NO	NO	NO	NO	NO	NO	NO	19,361.06
2A2 Lime Production	106.76	NE	NE	NO	NO	NO	NO	NO	NO	NO	NO	NO	106.76
2A3 Glass Production	354.96	NE	NE	NO	NO	NO	NO	NO	NO	NO	NO	NO	354.96
2A4b Other Uses of Soda Ash	346.42	NE	NE	NO	NO	NO	NO	NO	NO	NO	NO	NO	346.42
2A4d Other	405.26	NE	NE	NO	NO	NO	NO	NO	NO	NO	NO	NO	405.26
<b>2B Chemical Industry</b>													
<b>2C Metal Production</b>													
2C1 Iron and Steel Production	512.20	NE	NE	NO	NO	NO	NO	NO	NO	NO	NO	NO	512.2
<b>2D Non-Energy Products from Fuels and Solvent Use</b>													
2D1 Lubricant Use	294.41	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	294.41
<b>2F Product Uses as Substitutes for Ozone Depleting Substances</b>													
2F1 Refrigeration and Air Conditioning	NO	NO	NO	NO	NO	5,347.09	NO	NO	NO	NO	NO	NO	5,347.09
<b>2G Other Product</b>													
2G1 Electrical Equipment	NO	NO	NO	NO	NO	82.72	NO	NO	NO	NO	NO	NO	82.72
<b>2H Others</b>													
2H1 Pulp and paper	NO	NO	NO	NO	NO	NO	NO	NO	5.35	1.43	3.54	6.69	-
2H2 Food and Beverage	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	170.06	NO	-

Note: NE = Not Estimated, NO = Not Occurring

### 2.3.3 Agriculture

#### 2.3.3.1 Methodology

In this inventory, the methodologies used for the Agriculture sector were based on the 2006 IPCC guidelines. GHG estimations were calculated for 2 sub-categories, including 3A Livestock (3A1 Enteric fermentation and 3A2 Manure management) and 3C Aggregate sources and non-CO<sub>2</sub> emission sources on land (3C1b Biomass burning (Cropland), 3C2 Liming, 3C3 Urea fertilization, 3C4 Direct N<sub>2</sub>O emissions from managed soils, 3C5 Indirect N<sub>2</sub>O emissions from managed soils, 3C6 Indirect N<sub>2</sub>O emissions from manure management, and 3C7 Rice cultivation). Sub-categories 3C2, 3C3, and 3C6 were estimated for the first time in this inventory. Methodology tiers were chosen according to the decision trees in the 2006 IPCC Guidelines. Tier 1 and tier 2 methods were applied to the Agriculture sector.

#### 2.3.3.2 Greenhouse Gas Emissions 2018

Total GHG emissions from the Agriculture Sector in 2018 were 58,486.02 GgCO<sub>2</sub>eq. Livestock contributed 13,115.64 GgCO<sub>2</sub>eq (22.43%), comprising 10,052.24 GgCO<sub>2</sub>eq from enteric fermentation, 2,494.12 and 569.27 GgCO<sub>2</sub>eq for direct and indirect manure management, respectively. Meanwhile, crop related-GHG emissions accounted for 45,370.38 GgCO<sub>2</sub>eq (77.57%). Rice cultivation was the main GHG contributor in Thailand's Agriculture sector, at 29,990.25 GgCO<sub>2</sub>eq (51.28%). Agricultural soils emitted 11,974.34 GgCO<sub>2</sub>eq (20.47%) with direct and indirect emissions contributing 8,715.01 and 3,259.34 GgCO<sub>2</sub>eq, respectively. Field burning of agricultural residues and urea fertilizer contributed similar GHG emissions of 1,706.82 and 1,671.38 GgCO<sub>2</sub>eq (2.92 and 2.86 %), respectively. The lowest agricultural GHG emission in 2018 was from liming (27.59 GgCO<sub>2</sub>eq or 0.05%). Details of 2018 GHG emissions in the Agriculture sector by gas type and source are presented in Figures 2-6 and Tables 2-8.

In the Agriculture sector, field burning of agricultural residues was estimated based on the residues being burnt as residue management in croplands. This field burning was in the category of "3C1b Emissions from Biomass Burning in Cropland (Cropland Remaining Cropland)" in the 2006 IPCC Guidelines.

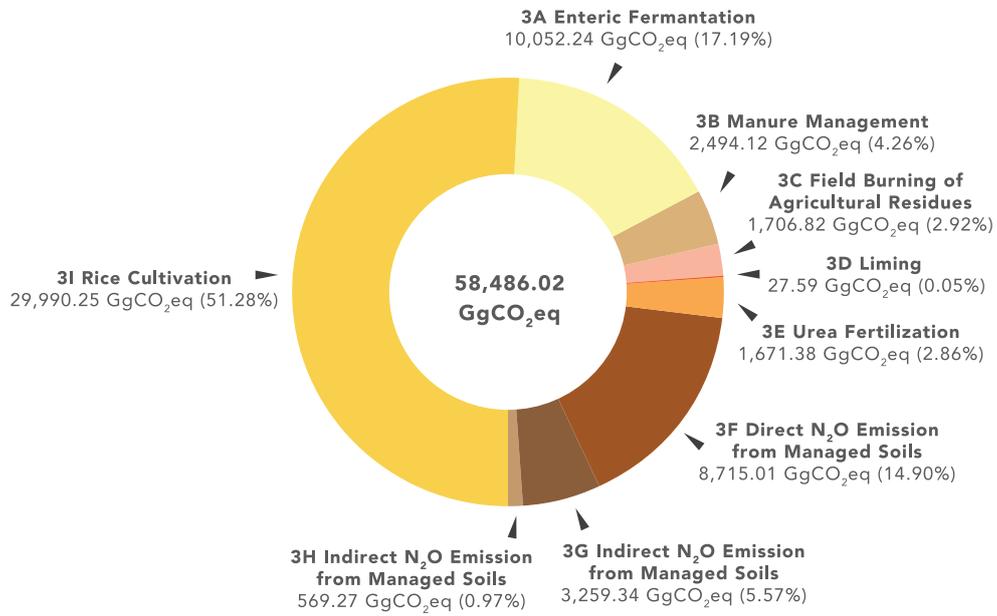


Figure 2-6: GHG emissions in **Agriculture Sector** 2018

Table 2-8: GHG emissions from various sources relative to total GHG emissions in the **Agriculture Sector 2018**

Greenhouse gas source and sink categories	CO <sub>2</sub> emissions GgCO <sub>2</sub> eq	CO <sub>2</sub> removals GgCO <sub>2</sub> eq	CH <sub>4</sub>		N <sub>2</sub> O		HFCs GgCO <sub>2</sub> eq	PFCs GgCO <sub>2</sub> eq	SF <sub>6</sub> GgCO <sub>2</sub> eq	NO <sub>x</sub> Gg	CO Gg	NMVOCs Gg	SO <sub>2</sub> Gg	Total GgCO <sub>2</sub> eq
			Gg	GgCO <sub>2</sub> eq	Gg	GgCO <sub>2</sub> eq								
3. Agriculture	1,698.97		1,731.67	43,291.75	45.29	13,495.31				48.29	1,777.13			58,486.02
3A Enteric Fermentation			402.09	10,052.24										10,052.24
3B Manure Management			77.82	1,945.38	1.84	548.74								2,494.12
3C Field Burning of Agricultural Residues	NA		52.15	1,303.87	1.35	402.94				48.29	1,777.13			1,706.82
3D Liming	27.59													27.59
3E Urea Fertilization	1,671.38													1,671.38
3F Direct N <sub>2</sub> O Emission from Managed Soils					29.24	8,715.01								8,715.01
3G Indirect N <sub>2</sub> O Emission from Managed Soils					10.94	3,259.34								3,259.34
3H Indirect N <sub>2</sub> O Emission from Manure Management					1.91	569.27								569.27
3I Rice Cultivation			1,199.61	29,990.25										29,990.25

Note: NA = Not Applicable

### 2.3.4 Land Use, Land-Use Change, and Forestry (LULUCF)

#### 2.3.4.1 Methodology

All methodologies and tools used to report GHG inventories for Land Use, Land-Use Change, and Forestry (LULUCF) were consistent with the 2006 IPCC Guidelines for National Greenhouse Gas Inventories (IPCC, 2006), Good Practice Guidance for Land Use, Land-Use Change, and Forestry (IPCC, 2003), and Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories (IPCC, 2000). The 2006 IPCC Guidelines define six land-use categories: forest land, cropland, grassland, wetlands, settlements, and other lands. GHG emissions/removals from the LULUCF sector during 2000-2018 were estimated for the three land categories (excluding grassland, wetlands, and settlements). The Tier 2 methodology was used primarily wherever activity data and country-specific emission factors were available. Approach 1 in the 2006 IPCC Guidelines was adopted for representing land-use areas of which total land-use areas in each stratification were reported without data on conversions between land uses.

#### 2.3.4.2 Greenhouse Gas Emissions 2018

The total CO<sub>2</sub> emissions/removals from C stock changes for each land use category is the sum of those from these all sub-categories taking into account the three carbon pools: (i) above-ground biomass, (ii) below-ground biomass, and (iii) dead organic matter (deadwood and litter). The LULUCF sector in Thailand showed a trend of increased net removals because the total removals exceeded the total emissions. LULUCF activities contributed to a tremendous increase in net removal from the atmosphere since 2000 due to the net removal of rubber plantations. It can be observed that cropland dominates the net removals estimated for the LULUCF sector for Thailand. The net removals in the period of 2000 –2014 fluctuated due to the net removals from cropland and emissions from land conversion, but it seemed stable after 2015.

In 2018, the LULUCF sector contributed to a net removal of 85,968.30 GgCO<sub>2</sub>eq, accounting for an increase by two folds compared with the year 2000. The net removal estimated for cropland remaining cropland was 68,806.14 GgCO<sub>2</sub>eq, accounting for almost 80% of the overall net removals of the LULUCF sector. The forest land conversion emitted 9,502.20 and 119.46 GgCO<sub>2</sub>eq from land converted to cropland and other lands, respectively, thereby decreasing about 60% compared with the emissions in 2000. While non-CO<sub>2</sub> emissions from biomass burning in the LULUCF sector emitted 19.52 GgCO<sub>2</sub>eq. Details of GHG emissions/removals in the LULUCF sector by gas type and source in 2018 are presented in Figure 2-7 and Table 2-9.

In the LULUCF sector, non-CO<sub>2</sub> emissions were estimated from biomass burning from an uncontrolled forest fire in natural forest (3B1a Forest Land Remaining Forest Land) and forest converted to cropland (3B2b Land Converted to Cropland) and to other lands (3B6b Land Converted to other lands) in the 2006 IPCC Guidelines.

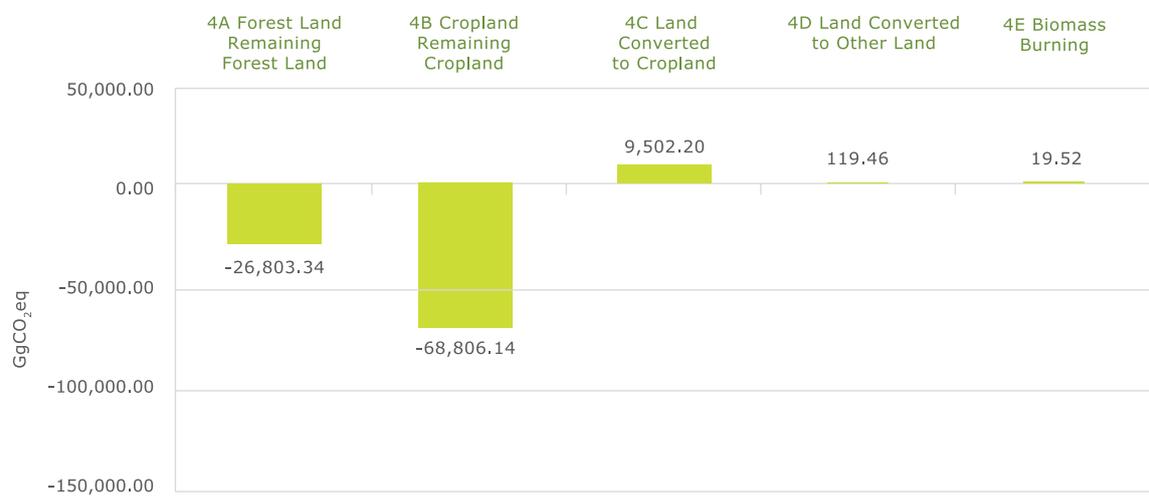


Figure 2-7: GHG emissions relative to **LULUCF Sector** 2018

Table 2-9: GHG emissions from various sources relative to total GHG emissions in the LULUCF Sector 2018

Greenhouse gas source and sink categories	Unit	CO <sub>2</sub> emissions	CO <sub>2</sub> removals	Net	CH <sub>4</sub>	NO <sub>2</sub>	HFCs	PFCs	SF <sub>6</sub>	NO <sub>x</sub>	CO	NMVOCs	SO <sub>2</sub>	Total
		GgCO <sub>2</sub> eq	GgCO <sub>2</sub> eq	GgCO <sub>2</sub> eq	Gg	GgCO <sub>2</sub> eq	GgCO <sub>2</sub> eq	GgCO <sub>2</sub> eq	GgCO <sub>2</sub> eq	Gg	Gg	Gg	Gg	Gg
4. Land Use, Land-Use Change and Forestry		57,378.59	-143,366.40	-85,987.81	0.58	0.02	NO	NO	NO	0.14	8.83	NO	NO	-85,968.30
4A Forest Land Remaining Forest Land		17,190.19	-43,993.52	-26,803.34	NO	NO	NO	NO	NO	NO	NO	NO	NO	-26,803.34
4B Cropland Remaining Cropland		30,566.74	-99,372.88	-68,806.14	NO	NO	NO	NO	NO	NO	NO	NO	NO	-68,806.14
4C Land Converted to Cropland		9,502.20	NO	9,502.20	NO	NO	NO	NO	NO	NO	NO	NO	NO	9,502.20
4D Land Converted to Other Land		119.46	NO	119.46	NO	NO	NO	NO	NO	NO	NO	NO	NO	119.46
4E Biomass Burning		NO	NO	NO	0.58	0.02	NO	NO	NO	0.14	8.83	NO	NO	19.52
4E1 Biomass Burning (Forest Land)		NO	NO	NO	0.38	0.01	NO	NO	NO	0.09	5.77	NO	NO	12.75
4E2 Biomass Burning (Cropland)		NO	NO	NO	0.20	0.01	NO	NO	NO	0.05	3.03	NO	NO	6.69
4E3 Biomass Burning (Other Land)		NO	NO	NO	0.00	0.00	NO	NO	NO	0.00	0.03	NO	NO	0.08

Note: NO = Not Occurring

## 2.3.5 Waste

### 2.3.5.1 Methodology

The methodologies and tools used for GHG inventory reporting followed the 2006 IPCC Guidelines for National Greenhouse Gas Inventories (IPCC, 2006). In the Waste sector, the methodologies used varied from Tier 1 to Tier 2, depending on types of activity data and emission factors. Tier 2 was adopted for solid waste disposal and Tier 1 for the rest.

### 2.3.5.2 Greenhouse Gas Emissions 2018

GHG emissions in the Waste sector were mainly from solid waste disposal, at 8,774.67 GgCO<sub>2</sub>eq (52.53%), and wastewater treatment and discharge, at 7,635.72 GgCO<sub>2</sub>eq (45.71%). Waste incineration accounted for 180.54 GgCO<sub>2</sub>eq (1.08%), while biological treatment of solid waste was the smallest proportion of total GHG emissions in this sector, with an amount of 112.76 GgCO<sub>2</sub>eq (0.68%). Details of GHG emissions in the Waste sector by gas type and source in 2018 are given in Figure 2-8 and Table 2-10.

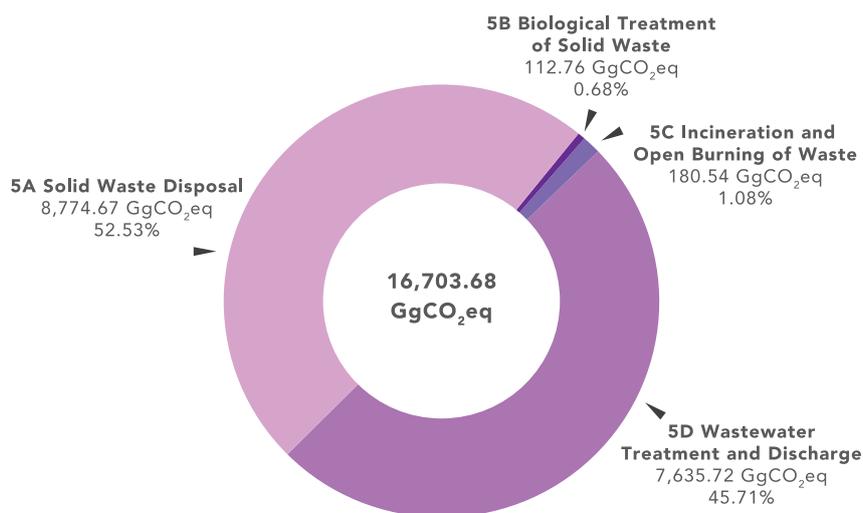


Figure 2-8: GHG emissions in **Waste Sector** 2018

Table 2-10: GHG emissions from various sources relative to total GHG emissions in the Waste Sector 2018

Greenhouse gas source and sink categories	CO <sub>2</sub> emissions GgCO <sub>2</sub> eq	CO <sub>2</sub> removals GgCO <sub>2</sub> eq	CH <sub>4</sub>		N <sub>2</sub> O		HFCs GgCO <sub>2</sub> eq	PFCs GgCO <sub>2</sub> eq	SF <sub>6</sub> GgCO <sub>2</sub> eq	NO <sub>x</sub> Gg	CO Gg	NMVOCs Gg	SO <sub>2</sub> Gg	Total GgCO <sub>2</sub> eq
			Gg	GgCO <sub>2</sub> eq	Gg	GgCO <sub>2</sub> eq								
5. Waste	175.84		630.04	15,751.08	2.61	776.76				NO/NA	NO/NA	NA	NA	16,703.68
5A Solid Waste Disposal			350.99	8,774.67								NA		8,774.67
5A1 Managed Waste Disposal Sites			224.34	5,608.47								NA		5,608.47
5A2 Unmanaged Waste Disposal Sites			126.65	3,166.20								NA		3,166.20
5B Biological Treatment of Solid Waste			2.44	61.08	0.17	51.68				NO		NA		112.76
5C Incineration and Open Burning of Waste	175.84		0.003	0.07	0.02	4.63				NA	NA	NA	NA	180.54
5C1 Waste Incineration	175.84		0.003	0.07	0.02	4.63				NA	NA	NA	NA	180.54
5D Wastewater Treatment and Discharge			276.61	6,915.26	2.42	720.46				NO	NO	NA		7,635.72
5D1 Domestic Wastewater Treatment and Discharge			75.09	1,877.16	2.42	720.46				NO	NO	NA		2,597.62
5D2 Industrial Wastewater Treatment and Discharge			201.52	5,038.10						NO	NO	NA		5,038.10

Note: NA = Not Applicable, NO = Not Occurring

## 2.4 Constraints, Gaps, and Needs in the National Greenhouse Gas Inventory by Sector

Thailand aims to improve its inventory quality in terms of transparency, accuracy, completeness, consistency, and comparability. During the national GHG inventory development, Thailand faced several constraints and gaps that needed to be addressed. This includes limitations and barriers that affect the quality of GHG inventory estimation and compilation. It is important to improve the quality of the national statistics compiled by relevant agencies to further improve the overall quality of the national GHG inventory. Further work and support are needed to improve the inventory quality, particularly in terms of transparency, accuracy, completeness, consistency and comparability. Enhancing the knowledge and understanding of GHG estimation methodologies among key stakeholders, particularly industrial partners, including training on sensitivity analysis and calculation, is also needed to strengthen the national GHG inventory development. The capacity building and technology transfer should be provided to relevant government agencies and relevant agencies.

The existing TGEIS database also needs to be updated periodically to reflect the progress of GHG inventory quality. COP26 decisions have determined that under the implementation of ETF, the national GHG inventory must follow the Common Reporting Tables format. To prepare for this reporting format, Thailand is updating our national GHG inventory system (TGEIS) and planning for an annual training workshop for relevant officers. Moreover, Climate Change Bill is being drafted. This will become a regulatory framework that enables relevant agencies in the government and private sectors to collect required data for the national GHG inventory, especially those not currently available.

### 2.4.1 Energy

There are two key areas of support needed: 1) activity data and 2) emission factors which can be summarized as follows:

- Country-specific emission factors should be developed and introduced for the main fuels used in Thailand, including biofuels.
- Although Thailand has already adopted the 2006 IPCC Guidelines in all sectors, Thailand needs to enhance the professional capacities of national experts involved in the inventory process. A transition from default emission factors and Tier 1 methodologies to country-specific emission factors and Tier 2 and 3 methodologies is needed, focusing mainly on key categories.

With international level supports through bilateral collaboration and international organizations, Thailand's national inventory has been drastically improved in the calculation and reporting in all sectors. However, several supports needed remain, which can be identified by sector, as follows.

The main areas of support needed in the Energy sector are:

- The Ministry of Transport, via the Civil Aviation Authority of Thailand (CAAT), is developing an approach to collect data on fuel consumption for international aviation.

### 2.4.2 Industrial Process and Product Use (IPPU)

Gaps, needs, and areas of improvement in preparing Thailand's National GHG inventory in the IPPU sector and using TGEIS can be identified below:

- Estimation of GHG emissions from the IPPU sector is considered a challenge for Thailand due to the diversity of GHG sources and gas types and the complexity of calculation methodologies and data requirements. Currently, the emissions from most sub-categories under the IPPU sector can be estimated using the Tier1 approach with adequate activity data and default EF values. Tier2 estimation is only possible for the cement industry, in which country-specific emission factors are available. For other sub-categories, specific emission factors need to be developed in order to shift to a more accurate Tier2 estimation.

- Currently, F-gases are estimated and included in Thailand's GHG emission inventory. There are many limitations and difficulties in data collection and classification and a lack of specific technical data, such as initial charge, lifetime of equipment, and emission factors. Thailand's Department of Industrial Works has imposed reporting requirements on F-gases consumption and import-export statistics. However, such aggregate data can be useful and possible for Tier 1 estimation. Improvement of data reporting forms is underway to collect disaggregate data at application or sub-application levels. Advanced techniques, such as monitoring and modeling approaches, are also required to obtain the activity and emission data for F-gas estimation in order to fulfill the gaps according to the 2006 IPCC guideline. In order to achieve more accurate GHG estimations and adopt the higher IPCC methodologies in the IPPU sector, the strengthening of data collection is required, particularly F-gas data.

### 2.4.3 Agriculture

Gaps, needs, and areas of improvement in the Agriculture sector preparing Thailand's National GHG inventory are as follows:

- To achieve more accurate GHG estimations and adopt the higher IPCC methodologies in the Agriculture sector, the required data should be collected or revised from the country. These include the updated livestock's characteristics and fractions of manure in management systems, determining more appropriate methods to estimate areas burnt in croplands by using satellite images, the revised fractions of crop

residues, gathering lime application to croplands from private sector, determining fertilizer application rates of major crops according to bottom-up approach, developing or revising country-specific EFs for agricultural soils and rice cultivation with water management (e.g., alternative wetting and drying).

- Due to the limitation in quality assurance or quality control (QA/QC) and uncertainty of the country's activity data and emission factors, improving the QA/QC procedure and uncertainty analysis in these data may enhance the accuracy of the inventory systems.

- Better understanding of the IPCC Guidelines, GHG estimation methodologies, and quality control systems, e.g., via activities on capacity building and technical transfer, should be provided for relevant government agencies and other parties. This may be important for strengthening institutions' capacity in data collection, quality control of data, and enhancing mitigation measures.

#### **2.4.4 Land Use, Land-Use Change, and Forestry (LULUCF)**

Although the MRV systems for the LULUCF sector have been developed and implemented among the relevant stakeholders, activity data relevant to forest land remains incomplete because forest areas in the LULUCF sector involve multiple departments (i.e., Royal Forest Department and Forest Industry Organization). For instance, there is also a gap between public and private data on forest plantation areas. In addition, activity data for biomass burning in forest land reported by various departments remains unclear in terms of burned areas and/or land categories. To provide more accurate GHG estimation and adopt the higher IPCC methodologies, remote sensing-based monitoring of land use and land cover is needed to classify types of natural forests and forest plantations, monitor their changes, and detect forest area burning.

Although cropland and forest land are key land categories contributing to the GHG net removals in the LULUCF sector, wood harvested from either cropland or forest plantations is not reported except for those reported by Forest Industry Organization. Thus, an approach must be developed for the government and private sector to enhance the MRV systems of essential activity data for the LULUCF sector.

Country-specific values are applied in most LULUCF categories, but some emission factors are adopted from IPCC defaults due to the use of the IPCC-2006 guidelines (i.e., below-ground to above-ground biomass ratio for natural forest and woody crops, deadwood and organic litters, trace gases emission ratio and uncertainty estimation). Furthermore, some parameters are not adequate to be used as national representatives due to the limitation of information (i.e., country-specific values relevant to croplands). Therefore, a new process for developing country-specific values is recommended to improve the accuracy of GHG inventory and adopt higher methodologies for the LULUCF sector.

### 2.4.5 Waste

Although MRV systems in the Waste sector have been developed and implemented among relevant stakeholders, some parameters are still out-of-date, such as solid waste composition and annual per capita protein consumption. Other parameters are not adequate to be used as nationally representative, including industrial production, wastewater generated, and Chemical Oxygen Demand (COD) in specific industrial wastewater. Meanwhile, other parameters are not available altogether, such as the degree of utilization of treatment discharge pathways or systems, including septic tanks, latrines, sewers, centralized wastewater treatment, and no treatment. Therefore, data collection systems and the creation of a centralized database need to be developed. Technical and funding support is required for capacity building within relevant agencies.

Development of country-specific values of emission factors for solid waste disposal and wastewater treatment and discharge of both domestic and industrial sources is also needed to improve data collection according to the 2006 IPCC Guidelines. This includes, for example, reaction constants and half-lives in the degradation of specific compositions of solid waste, the maximum methane producing capacity, and a methane correction factor for the wastewater treatment and discharge system. Technical and funding support is needed for initiating these studies.

Some cross-cutting issues need to be addressed, including archiving procedures, the planning, development, and implementation of a QA/QC system, and a process for uncertainty assessment.





# CHAPTER 3

## MITIGATION MEASURES



# CHAPTER 3: MITIGATION MEASURES

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*Thailand has put all efforts within its capacity to uphold its commitment under the Convention by integrating climate change mitigation into its national and sectoral policies and plans and implementing mitigating measures to achieve the national GHG reduction targets—NAMA’s target to reduce GHG emission by 7-20% from BAU by 2020 and NDC’s target to reduce GHG emission by 20-25% from BAU by 2030. Thailand submitted the 2<sup>nd</sup> updated NDC, which aligns with an ambitious pledge to reduce GHG emissions by 30 % from the BAU level by 2030. The contribution level increases to 40%, subject to adequate and enhanced access to technology development and transfer, financial resources, and capacity-building support. Furthermore, Thailand will continue efforts to meet the long-term goals of carbon neutrality by 2050 and net-zero GHG emissions by 2065.*

*This chapter lays out Thailand’s national, sectoral, and municipal mitigation policies and plans. The national plans include the 20-Year National Strategy, 12<sup>th</sup> National Economic and Social Development Plan, Climate Change Master Plan, Nationally Appropriate Mitigation Action (NAMA), Thailand’s Nationally Determined Contribution (NDC), and Long-Term Low Greenhouse Gas Emission Development Strategy (LT-LEDS). Aligning with the economy wide, the climate mitigation agenda is also incorporated into sectoral plans in emission-intensive sectors—energy, transport, IPPU, and waste sectors.*

*Subsequently, this chapter sums up the overall implementation of NAMA’s measures, its GHG reduction achievement, and the transition toward the NDC implementation. It further illustrates other mitigation actions, including voluntary actions from the carbon market and carbon label schemes which are increasingly developed.*

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### 3.1 Policies and plans

Thailand has integrated the climate change agenda into its national, sectoral, and municipal policies and plans to address the problem systematically and effectively.

#### 3.1.1 National Plans

The climate change agenda, particularly climate mitigation, has been incorporated into national development policies, strategies, and plans, including the 20-year National Strategy, the 12<sup>th</sup> National Economic and Social Development Plan, the Climate Change Master Plan, the Nationally Appropriate Mitigation Action (NAMA), the Nationally Determined Contribution (NDC), and the Long-Term Low Greenhouse Gas Emission Development Strategy.

### **The 20-Year National Strategy 2018 – 2037**

The 20-Year National Strategy (2018-2037) is the country's first national long-term strategy developed pursuant to the Constitution Section 65 stipulating that the State should develop a national strategy to be employed as the country's goal for sustainable national development in accordance with the principle of good governance. One of the key strategies is the "Eco-Friendly Development and Growth," aiming to 1) conserve and preserve natural resources and environment as well as culture for the next generation's sustainability, 2) restore and reconstruct natural resources and the environment for mitigation of negative impacts that may arise from national economic and social development, 3) ensure balanced utilization of the natural resource and environmental base by balancing development with ecosystem capacity, and 4) ensure the country's paradigm shift for the determination the country's natural resources and environment, as well as culture, based on good governance and public participation. This development strategy seeks to achieve all development aspects of the Sustainable Development Goals (SDGs), including promoting mutual growth in terms of the economy, environment, and quality of life. The focus is to create balance among these three factors to promote sustainability for future generations.

The National Strategy recognizes that climate change impacts have been anticipated to intensify concerning variability, frequency, and coverage. Such impacts will inevitably threaten lives, damage properties and necessary infrastructure, and affect agricultural production and water security. At the same time, ecological systems are likely to deteriorate. Given this recognition, Greenhouse gas (GHG) emissions and values of the bioeconomy are one of the key indicators for this development goal. The strategic guideline to promote sustainable climate-friendly based society growth focuses on the following points:

- Mitigation measures: reducing greenhouse gas emissions and promoting a low-carbon society, supporting agricultural management to benefit from greenhouse gas reductions, accelerating the restoration of deteriorated forests, and expanding forest areas to function as carbon storage areas.
- Adaptation measures: improving the overall disaster management system, enhancing people's capacity to cope with and adjust to any harmful impact caused by climate change, and developing preparedness and response systems for emerging and reemerging infectious diseases caused by climate change.
- Enabling measures: developing a database system, promoting low-carbon products and services to systematically reinforce national competitiveness, developing economic measures to incentivize investments that cope with climate change, encouraging businesses to plan for climate change, and improving relevant laws to drive climate change management.

*Source: The 20-Year National Strategy 2018 – 2037*

### **The 12<sup>th</sup> National Economic and Social Development Plan 2017-2021**

The 12<sup>th</sup> National Economic and Social Development Plan 2017-2021 recognizes that climate change and natural disasters have become more unpredictable and severe, particularly floods and droughts, causing impacts on the economic sectors and the domestic supply chain. Plus, international agreements on climate change and competitive trade have intensified. Thus, the fourth strategy, "Strategy for Environmentally Friendly Growth for Sustainable Development," seeks to improve greenhouse gas reduction and adaptation capacity, lessen the impacts of climate change, and improve the response to natural disasters. For this target, key indicators include: 1) the volume of greenhouse gas emissions in the energy and transport sectors decreases by 7% compared to the business as usual scenario for 2030, 2) the unit costs of GHG emissions reduction decrease (THB per ton of carbon dioxide equivalent), 3) there are action plans for adaptation to climate change in each of the priority sectors, such as water resources management, agriculture, health and forestry, and 4) domestic climate change mitigation mechanisms are established to provide support in terms of finance, technology, and capacity building.

The development guidelines to support greenhouse gas reduction as well as enhance adaptive capacity to climate change are as follows:

- Draft and amend laws and regulations related to climate change so that they can respond to international climate change agreements in an integrated and comprehensive manner.
- Prescribe measures and mechanisms to support greenhouse gas reduction in all sectors, emphasizing the following sectors: electricity generation, transport, industry, households, and buildings. Reduce the use of fossil fuels in generating power while promoting renewable energy, energy-saving, and waste-to-energy. Build the capacity of the workforce to excel in various forms of renewable energy. Support sustainable transport systems, and increase the efficiency of engines, machines, and instruments. Foster the establishment of financial mechanisms between the public and private sectors in order to support climate change actions that generate co-benefits. Moreover, encourage the private sector to invest more in greenhouse gas reduction.
  - Promote the private sector, state enterprises, and local administrations to collect and report information regarding greenhouse gas emissions, mainly from energy usage.
  - Enhance the capacity of R&D in science, technology, and innovation (ST&I) to support climate change adaptation.
  - Create knowledge and understanding and raise awareness and public participation from all stakeholders in response to climate change impacts.

*Source: The 12<sup>th</sup> National Economic and Social Development Plan 2017-2021*

### **Policy and Plan for Enhancement and Conservation of National Environmental Quality 2017 – 2036**

Under section 13 (1) of the Enhancement and Conservation of National Environmental Quality Act 1992, the Office of Natural Resources and Environmental Policy and Planning (ONEP) has prepared the Policy and Plan for the Enhancement and Conservation of Environmental Quality 2017–2036 as a direction framework for managing natural resources and the environment of the country in the next 20 years. The objectives are to be a policy framework and direction for integrally managing natural resources and the environment in the next 20 years; for all relevant sectors to use it as a guideline for the preparation of master plans and action plans in the mid-term (5 years) to achieve appropriate, proactive, and efficient natural resource and environmental management; and to enhance the environmental management capacity which enable environmentally friendly economic and social growth, promote equilibrium and sustainable development, and keep pace with global and regional changes.

The management of natural resources and the environment is based on 10 principles—Sustainable Development, Ecosystem Approach, Precautionary Principle, Polluters Pay Principle (PPP), Beneficiaries Pay Principle: BPP, Public-Private Partnership, Good Governance, Extended Producer Responsibility (EPR), Resource Decoupling/Resource Efficiency, and Human Rights—translating into 4 main policies as follows:

1) A policy to manage natural resources based on balance, fairness, and sustainability: It focuses on maintaining national biodiversity and balance of the ecosystem, which are the sources of food, water, and energy security. It aims to create a system that enables fair access, sharing, and utilization of natural resources within their limits of regenerating capacity.

2) A policy to generate environmentally friendly growth for wealth and prosperity: It seeks to provide people with a safe and quality environment, enhance an eco-friendly economy, and promote a production and consumption system with effective and efficient natural resource exploitation causing minimum waste and pollution.

3) A policy to enhance measures in natural resource and environmental management: It targets to create legal, financial, technical, and technology development mechanisms that enhance the capacity of natural resource management to be efficient and proactive and support environmentally friendly development and growth.

4) A policy to create partnerships in natural resource and environmental management: It aims to involve all sectors in managing and exploiting natural resources and the environment in the form of mutual ownership by encouraging all sectors to learn and have joint responsibility with the government, including enhancing the capacity for international environmental cooperation.

*Source: Office of Natural Resources and Environmental Policy and Planning (ONEP)*

### **Climate Change Master Plan (2015-2050)**

Aligning with the 20-Year National Strategy and the 12<sup>th</sup> National Economic and Social Development Plan, Thailand's Climate Change Master Plan (CCMP) aims for Thailand to be resilient to the impacts of climate change and achieves low carbon growth through sustainable development. The objectives of the plan are 1) to provide a long-term national framework for climate change adaptation and low carbon growth promotion according to the sustainable development principle; 2) to provide a policy framework for the development of mechanisms and tools at the sectoral and national level, to achieve effective resolutions for climate change, 3) to provide government agencies and relevant organizations with a framework for detailed action plans; facilitating awareness and mutual understanding by means of a common framework of reference points, thereby increasing integration and reducing redundant processes, 4) to provide budgeting agencies with a clear framework for budget allocation, thus enabling the mobilization of concrete climate change resolutions. The Master Plan also consists of three key strategies: climate change adaptation, mitigation, low carbon development, and enabling environment on climate change management. The implementation of these three strategies is divided into three phases: short-term 2016, medium-term 2020, and long-term 2050. The CCMP is subject to be revised according to the updated Nationally Determined Contribution and Long-Term Strategy Target.

The CCMP Strategy 2 "Mitigation and low carbon development" comprises actions and measures in the following eight sectors:

- *Power generation and energy supply*—focusing on decreasing fossil fuel consumption, increasing/developing renewable energy production, and developing infrastructure which facilitates low carbon development while simultaneously lowering GHG emissions
  - *Transport*—focusing on increasing the efficiency of transport and logistics, developing low carbon transport infrastructure, and applying sustainable principles to manage transport demand
  - *Energy consumption in buildings*—focusing on improving energy conservation and efficiency in buildings
  - *Industry*—focusing on improving the performance of machinery, energy efficiency, and waste reduction through measures such as the promotion of renewable energy production and consumption, and investments in low-carbon and environmentally friendly industries
  - *Waste management*—focusing on integrated life cycle waste management by prioritizing source reduction and the 3R (Reduce, Reuse, Recycle) in accordance with the waste hierarchy. Waste management efficiency will be increased by supporting waste-to-energy programs.
  - *Agriculture*—focusing on low emission agricultural practices with environmental and financial co-benefits; increasing the capacity of farmers to accommodate GHG reduction technologies and management systems

- *Forestry*—focusing on creating carbon sinks via forest conservation, restoration, reforestation, and afforestation. Measures that affect communities in forested areas should be evaluated on the merits of their environmental and social impact via public hearings of sufficient duration and transparency, which will ultimately aid the decision and policy-making processes.
- *Urban management*—focusing on increasing urban green spaces to act as carbon and pollution sinks which can also help mitigate GHG emissions from human activities in major cities

## Climate Change Master Plan (2015 - 2050)

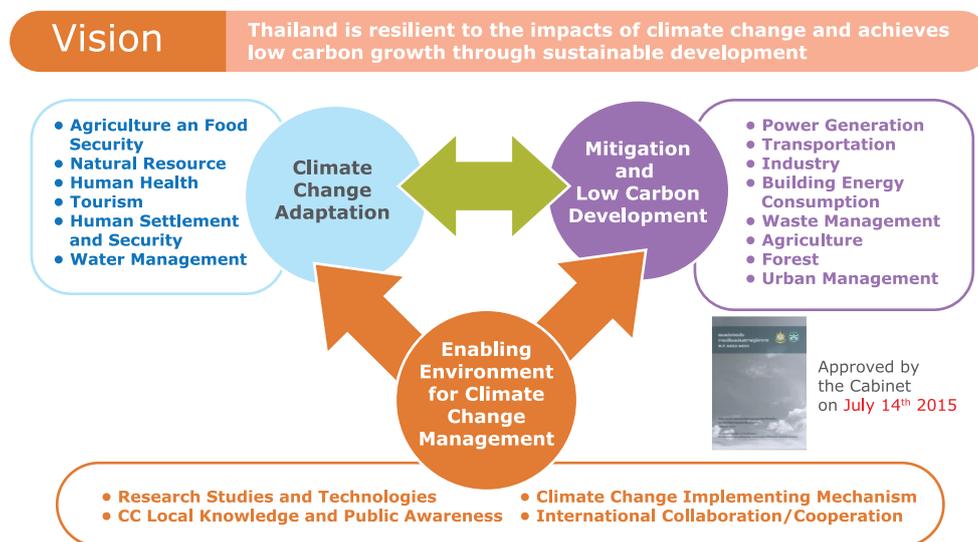


Figure 3-1: Overview of Climate Change Master Plan 2015-2050

Source: 1) Thailand's Climate Change Master Plan (2015-2050) 2) Office of Natural Resources and Environmental Policy and Planning (ONEP)

### Nationally Appropriate Mitigation Action (NAMA)

Thailand's GHG mitigation goal committed to UNFCCC can be divided into 2 phases: Pre-2020 and Post-2020. For the Pre-2020, Thailand's Nationally Appropriate Mitigation Action (NAMA) pledged in 2014 to reduce national GHG emissions in the range of 7-20% from the business-as-usual (BAU) scenario in the energy and transport sectors by 2020, subject to the level of international support provided. The details of the NAMA Roadmap and its progress were reported in the BUR3. Thailand implemented NAMA Roadmap and Action Plan and achieved a GHG emission reduction target. The overall NAMA implementation will be illustrated in section 3.2, "Mitigation Measures," of this chapter.

### Thailand's GHG Mitigation Target

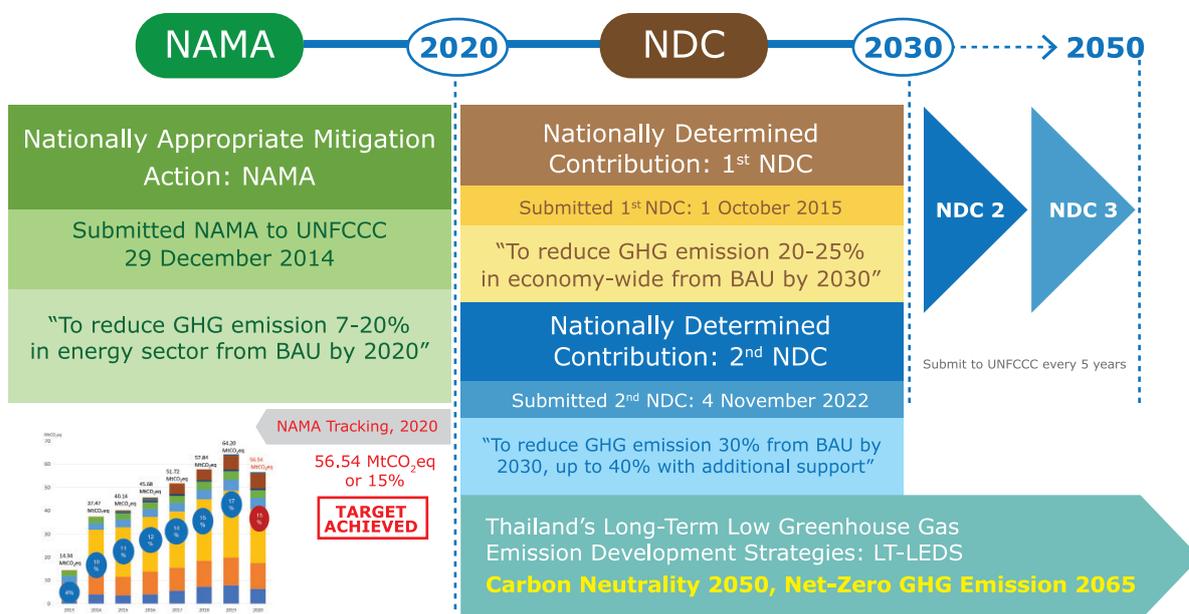


Figure 3-2: Thailand's GHG Mitigation Target

Source: 1) Thailand Third Biennial Update Report 2) Office of Natural Resources and Environmental Policy and Planning (ONEP)

### Thailand's Nationally Determined Contribution (NDC)

For the Post-2020, on 1 October 2015, Thailand submitted its Intended Nationally Determined Contribution (INDC) to UNFCCC. It later launched Thailand's Nationally Determined Contribution (NDC) Roadmap and Action Plan in 2017, aiming to reduce GHG emissions by 20-25% from the projected BAU level by 2030. The NDC Roadmap established a framework for mitigation measures in Energy, Transport, IPPU, and Waste sectors. To achieve the NDC targets, key agencies have developed NDC Sectoral Action Plans on greenhouse gas mitigation corresponding to the NDC Roadmap to ensure the achievement of the pledged target of a 20% reduction from the 2030 BAU. In addition, key agencies, NDC sectoral focal points, developed the Supportive Action Plan, which aims to create enabling environment to support the NDC implementation.

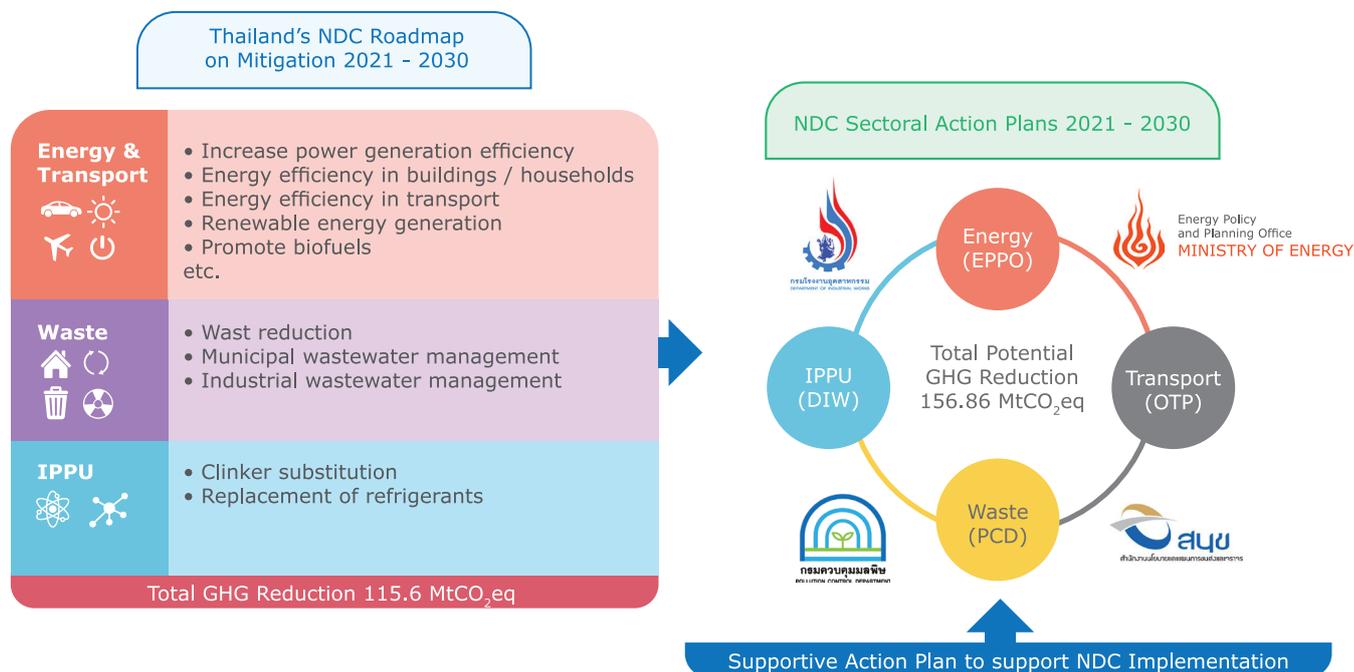


Figure 3-3: Overview of Thailand's NDC Roadmap and Action Plan

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

### NDC Sectoral Action Plan for Energy Sector 2021 – 2030

The Energy Policy and Planning Office (EPPO) was assigned by the National Climate Change Policy Committee (NCCC) to be the main responsible agency for the preparation of the national greenhouse gas reduction action plan for 2021 – 2030 in the energy sector together with the Office of Natural Resources and Environment Policy and Plan (ONEP) and Greenhouse Gas Management Organization (TGO). EPPO, ONEP, and TGO cooperate with related agencies, such as the Department of Alternative Energy Development and Efficiency (DEDE), Electricity Generating Authority of Thailand (EGAT), Office of the Energy Regulatory Commission (OEC), Office of Transport Policy and Planning, and Traffic (OTP), Chiang Mai University, and private power producers to prepare the details for the draft action plan aiming to national GHG emissions in the energy sector, which consists of three key plans:

1) Energy Efficiency Plan (EEP2015) aims to reduce energy intensity (EI) by 30 % in 2036 compared to 2010, which will be implemented in four economic sectors: industrial sectors, business and government buildings, residential sector, and transport sector.

2) Alternative Energy Development Plan 2015 – 2036 (AEDP2015) aims to increase the share of renewable energy consumption by considering the potential for renewable energy sources that can be developed in the form of electricity, heat, and biofuels accounting for 30 % of final energy consumption by 2036.

3) Power Development Plan 2018 – 2037 (Power Development Plan: PDP2018) has four main guidelines: 1) promote renewable power generation, 2) allocate main power plants for

regional energy security according to the necessity and sufficiency to maintain the stability of the electricity system, 3) renewable energy has an annual purchase policy under the renewable energy generation policy, and it is purchased at a price not exceeding Grid Parity to prevent the retail electricity price from rising, and 4) energy conservation policy can prove convincing with quality and compete with price not exceeding the Grid Parity.

The NDC Sectoral Action Plan for energy sector 2021 – 2030 aims to reduce greenhouse gases by at least 82 million tCO<sub>2</sub> by 2030, compared to a business-as-usual case. The plan laid down three strategies for greenhouse gas reduction operations: drive GHG reduction in the energy sector, prepare a long-term strategy for GHG reduction in the energy sector, and create a network of public, private, and public partnerships.

*Source: The Energy Policy and Planning Office (EPPO)*

### **NDC Sectoral Action Plan for Transport Sector 2021 – 2030**

The Office of Transport and Traffic Policy and Planning (OTP) has developed the NDC Sectoral Action Plan for Transport Sector 2021 – 2030, aiming to reduce GHGs by millions of tons of carbon dioxide equivalent with four key strategies: 1) supporting and promoting the planned implementation of relevant agencies in the transport sector, 2) developing and improving laws supporting GHG reduction, 3) developing measurement, reporting and verification (MRV), and 4) engaging and strengthening the capacity of all agencies to reduce GHGs. An emphasis is on developing efficient and sustainable transport systems to reduce energy consumption in the transport sector, lessen traffic congestion, create livable cities, and reduce greenhouse gas emissions, which will lead to stable and sustainable economic growth. Three key measures are as follows:

1) Avoid: developing policies that encourage people to avoid travel or reduce unnecessary travel distances by integrating urban planning with appropriate transportation planning, such as developing living spaces in compact areas, the development of the area around transit-oriented development (TOD), and work-from-home measure promotion.

2) Switch: developing policies that encourage people to switch from using private vehicles to more efficient and environmentally friendly forms of travel, including public transport and motorless travel (cycling and walking).

3) Improve: developing policies that improve energy efficiency in motor vehicles and fuel efficiencies such as automotive energy-saving technology, alternative energy consumption, promoting gasohol oil consumption, and promoting electric vehicles and bicycles.

*Source: The Office of Transport and Traffic Policy and Planning (OTP)*

### **NDC Sectoral Action Plan for IPPU Sector 2021 – 2030**

The Department of Industrial Works (DIW) has prepared the NDC Sectoral Action Plan for IPPU Sector 2021 – 2030 to reduce greenhouse gas emissions in the IPPU sector by setting targets for implementation in 2 phases: 1) Preparation phase (2019 - 2020) is to be completed in 2020, which is a preparation to support the implementation of measures according to the NDC roadmap starting in the year 2021; 2) Action Phase (2021-2030)

targets for driving key measures and supporting measures to reduce GHG emissions in the IPPU sector, including wastewater from industries to achieve the goal within the year 2030 according to NDC Roadmap and Action Plan.

The NDC Sectoral Action Plan for IPPU and industrial wastewater consists of three main measures:

1) Clinker substitution measures with 2 sub-activities: the use of clinker substitutes in the hydraulic cement production process and the increased use of cement substitutes in ready-mixed concrete.

2) Refrigerant replacement measures with 2 sub-activities: refrigerant modification under the RAC NAMA project and the proper disposal of waste and deteriorated refrigerant.

3) Measures to manage industrial wastewater: consistent and have the potential to reduce GHG emissions according to the NDC goals guideline, such as measures to increase biogas production from industrial wastewater by reusing Methane gas according to the Alternative Energy Development Plan 2015 – 2036 (AEDP2015), which sets goals for the use of biogas from industrial wastewater, agricultural waste ranch, and community waste to be utilized to generate electricity and heat.

*Source: The Department of Industrial Works (DIW)*

### **NDC Sectoral Action Plan for Waste Sector 2021 – 2030**

In conjunction with the relevant authorities, the Pollution Control Department (PCD) has developed the NDC Sectoral Action Plan for Waste Sector 2021-2030, targeting to reduce GHG emissions of 2.0 million tCO<sub>2</sub>eq from municipal solid waste and municipal and industrial wastewater. 65% of this target (1.3 million tCO<sub>2</sub>eq) is expected from implementing measures in the municipal solid waste sector, while 35% (0.7 million tCO<sub>2</sub>eq) is expected from implementing measures in wastewater management. The plan is divided into 2 parts: 1) NDC Action Plan in the municipal waste management sector, prepared by the Pollution Control Department, Ministry of Natural Resources and Environment, and 2) NDC Action Plan in the industrial processes and product use, including industrial wastewater sector, prepared by the Department of Industrial Works, Ministry of Industry.

The prospective mitigation measures in municipal solid waste management include: 1) landfill gas utilization, 2) waste to energy, 3) composting, 4) semi-aerobic landfill, 5) anaerobic digestion, and 6) mechanical biological treatment, whereas the potential mitigation measure in industrial wastewater management is methane recovery from industrial wastewater treatment. The MRV systems for implementation of NDC measures, including landfill gas utilization, waste to energy, composting, and methane recovery from industrial wastewater treatment, have been accomplished. Additionally, supportive mechanisms for effective implementation of the sectoral action plans in the waste sector, such as research and development, capacity building, and stakeholder engagement, are being executed.

*Source: The Pollution Control Department (PCD)*

### **Second Updated Thailand's Nationally Determined Contribution (2<sup>nd</sup> Updated NDC)**

At the World Leader Summit COP26 on 1 November 2021, Thailand's Prime Minister expressed Thailand's intention to fully elevate climate mitigation measures by all means. Thailand aims to achieve carbon neutrality by 2050 and net-zero Greenhouse Gas emissions by 2065. Furthermore, Thailand aims to increase the NDC target to reduce 40% of GHG emissions compared to BAU by 2030, given that the international community, through the mechanism of the Convention, can provide necessary financial, technical, technology, and capacity-building supports. Based on a more ambitious pledge, Thailand updated the Nationally Determined Contribution (NDC) and Long-Term Low Greenhouse Gas Emission Development Strategy (LT-LEDs) to reflect national targets aligning with the Prime Minister's statement. The 2<sup>nd</sup> Updated NDC was submitted to the UNFCCC on 4 November 2022.

The revised NDC concept framework of Thailand is similar to that of Thailand's Long-Term Low Greenhouse Gas Emission Development Strategy (LT-LEDs). The revised NDC is carried out with reference to the planned implementation goals of each relevant Ministry in the energy, IPPU, Agriculture, LULUCF, and waste management sectors. The plans include the Energy Efficiency Plan 2018–2037 (EEP2018), the Alternative Energy Development Plan 2018–2037 (AEDP2018), the Power Development Plan 2018–2037 No. 1 revised edition (PDP2018 Rev.1), and the guidelines for the promotion of electric vehicles (EV) of the country according to the 30@30 policy. Measures from the agricultural sector were incorporated into the revised NDC goal and guidelines to reduce greenhouse gas emissions. The revised NDC guidelines and measures include:

- Energy and transport sector: The energy sector has the most significant potential to reduce greenhouse gas emissions. It includes measures to increase the energy efficiency of equipment/machines in power plants and renewable energy utilization.
- IPPU sector, comprising clinker substitution measures and the refrigerant replacement.
- Waste management sector consists of municipal solid waste management, domestic wastewater management, and industrial wastewater management.
- Agriculture sector consists of fixed dome digester biogas production measures and improvements in rice farming to reduce methane emissions.

*Source: Office of Natural Resources and Environmental Policy and Planning (ONEP)*

### **Thailand's Long-Term Low Greenhouse Gas Emission Development Strategy (LT-LEDs)**

The implementation of Thailand's Long-Term Low Greenhouse Gas Emission Development Strategy is in accordance with Article 4 of the Paris Agreement, which requires all countries to develop and communicate a long-term strategy for low GHG emission development to the UNFCCC Secretariat aiming to limit global temperature from rising above 2°C or 1.5°C. Thailand sets long-term targets and guidelines for GHG reduction toward carbon neutrality by 2050 and net-zero emission in 2065 by identifying key measures in the sectors of energy, transport, IPPU, waste, agriculture, and LULUCF, which is the GHG removal sector of the country, for relevant agencies and sectors to use as operational guidelines.

ONEP revised and updated LT-LEDS and NDC with support from the Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH to study, improve, and formulate a long-term strategy for the country's low emissions development and set GHG reduction targets under the NDC consistent with the Prime Minister's statement at the COP26 meeting. The revised LT-LEDS was submitted to the UNFCCC on 7 November 2022. The revised LT-LEDS sets goals and measures aligning with an increase in global average temperatures of 1.5°C and moving toward carbon neutrality by 2050. It was developed by using the Asia-Pacific Integrated Assessment Model (AIMEnduse) to project the long-term low-level greenhouse gas emissions, including remedial policy measures for climate change adaptation action, and using a computable general equilibrium (AIM/CGE) model to assess the economic and environmental impacts of energy policy and others in the development of LT-LEDS. The current national plans used to develop and define LT-LEDS are as follows:

- 20-Year National Strategy 2018-2037
- Climate Change Master Plan 2015-2050
- Thailand Nationally Determined Contribution (NDC) 2021-2030
- National Energy Plan (2022)
- Energy Efficiency Plan 2018-2037 (EEP 2018)
- Alternative Energy Development Plan 2018-2037 (AEDP 2018)
- Power Development Plan 2018-2037 ( PDP 2018 Rev.1)
- The guideline for promoting electric vehicles (EV) under policy 30@30
- National Industrial Development Master Plan 2012-2031
- Industrial Development Strategy of Thailand 4.0 2017-2036
- Thailand Forest Reference Emission Level and Forest Reference Level REDD+ under the UNFCCC
- 20-Year Strategy of the Royal Forest Department 2017-2036

*Source: Office of Natural Resources and Environmental Policy and Planning (ONEP)*

### 3.1.2 Sectoral Plans

#### 3.1.2.1 Energy Sector

Moving toward Carbon Neutrality in 2050, the Ministry of Energy is developing details in the **National Energy Plan 2022 Framework**, consisting of 5 key plans:

- **Power Development Plan 2018-2037 (PDP):** The plan includes constructing new power plants with clean energy sources; phasing out fossil-fuel power plants; enhancing CCUS technology; developing an energy management system and energy forecast system; liberalizing the energy business; creating the wheeling charge system; and promoting EV and EV charging station production and purchasing system.

- **Alternative Energy Development Plan 2018-2037 (AEDP):** It aims to increase the renewable energy generation target and investment; enhance the renewable energy (RE) management and trade; develop RE at community levels to elevate farmers' standard of living and grassroots economy; formulate Data Platform and RE control center, research

and develop the Hydrogen utilization; and develop Bio Circular Economy, carbon credits mechanism and RECs, and biofuel market for energy and heat production.

- **Energy Efficiency Plan 2018-2037 (EEP):** It seeks to enhance energy efficiency in buildings, industries, and households; promote green industries and Smart Energy Management; and develop digital and EV Data platforms and charging stations to promote electric vehicle utilization

- **Gas Plan 2018-2037:** Its targets include enhancing LNG importation and management; promoting LNG use in industrial and transport sectors; developing capacity assessment and management system; and managing land-based and marine-based gas sources.

- **Oil Plan 2018-2037:** It intends to improve the standard of an oil refinery to EURO 5 and 6 and LNG and NGV management; promote proper biofuel utilization in the transport sector; develop an oil database and control system; reconstruct oil price and reduce biofuel cost; and manage oil industry to accommodate EV utilization.

The policy direction of National Energy Plan aims for 4 targets: increasing renewable energy to at least 50 %, transitioning the energy used in transportation to green energy by promoting electric vehicles to reduce GHG emissions and particulate matters, increasing energy efficiency by 30 % by utilizing technology and innovation to optimize energy efficiency and management, and modifying the energy business structure to embrace energy transition according to the 4D1E framework (Decarbonization, Digitalization, Decentralization, Deregulation, and Electrification).

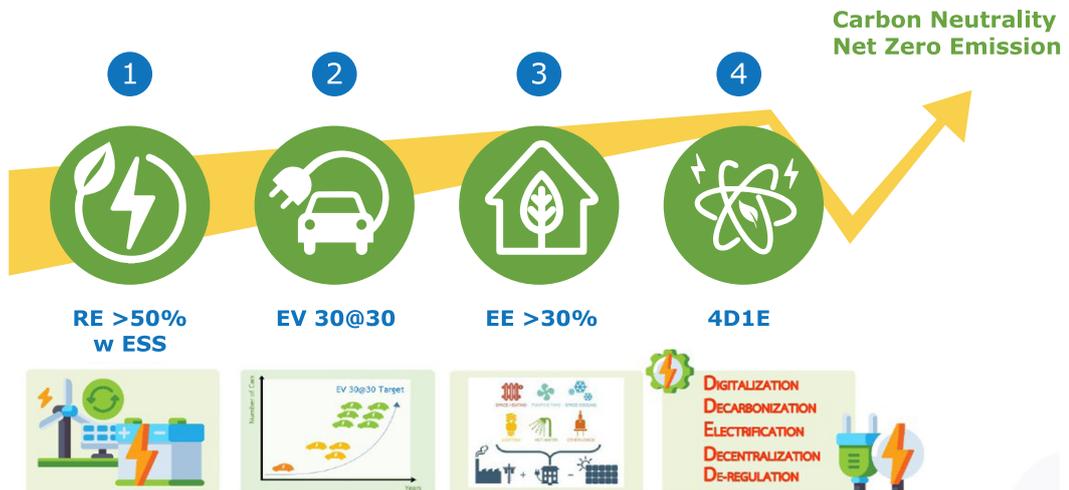


Figure 3-4 : Policy Direction of National Energy Plan 2022

Source: The Energy Policy and Planning Office (EPPO)

### 3.1.2.2 Transport Sector

#### Thailand's Transport Infrastructure Development Plan 2015-2022

Thailand's Transport Infrastructure Development Plan 2015-2022 is a development framework that seeks to improve people's quality of life by mobilizing long-term economic and social development, creating jobs, distributing income, stimulating the economy, and ensuring the safety of people's lives and properties. Five Action Plans are developing an intercity rail network, improving public transport networks, enhancing connectivity between key domestic production bases and neighboring countries, increasing water transport networks, and enhancing air transport capability.

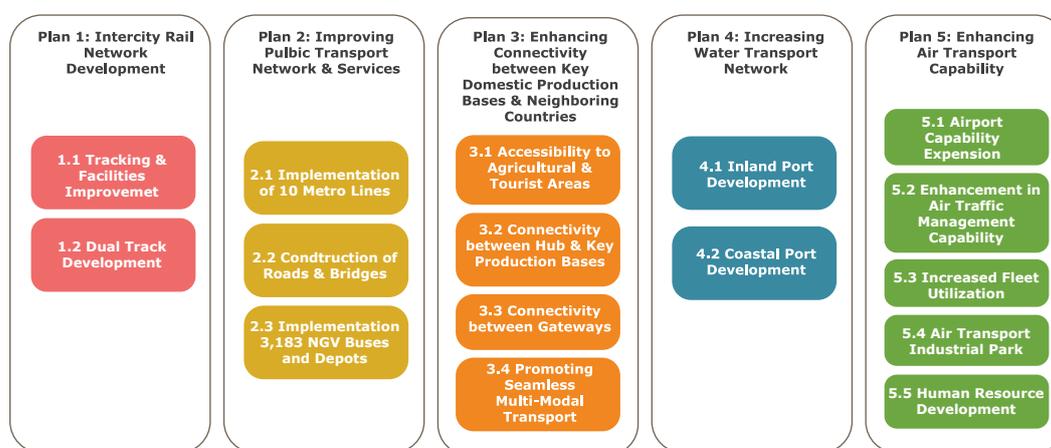


Figure 3-5: Thailand's Transport Infrastructure Development Action Plan

Source: Office of Transport and Traffic Policy and Planning

### 3.1.2.3 Industrial Sector

#### National Industrial Development Master Plan 2012-2031

As climate change is one of the key factors affecting the changing dynamic of the Thai industrial sector, National Industrial Development Master Plan 2012-2031 aims to achieve sustainable production that takes into account social and environmental considerations "Environmentally Friendly - Green and Clean." The development in the industrial sector should reflect a green growth industry, climate resilience society, and low carbon society. Therefore, the industrial development framework in the master plan aims to strike a balance between 4 dimensions: 1) Enhancing economic wealth and security, 2) Utilizing human wisdom for innovation and value creation for sustainable development, 3) Securing social well-being and reducing social inequality, and 4) Promoting environmental wellness to raise public awareness for environmental conservation and improving regulations and their enforcement to support environmentally friendly production and eliminate negative externalities.

**Thailand’s Industrial Development Strategy 4.0 (2017-2036)**

In the fourth phase of industrial development, Thailand seeks to shift the paradigm into an innovative-driven economy targeting prosperity, security, and sustainability through three mechanisms: productive growth engine, inclusive growth engine, and green growth engine. The green growth engine focuses on environmentally friendly technology development and renewable energy transition. The development perspective shifts from cost advantage to loss advantage—considering the benefits of overall loss mitigation. The cornerstone is ensuring that the production process internalizes the negative externalities and minimizes adverse environmental effects. The green growth engine solves the “inequitable development trap” between the environment and human needs. The phases and mechanisms of industrial development in Thailand can be illustrated in the Figure below:

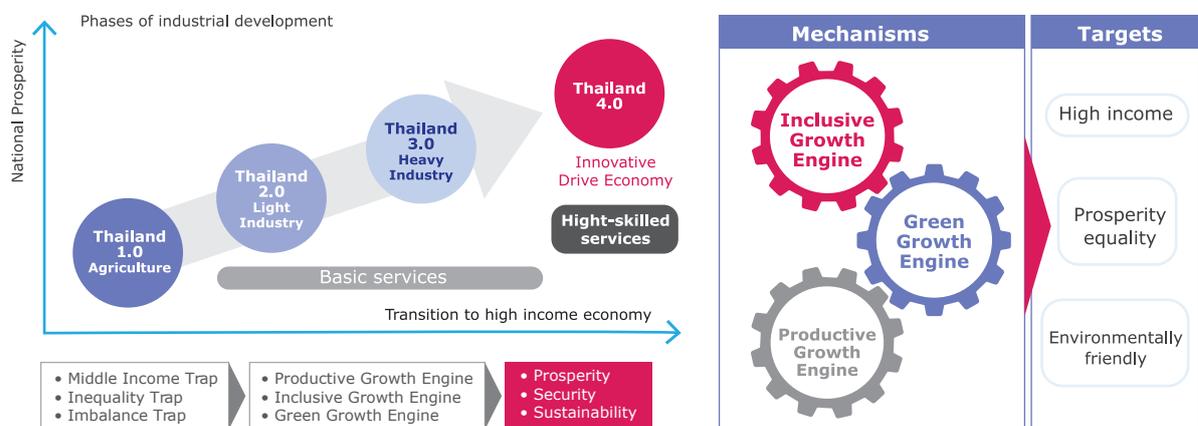


Figure 3-6: Industrial development phases of Thailand and mechanisms for industrial development 4.0

Source: 1) National Industrial Development Master Plan 2012-2031 2) Thailand’s Industrial Development Strategy 4.0 (2017-2036)

**Green Industry**

The Ministry of Industry launched Thailand’s Green Industry Initiative and established two implementation guidelines:

1. Set guidelines and create a concrete green industry under two main concepts: continuous improvement and sustainable development
2. Integrate environmentally relevant projects of all departments within the Ministry of Industry under the green industry projects

Thailand’s Green Industry Initiative is implemented on a voluntary basis to conduct business in a community and environmentally friendly manner for sustainable development. Green industry means industry committed to continuously improving production processes and environmentally friendly business management and adhering to business operations with the responsibility to society both inside and

outside the organization throughout the supply chain. The Ministry of Industry promotes the industry sector in Thailand to achieve environmentally and socially friendly operations by encouraging establishments nationwide to integrate environmentally friendly practices into business operations and continue to evolve into green industries on 5 levels. The industries can acquire benefits according to the level achieved such as using Green Industry logo or acquiring governmental procurement. The 5 levels of implementation are as follows:

- **Level 1: Green Commitment** is a manifestation of commitment in the form of policies, goals, and plans to reduce environmental impacts and have communications within the organization.
- **Level 2: Green Activity** is the implementation of policies by having goals and a roadmap to reduce environmental impacts in a concrete way and achieve the set commitments.
- **Level 3: Green System** is systematic environmental management—monitoring, evaluation, and review for continuous development or awarding recognized or accredited environmental awards related to the conservation of resources and environments.
- **Level 4: Green Culture** is when everyone in the organization has a common conscience to preserve and maintain a good environment and cooperate in all aspects of the business to be environmentally friendly and take action to become part of the corporate culture.
- **Level 5: Green Network** is an extension of the scope of the green industry from within the organization itself and throughout the supply chain by encouraging partners to be part of the green industry.

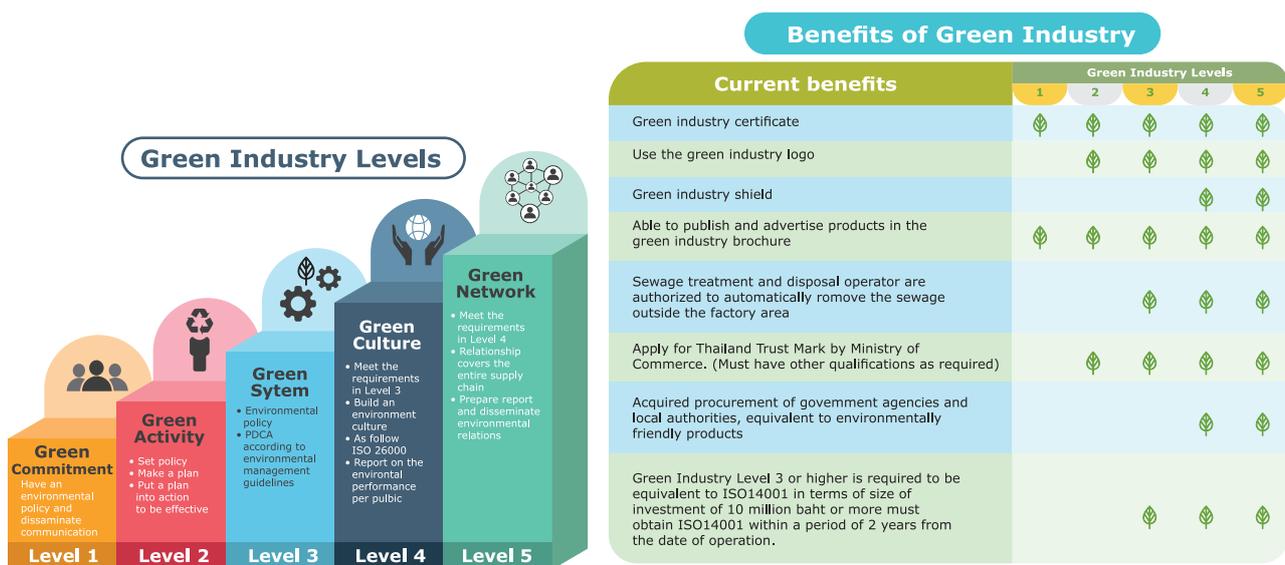


Figure 3-7: Green Industry levels and its benefits

Source: Ministry of Industry

### 3.1.2.4 Waste Sector

#### **Draft National Waste Management Action Plan 2022-2027**

The Draft National Waste Management Action Plan 2022 – 2027 was prepared as a framework and guidelines to drive waste management operations to align with the country's development guidelines and the global context. The Action Plan is set to frame new waste management for a clean environment and promote a sustainable society and the following principles:

- Bio-Economy, Circular Economy, and Green Economy (BCG Model) consists of three elements: 1) Bio-Economy aims to enhance technology and innovation to develop biological resources or agricultural products such as the development of biodegradable plastics (compostable plastics) or alternative plastic products from natural materials, 2) Circular economy focuses on bringing used resources or products back to the production process again to be recycled or processed into a new product, creating value for waste and reducing the amount of waste in the manufacturing sector to zero (Zero Waste), and 3) Green Economy promotes the use of environmentally friendly production technology such as using bio-based substances instead of chemical pesticides. The BCG Model is a strategy to develop the national economy by balancing economic growth and natural resource sustainability.

- 3R principle (Reduce, Reuse, Recycle): Reduce the waste generation at the source in the process of design, production, and consumption, reuse the packaging waste or waste material without processing or reprocessing, and recycle waste materials by processing in the production process and produces a new product.

- Polluter Pays Principles (PPP): Economic tool used to manage natural resources and the environment. The polluters must bear the cost of preventing damage to human health or the environment.

- Public-Private Partnership: All sectors should participate in waste management from production, import, distribution, consumption, and management at the destination, which encourages the private sector to invest or jointly invest in the operation of a waste management system.

- Extended Producer Responsibility (EPR): The principle encourages producers to take responsibility for their products after public consumption by jointly paying the production handling fee and participating in waste recovery for reuse, recycling, and environmentally safe disposal. It also encourages the producers to modify the design and manufacturing process to be more environmentally friendly by reducing the use of harmful substances in products and consider designing and manufacturing products that will last a lifetime.

The objectives for implementing the National Waste Management Action Plan (2022 – 2027) by the year 2027 seek to have 80% of solid waste properly managed, 60% of household hazardous waste properly managed, 100% of infectious waste properly managed, and 100 % of hazardous industrial waste correctly processed in the management system. The implementation measures focus on “Reduce and Enhance”—reducing the generation of solid waste and hazardous waste at source and enhancing capacity to manage solid waste and hazardous waste, promoting solid waste and hazardous waste management.



Figure 3-8: Bio-Economy, Circular Economy, and Green Economy (BCG Model)

Source: The Office of National Higher Education Science Research and Innovation Policy Council (NXPO)

### Thailand's Roadmap on Plastic Waste Management 2018 – 2030

According to the Pollution Control Department report in 2019, the amount of plastic waste was 1.91 million tons, and 0.36 million tons (about 19%) were recycled. The COVID-19 pandemic also intensifies the plastic waste problem. In addition, a 2021 UN comprehensive assessment report, released before COP26, emphasized that plastics are a climate problem. Plastics, the by-product of fossil fuels, contribute to GHG emissions throughout the life cycle, from production to disposal. Acknowledging that plastic waste and the climate change problems are intertwined, Thailand has formulated the Plastic Waste Management Roadmap 2018-2030 to move toward sustainable plastic management based on the principle of Circular Economy, seeking to serve as a framework and direction for preventing and solving the plastic waste problem in the country. The roadmap's underlying principles include Circular Economy, Responsible Production and Consumption, Public-Private Partnership, and Life Cycle Approach.

Guidelines for operation under the roadmap are divided into 3 measures: 1) Measures to reduce the generation of plastic waste at the source, 2) Measures to reduce the use of single-use plastic (Single-use Plastic) in the process of consumption, and 3) Measures to manage the plastic waste after consumption by supporting and encouraging them to be reused. The roadmap also defines the roles, duties, and responsibilities of relevant agencies in the implementation of the draft Roadmap in all sectors. It further defines various mechanisms for the Roadmap mobilization, such as enhancing knowledge and understanding with relevant agencies, people, and consumers in order to develop integrated cooperation for the operation and public relations campaign through social media. There will be studies and target setting on recycled plastics and plastic waste that cannot be recycled to be disposed of properly.

The mechanism of plastic waste management and its roadmap can be illustrated in the Figure below:



Figure 3-9: Thailand’s Roadmap on Plastic Waste Management 2018 – 2030

Source:1) Pollution Control Department 2) Draft National Waste Management Action Plan 2022-2027 3) Thailand’s Roadmap on Plastic Waste Management 2018 – 2030

### 3.1.3 Municipality Plan

#### Draft Bangkok Climate Change Master Plan 2021-2030

In 2021, Bangkok Metropolitan Administrator (BMA) and the Japan International Cooperation Agency (JICA) developed the draft Bangkok Master Plan on Climate Change 2021-2030. The Master Plan aims to align with the Nationally Determined Contribution (NDC) in terms of both the policy and the implementation timeframe. It will significantly contribute to Bangkok’s long term vision to achieve net-zero GHG emissions by 2050. The plan outlines the development of key measures for GHG reduction and climate change adaptation, including institutional structures, monitoring and evaluation (M&E), and measurement, reporting, and verification (MRV) systems.

Bangkok intends to achieve the GHG emission reduction target and the response to climate change by setting the target and the commitment to reduce its GHG emissions by 19% compared to the BAU from the base year of 2018 by 2030 and to have the long-term goal under the vision to continually reduce greenhouse gases toward a “net-zero emission city” by 2050. The mitigation measures of GHG reduction under this master plan cover 4 sectors: transport, energy, waste and wastewater, and green urban planning. The significant sectors for GHG emissions reduction are energy and transport, with a reduction target of 94% of the total, and the remaining 6% is from the waste management sector. Green urban planning is the sector that does not directly reduce GHG emissions but helps to absorb GHGs in the atmosphere.

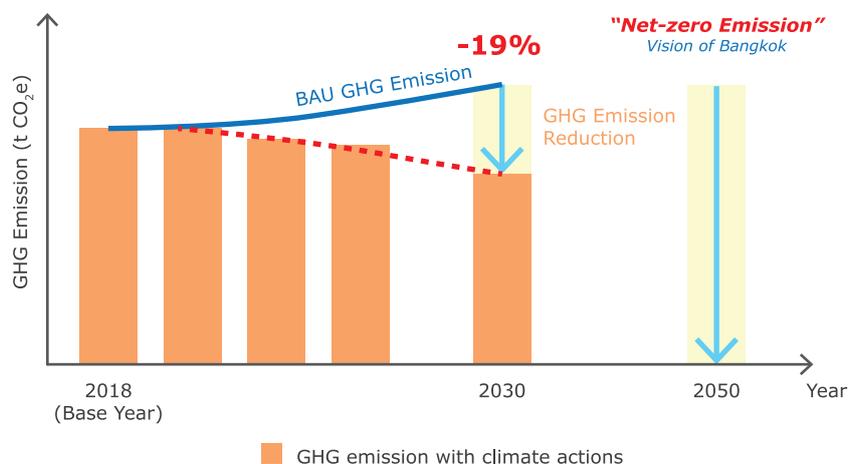


Figure 3-10: Bangkok's interim target by 2030 and long-term vision toward net-zero emission by 2050

Source: Bangkok Metropolitan Administrator (BMA)

## 3.2 Mitigation Measures

### 3.2.1 Thailand's Nationally Appropriate Mitigation Action (NAMA)

#### 3.2.1.1 Domestic NAMA

Thailand proclaimed its Nationally Appropriate Mitigation Action (NAMA) to reduce national GHG emissions from the energy and transport sectors compared to the Business as Usual (BAU) by stating that Thailand had the potential to reduce GHG emissions by 7-20 % by 2020. After the target was set, Thailand developed a system to monitor and assess the amount of GHGs reduction from domestic measures, especially measures on energy and transport. Thailand has implemented monitoring and evaluation of GHG reductions as follows:

1) A GHG reduction reporting structure was established according to the Domestic MRV structure approved by the National Committee on Climate Change Policy, as illustrated in Chapter 1.

2) The mechanism of the Working Group on GHG Inventory and Mitigation Measures in the energy sector, as referred to in Chapter 1, "Institutional Arrangement," was employed in selecting the appropriate measures/policy for monitoring and evaluating GHG reduction according to the criteria. Once the measures/policies were obtained, a method for calculating the GHG reduction was developed, and the Coefficient/Emission Factor was designated. The MRV process for activity data and calculating GHG reduction from measures/policy was commenced to prepare a report on greenhouse gas reduction results.

3) When the Working Group on GHG Inventory and Mitigation Measures approved the detailed information in the second step, they would send the official information to the relevant Ministries, i.e., the Climate Change Coordinating Working Group under

the Ministry of Energy, to consider the following: appropriate measures/policies for monitoring and evaluating GHG reductions, GHG reduction calculation methods, MRV process structure for activity data, and GHG reductions from measures/policy and GHG reduction reports. When the Ministries approved, they must notify the secretary of the Working Group on GHG Inventory and Mitigation Measures. In case of disagreement or amendments, the Ministries could propose and stress the issues that need to be revised.

4) After the relevant Ministries have considered and approved the details under the third step, the Ministry's consideration would be submitted to the Subcommittee on Climate Change Knowledge and Database for further approval.

5) Once the Subcommittee on Climate Change Knowledge and Database has approved, the GHG reduction results would be presented to and approved by the National Committee on Climate Change Policy. After approval, GHG reduction results would be reported in the BUR and NC reports.

For the first phase, achieving the NAMA's target was the first steppingstone toward Thailand's success in reducing GHG emissions in line with the goals of the 20-Year National Strategy, National Reform Plans, the National Economic and Social Development Plan, and the country's Climate Change Master Plan focusing on developing a low-carbon economy. Since 2015, the Ministry of Energy by the Climate Change Coordinating Working Group has assigned the Energy Policy and Planning Office (EPPO) to be the coordination unit for implementing the monitoring and evaluation report on GHG reductions from energy measures. In 2019, the Office of Transport and Traffic Policy and Planning (OTP) started reporting GHG reduction in the transport sector. The results of the GHG reductions from 2013 - 2019 are summarized as follows:

- In 2013, the GHG reduction was 14.34 MtCO<sub>2</sub>eq, equivalent to (3.91%) compared to BAU.
- In 2014, the GHG reduction was 37.47 MtCO<sub>2</sub>eq, equivalent to (10.21%) compared to BAU.
- In 2015, the GHG reduction was 40.14 MtCO<sub>2</sub>eq, equivalent to (10.94%) compared to BAU.
- In 2016, the GHG reduction was 45.68 MtCO<sub>2</sub>eq, equivalent to (12.45%) compared to BAU.
- In 2017, the GHG reduction was 51.72 MtCO<sub>2</sub>eq, equivalent to (14.09%) compared to BAU.
- In 2018, the GHG reduction was 57.84 MtCO<sub>2</sub>eq, equivalent to (15.76%) compared to BAU.
- In 2019, the GHG reduction was 64.20 MtCO<sub>2</sub>eq, equivalent to (17.49%) compared to BAU. (Including transport sector)

In 2020, Thailand reduced GHG emissions to 56.54 MtCO<sub>2</sub>eq (15.40%) from 10 mitigation measures in the energy and transport sectors.

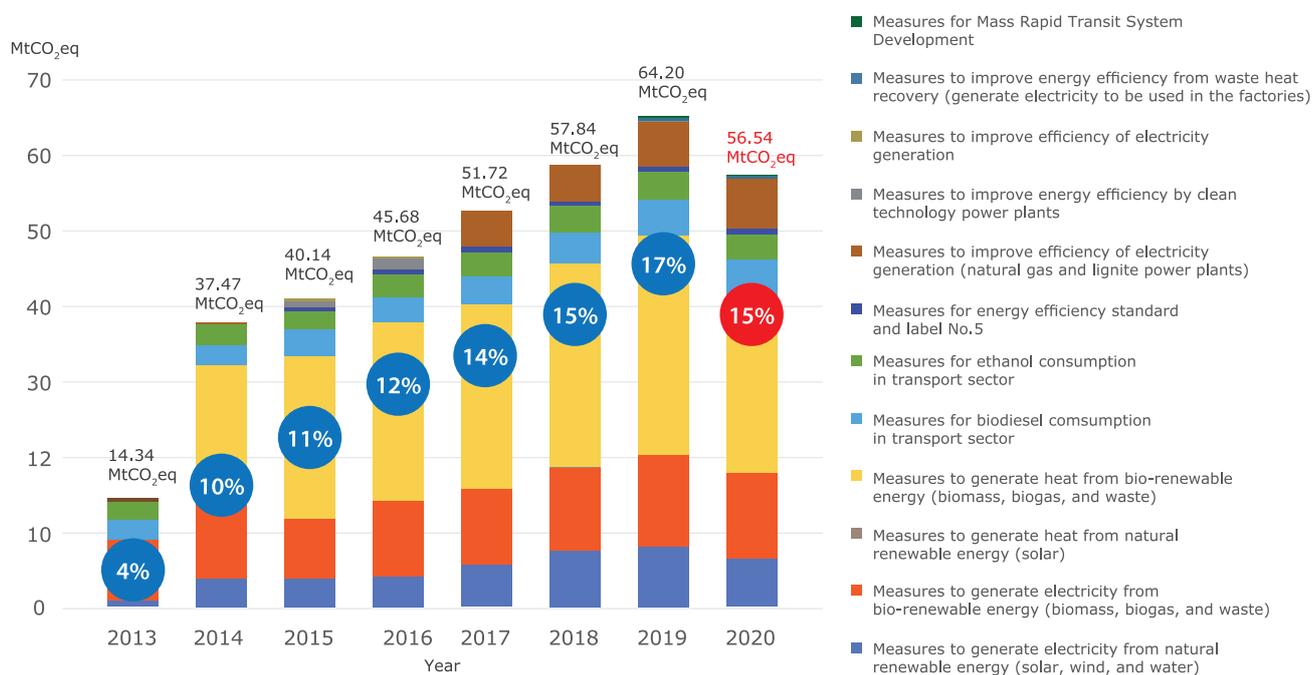


Figure 3-11: Thailand's GHG emission reduction from NAMA implementation 2013-2020

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

Important lessons learned from the implementation of NAMAs which can be beneficial for the preparation of new mitigation measures are as follows:

- 1) The formation of the NAMA mitigation roadmap for the energy and transport sectors in line with the existing plans of government agencies contributed to the success of respective mitigation measures.
- 2) The development of a domestic MRV system to track progress toward NAMA targets involved the Ministry of Natural Resources and Environment, Ministry of Energy, and Ministry of Transport, as well as strong cooperation from other stakeholders in the public and private sectors.
- 3) Apart from GHG reduction, other environmental co-benefits could be integrated into Thailand's policies and measures, such as biodiversity conservation, air pollution reduction, and marine litter management, creating multilateral cooperation under other conventions.

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

### 3.2.1.2 International Support

Apart from the national efforts to achieve NAMA's target, Thailand received international support in two key projects to reduce GHG emissions:

#### **RAC NAMA**

RAC NAMA project, or Thailand Refrigeration and Air Conditioning Nationally Appropriate Mitigation Action, is commissioned by the NAMA Facility on behalf of the German Ministry for the Environment, Nature Conservation, and Nuclear Safety and the UK's Department for Business, Energy & Industrial Strategy and implemented by GIZ with support from Department of Alternative Energy Development and Efficiency (DEDE) and Office of Natural Resources and Environmental Policy and Planning (ONEP). A milestone for the IPPU sector, contributing to the NDC achievement with a total emission reduction of 35,000 tCO<sub>2</sub>eq. The project implementation can be classified and illustrated as follows:

- **Policy:** The MRV system has been set for the RAC NAMA project through the policy and technical recommendations so that Thailand can report the implementation following the commitment under the Convention and elevate the emission reduction targets in this sector. The RAC NAMA safety system was demonstrated to relevant stakeholders to mimic the actual leakage and designate the intensity of leakage from the system. The result showed the efficiency of the system without any hazards.

- **Technology and training:** The training center was founded to train chief mechanics on the safe handling of flammable refrigerants. Nine business operators were adequately trained to transition the production line and development. The industries and prototype passed the safety test. The testing operational labs within the Ministry of Industries were reconditioned to support the testing of air condition using flammable refrigerants according to new standards of IEC, EN, and TISI 1529-2561

- **Financial support:** The RAC NAMA fund was established with 8.3 million EUR or about 300 million THB by EGAT in the name of the Thai government to be the fund manager. The fund aims to promote the production and utilization of eco-friendly and energy-efficient refrigeration technology. EGAT has provided financial aid through various financial instruments for the past two years.

- **Supply-side:** for the producers to transition their production lines, EGAT provided 1) a short-term loan for one year without interest for 52 million THB and 2) grants for 80 million THB.

- **Demand-side:** 1) over 10 million THB as a subsidy to induce consumers to purchase eco-friendly refrigerators and 2) over 146 million THB as subsidy without interest for marketing measures

- **Service sector:** 1) 15 million THB of grants to purchase equipment for the 8 training centers and 2) 2.5 million THB grants for reconditioning testing operational labs at electric and electronics institutes.

### Thai Rice NAMA

Thai Rice NAMA is a cooperative project between MOAC and GIZ, funded by NAMA Facility. This project, implemented from 2018 to 2023, promotes converting traditional to sustainable rice cultivation or GAP++ by adopting Alternative wetting and drying (AWD), site-specific nutrient management (SSNM), and crop residue management. The project targets is 100,000 farmer households in Thailand's Central plain area (6 provinces). The implementation and progress of the project can be described as follows:

- GHG emission reduction: It targets GHG reduction of 1.7 million tCO<sub>2</sub>eq. in a 5-year period (2018-2023). In 2021, the emission decreased by 160,000 tCO<sub>2</sub>eq. Due to the COVID-19 pandemic, drought, and floods, the implementation is delayed.
- Technology transfer: Emission reduction technologies were transferred to and widely adopted by farmers consisting of Alternative wetting and drying (AWD), Laser Land Leveling, site-specific nutrient management (SSNM), and crop residue management.
- Policy and management: The Sustainable Rice Platform National Chapter was established as a forum to engage all stakeholders in developing Thai GAP++ (Sustainable rice standard). The Sustainable Rice Standard has been circulated for public hearing. Now it is in the process of revision before submission for Agriculture Standard Committee's approval and announcement. The standard promotes rice cultivation method that is internationally recognized as contributing to climate mitigation and adaptation.
- Technical and capacity building: Series of training on sustainable rice cultivation were provided for 295 officials from the Rice Department (RD) and Department of Agricultural Extension (DOAE) and 13,220 farmers, the entire rice fields of approximately 63,450 ha. There was a series of training to build capacity for the service providers on Laser Land Leveling technology. Subsequently, the service providers used this technology to level the rice fields to 69 farmers in 151.24 ha.
- Financial mechanism: Pre-finance mechanism was established by having the Bank for Agriculture and Agricultural Cooperatives (BAAC) as a grant manager. By integrating the project into BAAC's green finance mechanism, 1,328,444 THB were provided for farmers to prepare rice fields using Laser Land Leveling technology.

From implementing the Thai Rice NAMA project, the RD, BAAC, and GIZ considered that sustainable rice cultivation benefited Thailand's economic, social, and environmental development and enhanced the farmers' standard of living. The relevant agencies continue to scale up and expand the project implementation to other provincial parts of Thailand. As an Accredited Entity, GIZ held a discussion session with the ONEP and BAAC to develop a concept note for strengthening **Climate Smart Rice Farming** and submit this concept project to Green Climate Fund: GCF in 2021. The approval is to be followed.

Another extension from the Thai Rice NAMA is the project of **Strengthening Climate-Smart Rice Value Chains**, aiming to improve the capacity of rice farmers and service providers on climate mitigation and adaptation technology. The project targets 250,000 farmer households in 15 provinces with emissions from rice fields of 3.7 million tCO<sub>2</sub>eq. The project will be developed through a rice cultivation paradigm shift, rice value chain generation, and private sector participation.

Source: Bangkok Metropolitan Administrator (BMA)

### 3.2.2 Preparation for NDC Transition

When NAMA ended in 2020, Thailand has transitioned toward the second phase, i.e., Nationally Determined Contribution (NDC) that focuses on reducing GHG emissions in the energy, transport, IPPU, and waste management sectors which is more challenging than the first phase. Therefore, it is necessary to have various mechanisms for operations to achieve the goals. ONEP has prepared the following:

#### 3.2.2.1 Preparation for NDC Tracking System

Thailand has established the MRV system to track progress on climate mitigation measures under the NDC Roadmap 2021-2030. MRV system plays a significant role in steering the implementation of mitigation measures to achieve the targets set by responsible agencies in the following sectors: Energy, Transport, IPPU, and Waste. It also enables all relevant stakeholders' engagement, including the public sector, private sector, academic institutions, international organizations, and citizens, to acknowledge problems and constraints arising from such implementation. Thus, the mitigation policies, plans, and measures can be revised, making them appropriate and in line with the current situation.

ONEP, as a national focal point of the Convention, the Ministry of Energy, Ministry of Industry, Ministry of Natural Resources and Environment, and the private sectors has prepared to measure, report, and verify the implementation of mitigation measures under the NDC Roadmap on three sectors: Energy, IPPU, and Waste.

In the Energy sector, the information form and methodology were developed. The handbook on MRV will be prepared to apply for 1) measures enhancing energy efficiency from reusing heat (energy production and industrial use), 2) measures enhancing energy efficiency from electricity used in the manufacturing industry, and 3) measures enhancing energy efficiency from heat production in the manufacturing industry. In the IPPU sector, the representatives from the Ministry of Industry, Thai Cement Manufacturers Association, and Thailand Concrete Association have discussed and prepared the MRV system. As a result, the MRV framework will be applied to clinker substitution measures in hydraulic cement production. In the Waste sector, ONEP initiated a working session with TGO and PCD to develop a methodology for GHG emission reduction, designate the emission factors, test the MRV system, and improve the MRV handbook for measures on municipal solid waste management and biogas production from industrial wastewater.

#### 3.2.2.2 Study and analysis of guidelines for reporting GHG reduction and developing a system to collect and link data from all sectors under the Enhanced Transparency Framework (ETF) of the Paris Agreement

ONEP has prepared a study and an analysis of activity data reporting patterns and supporting information in various fields from measures under the national participation mechanism established in accordance with the Enhanced Transparency Framework under the framework of the Paris Agreement Work Program (PAWP) and the resolutions of the Conference of Parties (COP). This preparation aims to develop a TGEIS system to support GHG inventory and the MRV system for NDC tracking. ONEP has also analyzed the monitoring and evaluation guidelines to cover the NDC action plan for 2021–2030.

### 3.2.2.3 Preparation for an economic and social impact assessment on LT-LEDS measures implementation

ONEP has prepared a study to assess the economic and social impacts of the implementation of greenhouse gas reduction measures under the long-term national strategy by gathering information related to the socio-economic impact assessment, such as general information, socio-economic status, demand-supply condition (demand-supply), both current and future forecasts, the impact of COVID-19 pandemic, demographics, employment, and related policies. Subsequently, ONEP has used a model to analyze and compare the results of overall and sectoral studies of long-term GHG reduction measures implementation under the case of 1.5 °C and the case where Thailand moves toward carbon neutrality.

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

### 3.2.3 Supporting Measures and Voluntary Actions

#### Clean Development Mechanism: CDM

The Clean Development Mechanism (CDM), defined in Article 12 of the Kyoto Protocol, allows a country with an emission-reduction or emission-limitation commitment under the Kyoto Protocol (Annex B Party) to implement an emission-reduction project in developing countries. Such projects can earn saleable certified emission reduction (CER) credits, each equivalent to one ton of CO<sub>2</sub>, which can be counted toward meeting Kyoto targets. Thailand Greenhouse Gas Management Organization (TGO), as Designated National Authority of CDM, has issued Letter of Approval to 222 projects. Thailand has 154 CDM projects registered by the Clean Development Mechanism Executive Committee (CDM EB), classifying UNFCCC projects into 147 general projects and 7 planned projects (PoA). In addition, Thailand has 70 CDM projects certified for greenhouse gases (issued CERs) with 15.03 million tCO<sub>2</sub>eq.

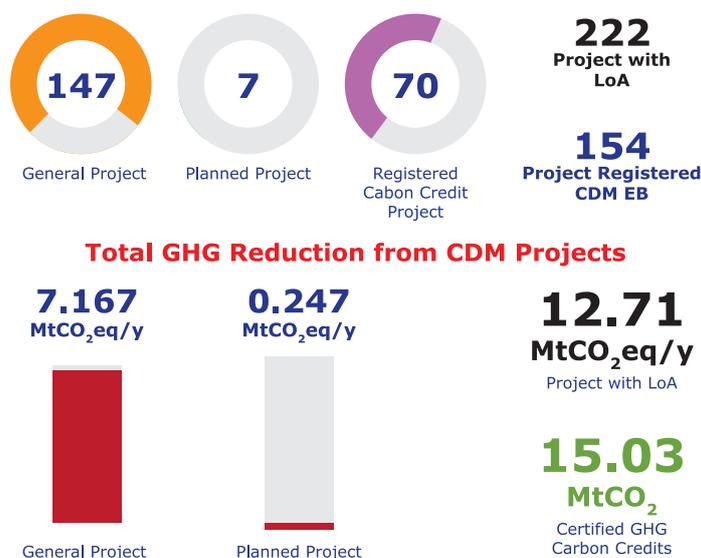


Figure 3-12: Thailand's GHG emission reduction 2013-2020 from NAMA implementation

Source: Thailand Greenhouse Gas Management Organization (TGO)

### **Joint Crediting Mechanism (JCM)**

The Joint Crediting Mechanism (JCM) is a bilateral mechanism initiated by Japan to help Thailand adopt low-carbon technology for greenhouse gas reduction projects with financial support from the Japanese government. The JCM mechanism is managed by the Joint Committee, which consists of committees from Japan and Thailand. Greenhouse gas reduction projects require measurement, reporting, and verification (MRV) to ensure reliable reduction in greenhouse gases. The Joint Committee endorses the methodology used to calculate the amount of greenhouse gases that can be reduced. Register and certify the amount of greenhouse gases that the project reduces, also known as carbon credits. Certified reductions in greenhouse gases can be used to meet greenhouse gas reduction targets under the United Nations Framework Convention on Climate Change (UNFCCC). From 2015-2021, the Ministry of Environment of Japan has funded 38 of Thailand's projects to develop JCM Model Projects, expected to be reduced GHG by 204,968 tCO<sub>2</sub>eq/year.

*Source: Thailand Greenhouse Gas Management Organization (TGO)*

### **Low Emission Support Scheme (LESS)**

The Low Emission Support Scheme, also known as the LESS project, aims to raise awareness of greenhouse gas emission reduction and support the operators of greenhouse gas reduction activities by providing them a letter of recognition (LOR). LOR is issued for the activities that have already been implemented and achieved GHG reduction, and the GHG reduction cannot be sold or purchased. The objectives are to honor the operators, encourage greenhouse gas reduction activities on a small scale, such as communities, temples, and schools, and encourage support for implementing greenhouse gas reduction projects. The benefits of LESS implementation include:

- Showing Corporate Social and Environmental Responsibility (CSR) through the implementation of greenhouse gas reduction activities
- Creating opportunities for the communities to receive funding, technology, and potential development support in conducting greenhouse gas reduction activities
- Contributing to job creation and revenue from activities that reduce greenhouse gases
- Supporting the development of greenhouse gas reduction technology in the country
- Restoring and maintaining the ecological balance of natural resources and the environment
- Raising awareness for organizations, agencies, and communities to contribute to greenhouse gas reduction and conduct environmentally friendly activities

From 2015-2021, there are 1,041 operators and 7,697 activities with total GHG reduction of 3,518,444 tCO<sub>2</sub>eq and total carbon sequestration 186,582,286 tCO<sub>2</sub>eq.

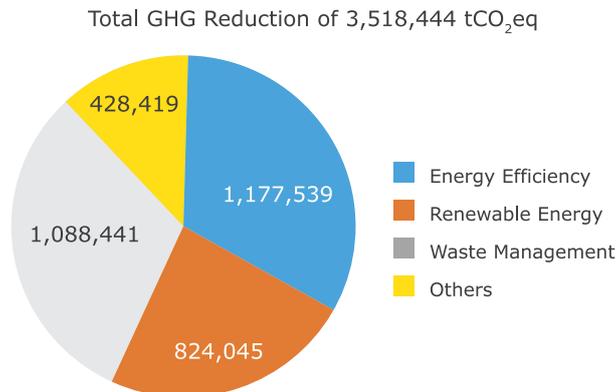


Figure 3-13: GHG reduction from LESS projects during 2015-2021

Source: Thailand Greenhouse Gas Management Organization (TGO)

### Thailand Voluntary Emission Reduction Program (T-VER)

Thailand has established guidelines on the trading and use of carbon credits for domestic and international purposes. Recognizing global awareness of climate change and GHG emissions reduction, as well as the guidelines under Article 6 of the Paris Agreement, Thailand Greenhouse Gas Management Organization (TGO) has developed an internationally equivalent standard of Thailand Voluntary Emission Reduction Program or T-VER as an alternative for project developers to use and trade internationally recognized carbon credits. T-VER mechanism promotes and supports all sectors to voluntarily participate in GHG emission reduction. The T-VER carbon credits are developed in compliance with the requirements of the GHG reduction mechanism under Article 6.4 of the Paris Agreement and the international voluntary GHG reduction mechanism implemented by non-governmental organizations such as the Verified Carbon Standard (VCS) and the Gold Standard (GS). The participants can trade the emission reduction unit or carbon credit, called "T-VER," under the voluntary carbon result in carbon sequestration within Thailand's jurisdiction. The benefits of T-VER include:

- Carbon Credits can be used for CSR purposes and voluntary carbon offsets for companies.
- Encouraging the development of GHG emission reduction projects with co-benefits by means of certifying carbon credits
  - Promoting Voluntary Carbon Market in Thailand
  - Raising perception /awareness of climate change and encouraging public and private sector involvement
  - Preparing all stakeholders for the future new agreement on Global GHG emission reduction

From 2014-2021, 257 projects have been registered as T-VER projects with the expected GHG emissions reduction potential of 9,582,052 tCO<sub>2</sub>eq per year.

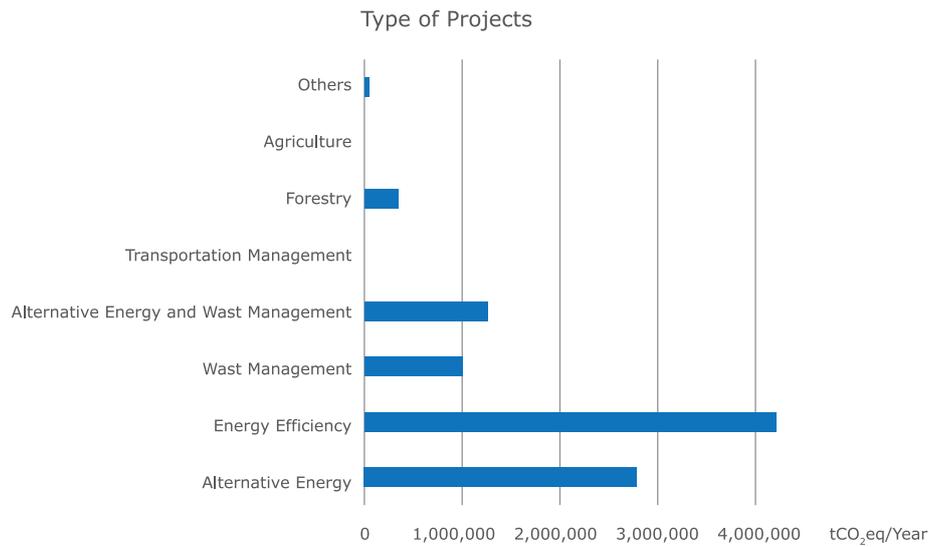


Figure 3-14: Expected GHG reduction from T-VER projects 2014-2021 (tCO<sub>2</sub>eq/year)

Source: Thailand Greenhouse Gas Management Organization (TGO)

### Carbon Offsetting Program and Voluntary Carbon Market

In 2013, Thailand launched the Thailand Carbon Offsetting Program (T-COP). Each participant (i.e., individuals, organizations, products & services, and events) can voluntarily offset their GHG emissions in this offsetting carbon program. It provides a platform for a participant to offset its carbon footprint by contributing money to retire the certified carbon credits, particularly the domestic carbon credits from (T-VER). This has created a voluntary carbon market in Thailand with a transaction volume of around 286,000 tCO<sub>2</sub>eq at the average price of carbon credits around 34 THB/tCO<sub>2</sub>eq. Thailand's carbon market is a small voluntary market with an average growth rate of 8.5% per annum, with most carbon credit trading within Thailand in the form of negotiations. (Over-the-Counter: OTC) the price of carbon credits is between 15-200 THB/ tCO<sub>2</sub>eq. From 2013-2021, overall participants are 112 companies with 690,678 tCO<sub>2</sub>eq carbon credits, 46 products with 3,471 tCO<sub>2</sub>eq carbon credits, 107 events with 15,523 tCO<sub>2</sub>eq carbon credits, and 1,265 individuals with 5,817 tCO<sub>2</sub>eq carbon credits.

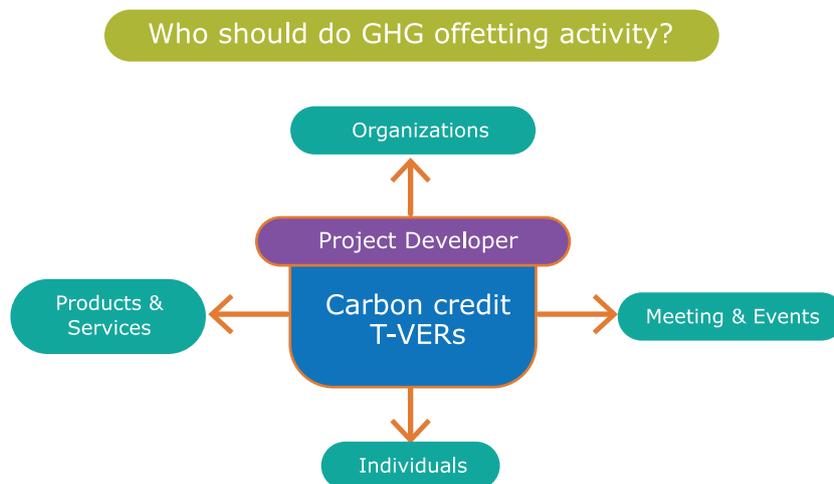


Figure 3-15: Participants in Thailand Carbon Offsetting Program (T-COP)

Source: Thailand Greenhouse Gas Management Organization (TGO)

**Corporate Carbon Footprint (CCF)**

Corporate Carbon Footprint for Organization (Corporate Carbon Footprint: CCF) is a method for displaying the amount of greenhouse gases emitted from corporate operations. This will lead to the determination of the management approach. Manage to effectively reduce greenhouse gas emissions at the factory, industrial and national levels. Currently, TGO has created a project to promote the organization’s carbon footprint in the industrial sector and local government. CCF shows the amount of greenhouse gases emitted by corporate activities such as fuel combustion, electricity consumption, waste management, and transportation. It can be used to drive the organization’s management of greenhouse gas emission reduction.

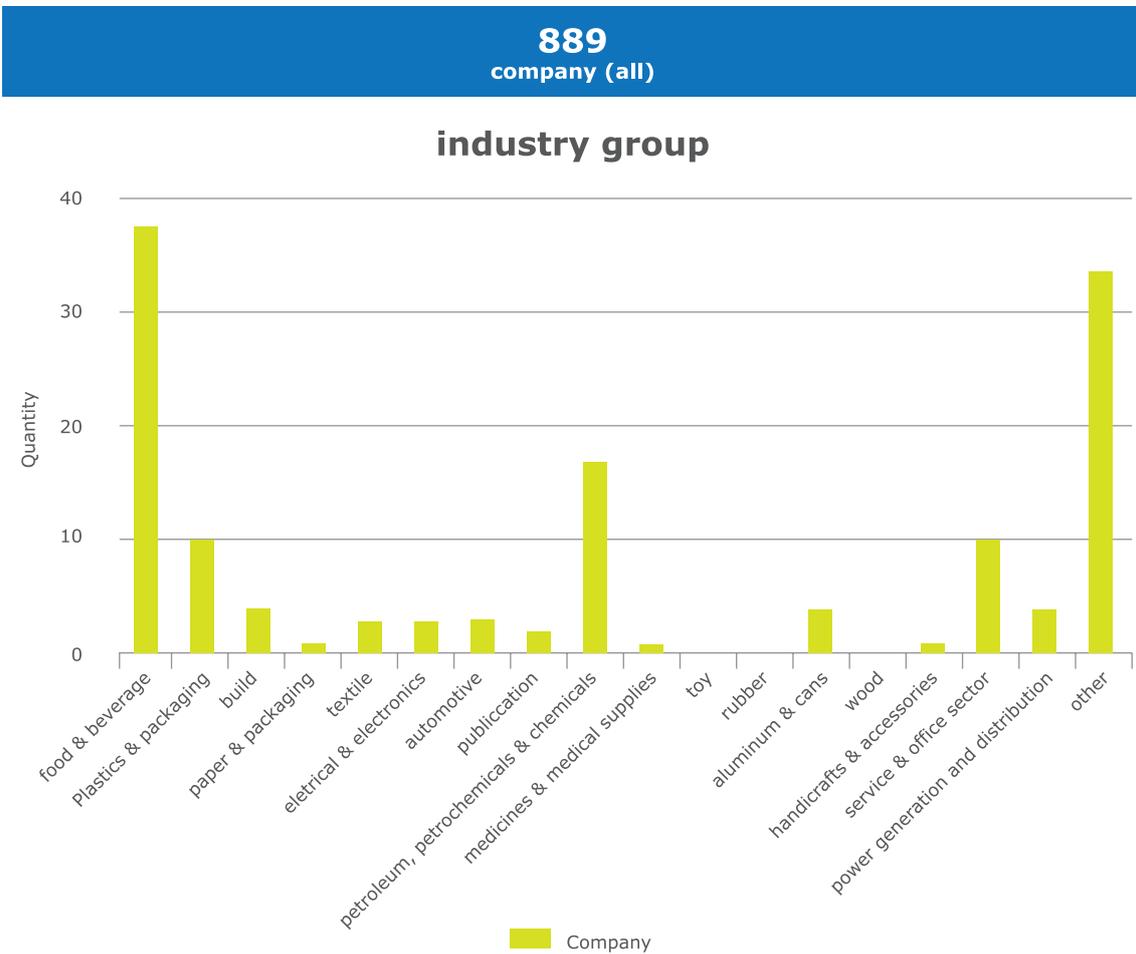


Figure 3-16: Statistic of registered companies for CCF

Source: Thailand Greenhouse Gas Management Organization (TGO)

### **Carbon Footprint Products (CFP)**

TGO initiated the Carbon Footprint of Products promotion project to raise consumer awareness and disseminate Carbon Footprint (CFP) labeling information from the production process through the products in the market. The CFP label attached to the products shows consumers how much greenhouse gases are emitted throughout the products' life cycle from acquiring raw materials, production processes, distribution, use, and waste management after expiration of use, which helps to make consumers' decisions. The scheme aims to induce manufacturers to adopt mitigation measures and reduce GHG production with consumers' purchase power. Furthermore, this CFP can be used by business partners through their supply chain; the buyers can request CF information of purchased raw materials from suppliers to quantify their CFP through their products' life cycle. Thus, the final manufacturers can disclose their CFP on products to express their awareness of global warming and climate change.

This effort can also increase the competitiveness of Thai producers in the global market, where the concern on the importance of global warming and climate change is continually increasing. TGO, in collaboration with the National Science and Technology Development Agency (NSTDA), developed requirements and guidelines for quantifying the Carbon Footprint of Products. The guidelines aim to disseminate a standardized approach to Thai producers to quantify their CFP. TGO has developed the CFP certification and registration scheme for Thai producers in accordance with ISO 14067: 2018 Greenhouse gases – Carbon footprint of products – Requirements and guidelines for quantification and developed a third-party verification system to increase the credibility and reliability of the Thai CFP scheme to meet the International Standardization. Producers who intend to quantify their CFP shall comply with the assigned Product Category Rule (PCR) and the requirements and guidelines for quantifying the Carbon Footprint of Products.

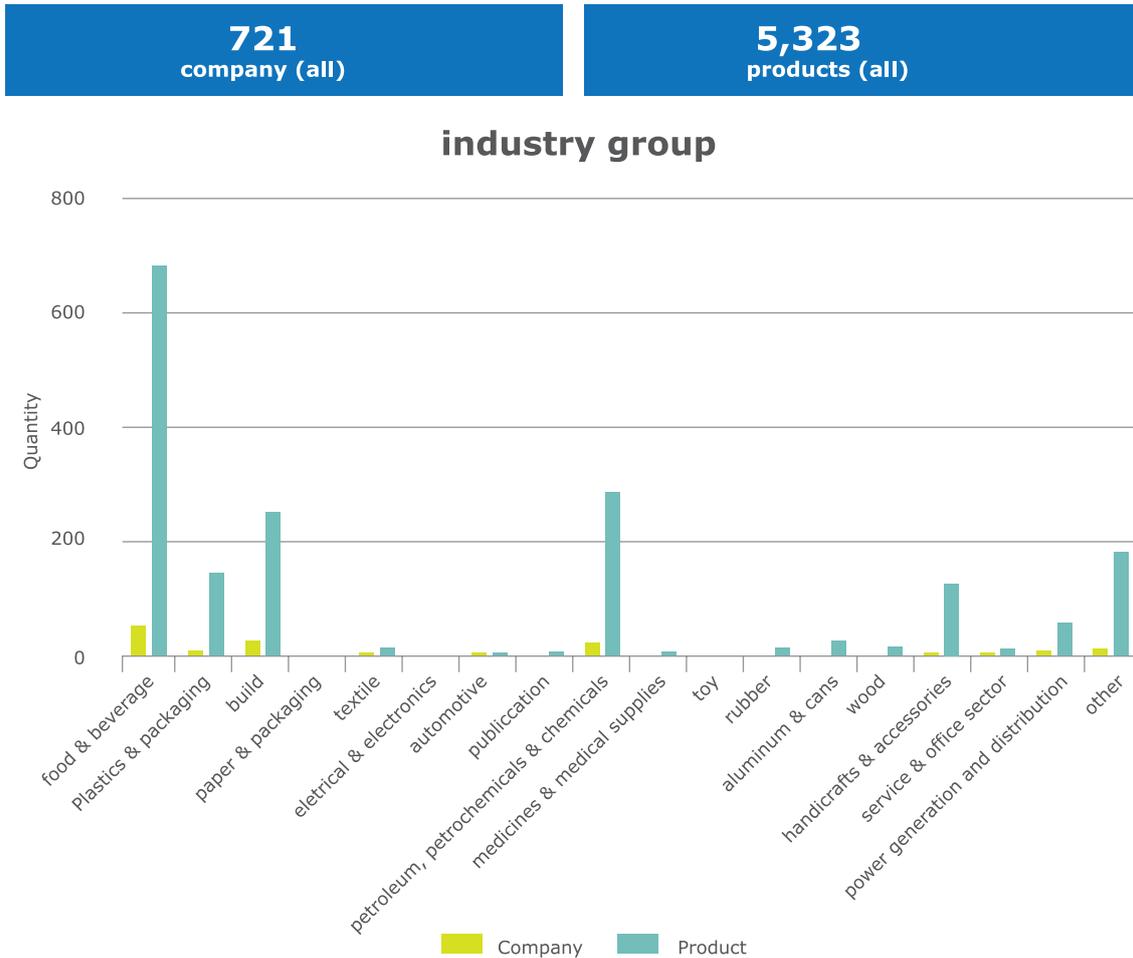


Figure 3-17: Statistic of registered products for CFP

Source: Thailand Greenhouse Gas Management Organization (TGO)

### Carbon Footprint Reduction (CFR)

Carbon Footprint Reduction Label (CFR) or Global Warming Reduction Label is a label that demonstrates a certified Carbon Footprint of Product (CFP) and its emissions reduction based on the TGO eligible reduction criteria. The CFR evaluation process includes the quantification and certification of the base year and current year CFP and the comparison results between the base year and current year certified CFP or against its product category benchmarking threshold announced by TGO. The product registered as CFR shall comply with the following requirements: 1) The certified CFP of its current year compared to the base year certified CFP shall be reduced not less than 2% or 2) The certified CFP of its current year is equal to or less than the product category benchmarking threshold and not more than its base year certified value. In 2021, 127 products from 28 companies were labeled with an overall emission reduction of 294,055 tCO<sub>2</sub>.

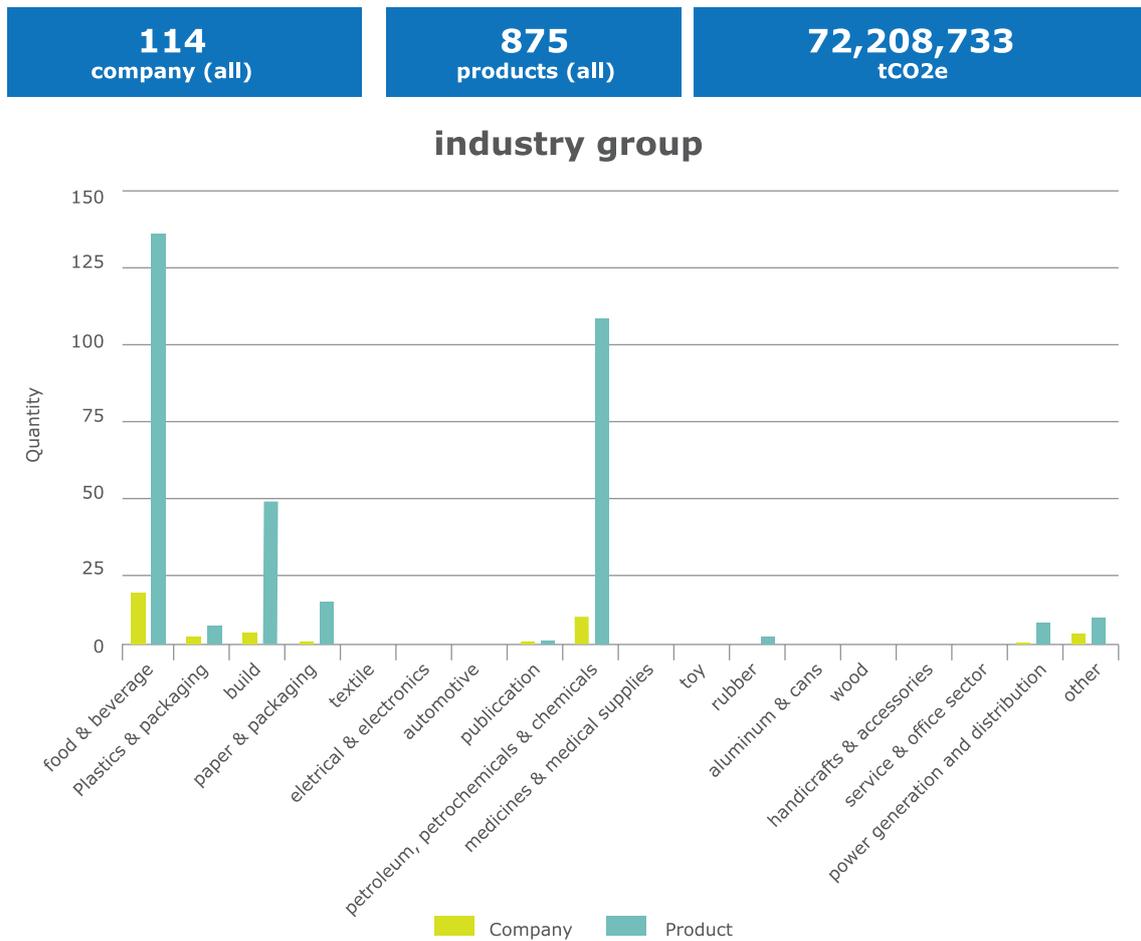


Figure 3-18: Statistic of registered companies and products for CFR

Source: Thailand Greenhouse Gas Management Organization (TGO)

### Low Carbon City

- **Municipality and GHG Inventory**

The department of local governments and TGO collaborated to encourage local governments to report greenhouse gas data in local governments and cities to promote the management of greenhouse gases in local governments to become a carbon reduction politics and as a database for greenhouse gas reduction activities to become a carbon reduction city. From 2011-2021, a total of 237 municipalities participated in the project, and also expanded the city's carbon footprint in 2014 to guide the reporting of urban greenhouse gas data as well as for the year 2019, with the cooperation of 94 municipalities, which has been implemented in the city-level greenhouse gas data reporting guidelines and appropriate greenhouse gas reduction plans in each area.

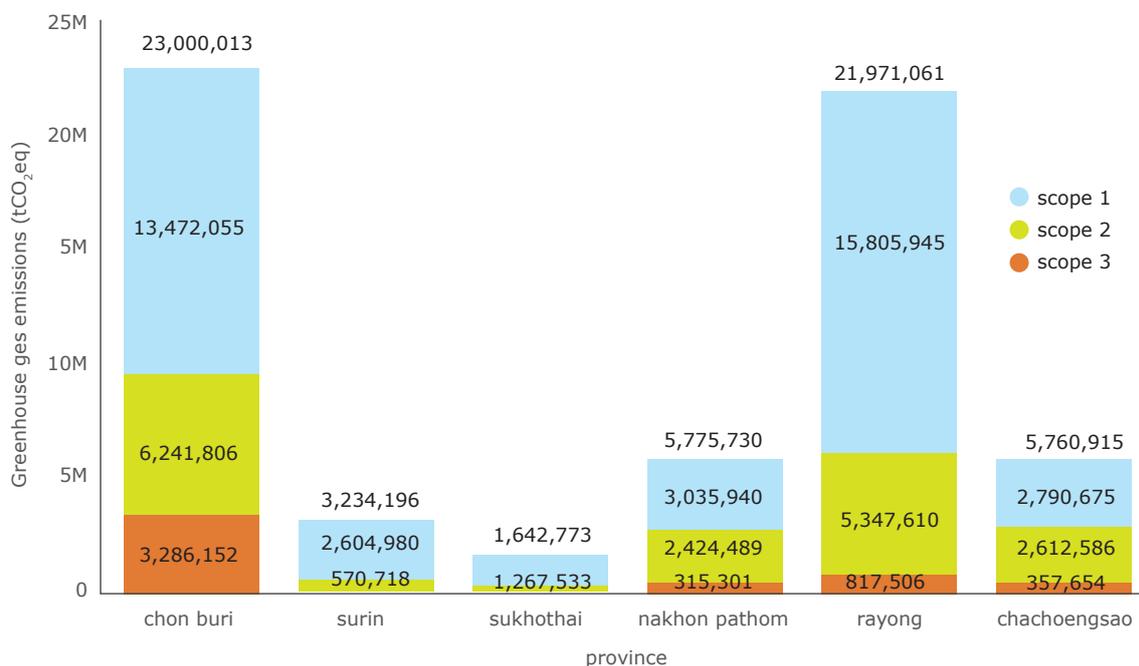


Figure 3-19: GHG emissions caused by provincial activities in 2021

Source: Thailand Greenhouse Gas Management Organization (TGO)

• **Achieving Low Carbon Growth in Cities through Sustainable Urban System Management in Thailand Project (GEF5) (LCC)**

TGO and the United Nations Development Programme (UNDP) have joined forces to develop the project “Achieving Low Carbon Growth in Cities through Sustainable Urban System Management in Thailand,” with financial support from the World Environment Fund (Global Environment Fund: GEF) of 3.15 million USD. The project was launched in 2017 and accomplished in July 2021.

The LCC project was designed as a four-year project to promote low-carbon urban development in mid-sized Thai cities. It pursues the dual aims of greenhouse gas (GHG) emissions reductions, economic benefits, and enhancement of the lives of local people through an improved urban environment. Emphasis is on the waste management, transport, and electricity end-use sectors. The project cooperates with the four mid-sized Thai cities of Nakhon Ratchasima, Chiang Mai, Samui, and Khon Kaen.

LCC targets three outcomes for its partner cities: (1) low carbon planning, (2) demonstration of low carbon city initiatives, and (3) financing of increased investment in low carbon city initiatives. For each city, the low carbon planning work features, development of city carbon footprints, and low carbon development strategies are to be incorporated into mainstream planning. The demo outcome features a package of demos for each city. Nakhon Ratchasima and Khon Kaen demos cut across all three sectors: waste management, end-use energy/ distributed solar PV, and transport, while

Chiang Mai focuses entirely on transport and Samui on organic waste management. The financing/ investment outcome was intended to develop financing mechanisms for low carbon development, but its design also features capacity building and awareness-raising. Subsequently, TGO has set up a Bureau for Low Carbon Cities and plans additional city-level outreach, though it aims to address the local level through cooperation with provinces. TGO also plans to work with the responsible Ministry, MOI, to develop low-carbon KPIs for the city and provincial staff.

*Source: 1) Thailand Greenhouse Gas Management Organization (TGO) 2) Terminal Evaluation – Thailand LCC Project, United Nations Development Programme*

### **Developing Low Carbon and Circular Economy Model for Industry in Eastern Economic Corridor (EEC) Area**

To accelerate economic growth in the next 20 years, the Thai government has set a strategy to promote investment, trade, production, and services in the Eastern Economic Corridor (EEC). The EEC was designated as a sandbox (pilot area) for various economic, social, and environmental development initiatives. In terms of production, more than 37% of the total factories in Thailand are located in the EEC area. Thus, this area possesses a high GHG reduction potential and could be developed as a model for low-carbon industrial cities. In 2018, TGO initiated “Integrating Climate Actions into the Eastern Economic Corridor: Toward Low Carbon Industry Project.” The objectives are 1) to develop

a circular economy and low carbon model for the industry in the EEC area (CE-EEC model), 2) to provide recommendations on circular economy for low carbon industry in the EEC area, 3) to conduct a survey on low carbon technologies and encourage industries to self-assess their low carbon industry readiness, and 4) to develop and integrate the circular economy database into GHG Mitigation Information Platform developed by TGO.

During 2019-2020, policy recommendations and action plans during 2021-2030 were developed to promote the low-carbon industry in the EEC area. Sixty factories from 3 provinces in the EEC area participated and implemented GHG management and emission reduction activities. Among these factories, 44 factories calculated and reported an organization’s carbon footprint (CFO), 11 factories reported the carbon footprint of a product (CFP), and 7 factories developed T-VER projects. GHG Mitigation Information Platform was established to disseminate the project information, knowledge, and information relevant to GHG emission reduction, such as low-carbon technologies, number, and name of factories registered to CFO/CFP/T-VER scheme with TGO. In 2021, 6 industries were adopting the CE-EEC Model with the capacity to reduce GHG emissions equivalent to 1.69 million tCO<sub>2</sub> per year. Sets of data on raw materials, product parts, by-products, and wastes were collected from 88 industries in the EEC areas. From the data received from 111 industries, in case technologies are advanced, the capacity to reduce GHG emissions significantly increases to 11,772.42 tCO<sub>2</sub>. A low carbon technologies database surveyed 85 factories, and results reveal the low carbon industry readiness self-assessment from 75 factories.

*Source: Thailand Greenhouse Gas Management Organization (TGO)*

**Thailand Carbon Neutral Network (TCNN):**

Thailand Carbon Neutral Network was established to promote cooperation between governments in GHG reduction to create sustainable growth in a climate-friendly society and move toward net-zero GHG emissions aligning with the international community and the Paris Agreement. The operational objectives include: promote and support organizations in feasibility studies, readiness potential implementation guidelines and announcement of carbon neutral targets at the enterprise level; encourage increased GHG reduction activities; enhance the benefits of sustainable development from greenhouse gas reduction activities and projects; create a platform for exchanging best practices and experience in managing and reducing greenhouse gas emissions between organizations in the network; and promote info sharing/ exchanges between government agencies and private sector organizations in the network. Network member's features are organizations registered in Thailand or established under Thai law and express a willingness to participate in promoting the pursuit of carbon neutrality, at least one level of activity, product, or organization.

*Source: Thailand Greenhouse Gas Management Organization (TGO)*





# CHAPTER 4

## VULNERABILITY AND ADAPTATION



## CHAPTER 4: VULNERABILITY AND ADAPTATION

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*In accordance with Article 7, paragraph 10 and 11 of the Paris Agreement, this chapter, Vulnerability and Adaptation of this NC is also Thailand's first Adaptation Communication.*

*It is vital for Thailand, one of the most vulnerable countries to climate change impacts, to assess climate risks, impacts, and the country's vulnerability and set up adaptation plans in all climate-variable sectors with the objective of becoming climate-resilient.*

*This chapter begins with a brief description of national circumstances, institutional arrangements, and legal frameworks for climate change adaptation. It further reveals the study on Thailand's climate impacts, risks, and vulnerabilities assessments in 6 significant sectors: water management, agriculture and food security, tourism, public health, natural resources, and human settlement and security. The risk and vulnerability assessments are based on the top-down approach using climate scenarios generated through the most updated version of the General Circulation Models (GCMs). After the risks and vulnerabilities assessment, the chapter illustrates the National Adaptation Plan (NAP), which has a vision that "Thailand is resilient with adaptive capacity to climate change impacts and move toward sustainable development," and its priorities and implementation focus on the followings: increasing water security and reducing losses and damage from water-related disasters; maintaining productivity and food security amidst climate change risks and impacts; strengthening the capacity of the tourism sector toward climate-resilience and sustainable development; establishing effective public health systems to manage risks and reduce impacts from climate change; ensuring sustainable management of biodiversity resources to respond to climate change impacts; and enhancing the capacity of individuals, communities, and cities to adapt to climate change impacts appropriately according to the local context.*

*Nevertheless, certain barriers remain for Thailand to overcome in order to have effective and efficient climate adaptation implementation—limitation of knowledge, lack of continued financial support, lack of central database, lack of national climate information center, and lack of access to adaptation technologies. Therefore, Thailand requires technical, technology, and financial support in establishing a unified data system and coordination mechanism, monitoring and evaluation system, and financial mechanism for fund mobilization and utilization.*

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## 4.1 National Circumstances, Institutional Arrangements, and Legal Frameworks

### 4.1.1 National circumstances

Thailand is highly vulnerable to the impacts of climate change. According to the Global Climate Risk Index 2021, which is the index that analyzes the extent to which countries and regions have been affected by impacts of weather-related loss events, Thailand was ranked the 9<sup>th</sup> most affected country – both in terms of human impacts (fatalities) and direct economic losses – from weather-related loss events during 2000-2019. Different sectors and different regions in Thailand are vulnerable to different climate hazards. Thailand's coastal zone is at greater risk of intensive flooding resulting from sea-level rise and coastal erosion in several provinces. Around 20 million people are living in these vulnerable areas. The country's total coastal length is approximately 3,151 kilometers, around a quarter of which are experiencing erosion rates between 1-5 meters per year. Bangkok, the capital city of Thailand, has one of the highest risks in the world for intensive flooding because of climate change-induced changes in precipitation, sea level rise, and coastal erosion.

In term of sectoral impacts, given that around 47% of land use in Thailand is dedicated to agriculture and around 30% of the Thai labor force still participate in the agricultural sector, the vulnerability of the agricultural sector to climate change is a point of concern. Thailand's production of crops, livestock and fisheries crucially depend on suitable climate (IPCC, 2014). In the context of Thailand, as indicated in Thailand's First Assessment Report on Climate Change 2011, different crops have varying degrees of exposure to the effect of climate change. For instance, rice is sensitive to high temperature, drought, and flood. Livestock is also vulnerable to high temperature and drought as increased temperature might cause heat stress in some types of livestock, particularly swine. Fisheries and aquaculture are also vulnerable to high temperature, salinity, and acidification. Apart from agricultural sector, other sectors are also vulnerable to impacts of climate change, namely water resource management, public health, tourism, natural resource management, and human settlement and security.

In addition to the physical impacts of climate change, Thailand is also vulnerable to changes in socio-economic conditions. Among several major driving forces, the aging population is one of the issues of concern. A decline in birth rate with a concurrent increase in life expectancy has contributed toward shaping Thailand's population structure into an "aging society." Thailand is projected to be a "super-aged society" by 2035. This is projected to put a financial strain on healthcare, long-term care, and pensions, among other things. Plus, the shrinking labor force will impact Thailand's economy, and the aging population is more vulnerable to the impacts of climate change.

### 4.1.2 Institutional arrangements and legal frameworks

With regard to the institutional arrangements for climate change adaptation, the Subcommittee on Climate Change Policy and Planning Integration is a subcommittee under the National Committee on Climate Change (NCCC). 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 mechanism and measures, including law regulations and financial measures; and push forward an integrated budget allocation system on climate change. The Subcommittee on Climate Change Policy and Planning Integration appointed the Working Group on National Climate Change Adaptation Implementation Integration for the first time on 11 April 2017 and revised its composition and role to be appropriate and effective on 25 March 2019. Figure 4-1 shows the institutional arrangement related to climate change adaptation. The roles of the Working Group on National Climate Change Adaptation Implementation Integration are to provide suggestions, recommendations, and supports in the development of the National Adaptation Plan as well as research, policy, strategies, plans, tools and mechanisms related to the National Adaptation Plan; support the integration and mainstreaming of National Adaptation Plan into sectoral and regional plans; drive the implementation of the National Adaptation Plan as well as the related policies, strategies and plans; monitoring and evaluation of adaptation measures under the National Adaptation Plan; and inviting representatives of public and private organizations to share information to the National Working Group on Integration of Adaptation Implementation.

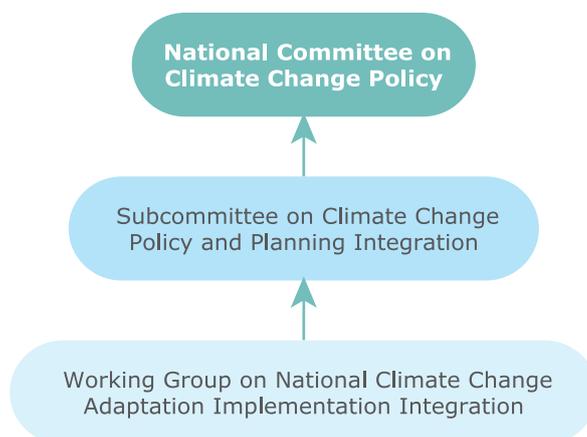


Figure 4-1: Institutional arrangement for climate change adaptation

The Secretary General of ONEP is serving as a Chairman of the Working Group on National Climate Change Adaptation Implementation Integration. This Working Group comprises 23-line ministries, representatives from academia and the private sector, and 7 national experts related to climate change adaptation. The Climate Change Management and Coordination Division, ONEP serves as secretary of the National Working Group on Integration of Adaptation Implementation.

When it comes to the National Adaptation Plan (NAP) formulation process, Figure 4-2 shows that once the second draft of NAP was formulated, it first went through the review and consideration by the Working Group on National Climate Change Adaptation Implementation Integration, and subsequently being reviewed and considered by the Subcommittee on Climate Change Policy and Planning Integration and the National Committee on Climate Change (NCCC) before being submitted to the Cabinet for final approval. Once the Cabinet approved the NAP, it was then submitted to the UNFCCC.

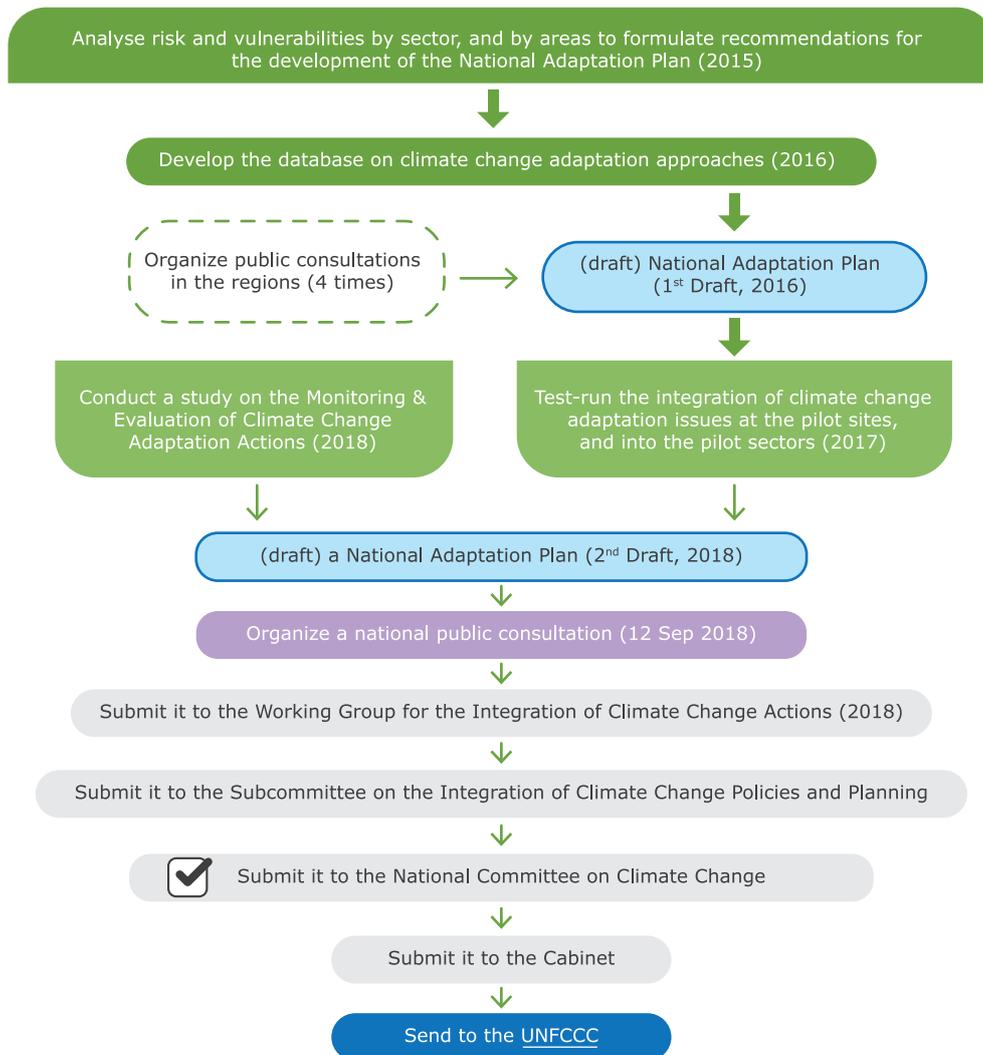


Figure 4-2: National Adaptation Plan formulation process

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

With regard to the legal framework, Thailand's Climate Change Bill was formulated by ONEP. The Climate Change Bill aims to increase the efficiency of climate actions in Thailand, put in place long-term adaptation to climate change, and promote sustainable development. The Climate Change Bill stipulates that there should be climate projection and the risk and vulnerability assessments. In addition, the national central climate change database should be developed and accessible to the public so that the data can be used to assess the risks and impacts of climate change. The National Adaptation Plan will provide guidelines and measures to support adaptation to climate change and reduce the risks of climate change.

### 4.2 Impacts, Risks, and Vulnerabilities

#### 4.2.1 Past and current climate

Chapter 1 presents the trend in past climate – annual mean maximum temperature (Figure 1-7), annual mean minimum temperature (Figure 1-8), annual mean temperature (Figure 1-9), and annual mean rainfall (Figure 1-10) – for Thailand during 1950-2021. Figures 1-7 and 1-8, clearly illustrate that both annual mean maximum and minimum temperature in Thailand are on an upward trend. Considering the annual mean temperature shown in Figure 1-9, it was found that between 1981-1990, temperatures increased by 0.33°C, while the periods of 1991-2000 and 2001-2010 recorded annual mean temperature increases of 0.16°C and 0.145°C per decade, respectively. The average temperature in Thailand from 2011 to 2021 increased by an average of 0.09°C per year.

Considering the past trend in annual mean rainfall for Thailand, according to Figure 1-10, precipitation in Thailand has high variability. Based on the Thai Meteorological Department's climate changes report, it was found that the variation of precipitation and the number of rainy days has oscillated over time. This widening range in rainfall pattern and amount can present a host of problems in many sectors, especially agriculture and water management.

#### 4.2.2 Projected Climate Trends and Hazards

With regard to future changes in temperature, according to the study by ONEP and RU-CORE (2021), three scenarios were considered, i.e., 1°C, 1.5°C, and 2°C rise in temperature relative to the 1970-2005 period. The results shown in Figure 4-3 are based on 3 General Circulation Models, namely MPI-ESM-MR, EC-Earth, and HadGEM2-ES, and Ensembled or the group of climate models.

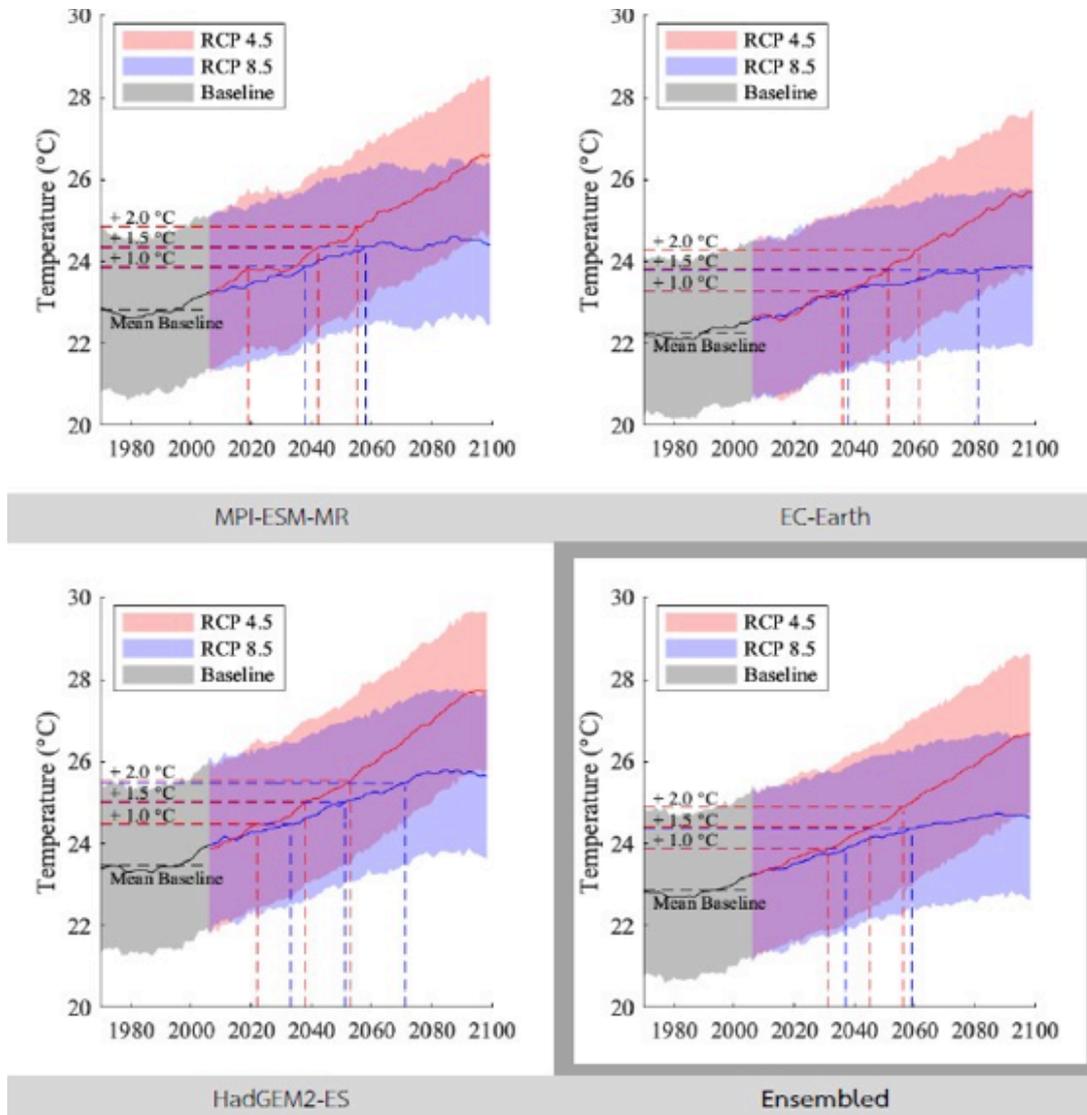


Figure 4-3: Future changes in temperature in Thailand

Source: Thailand Science Research and Innovation (TSRI) and Ramkhamhaeng University Center of Regional Climate Change and Renewable Energy (RU-CORE) (2020)

## CHAPTER 4

In terms of future projection of extreme rainfall, Figure 4-4 shows the maximum 1-day precipitation (Rx1day) under RCP4.5, under 3 GCMs, namely EC-Earth, HadGEM2-ES, and MPI-ESM-MR and 3 time horizons: near future (2016-2035), intermediate future (2046-2065), and far future (2081-2099). Figure 4-4 shows that the maximum 1-day precipitation is projected to increase. This reflects the tendency of flash flood from heavy precipitation.

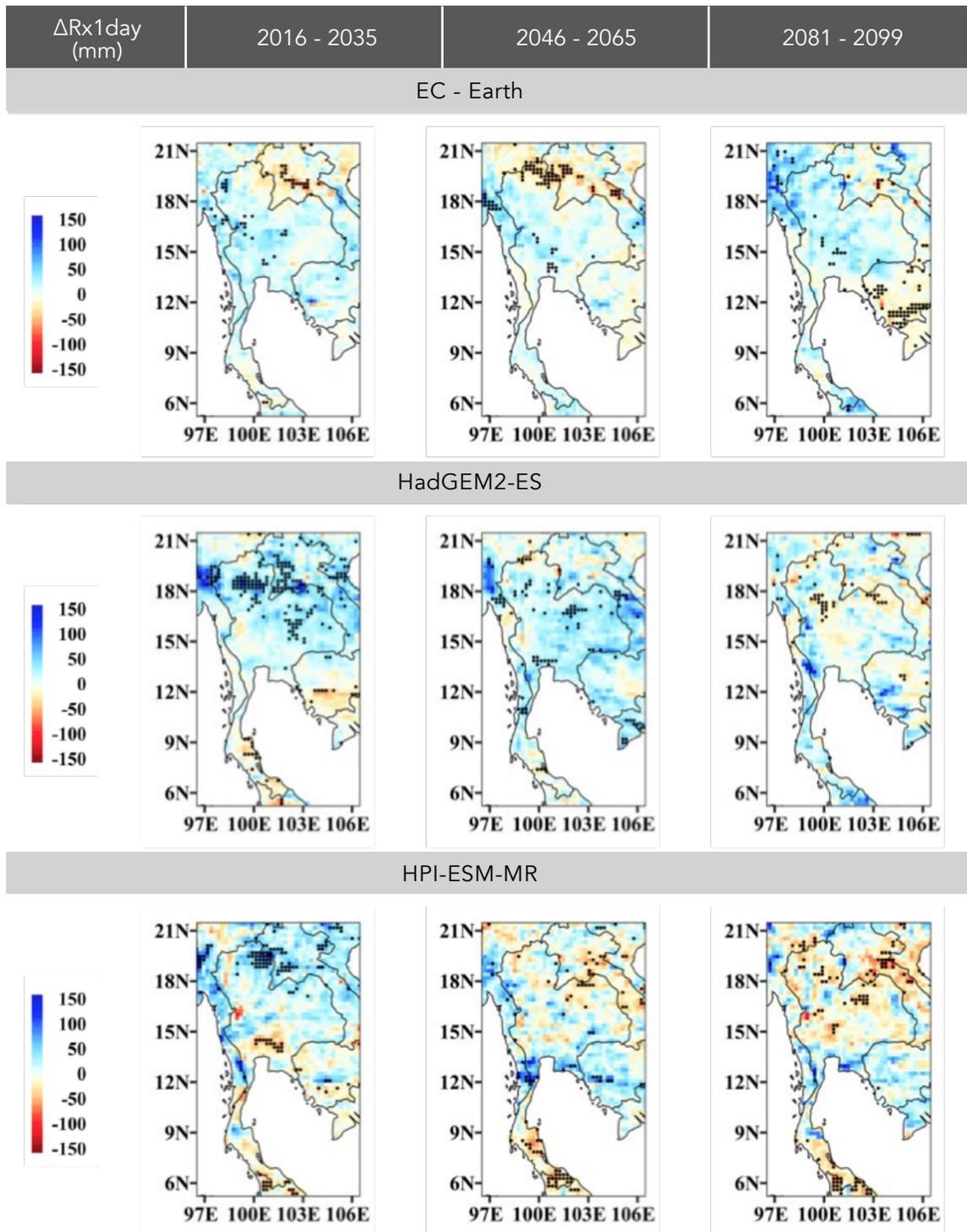


Figure 4-4: Projection of Rx1day anomaly under RCP4.5

Source: Thailand Science Research and Innovation (TSRI) and Ramkhamhaeng University Center of Regional Climate Change and Renewable Energy (RU-CORE) (2020)

Figure 4-5 shows the total precipitation under RCP4.5 and from 3 GCMs. According to Figure 4-5, the total annual precipitation is projected to decrease, which reflects the signal of drought under the future climate change. Under the future climate change scenarios, the northeastern and southern regions tend to have higher drought impacts than other regions of Thailand (Jerasorn Santisirisomboon, Jaruthat Santisirisomboon, Waranyu Wongserree, et al., 2021b).

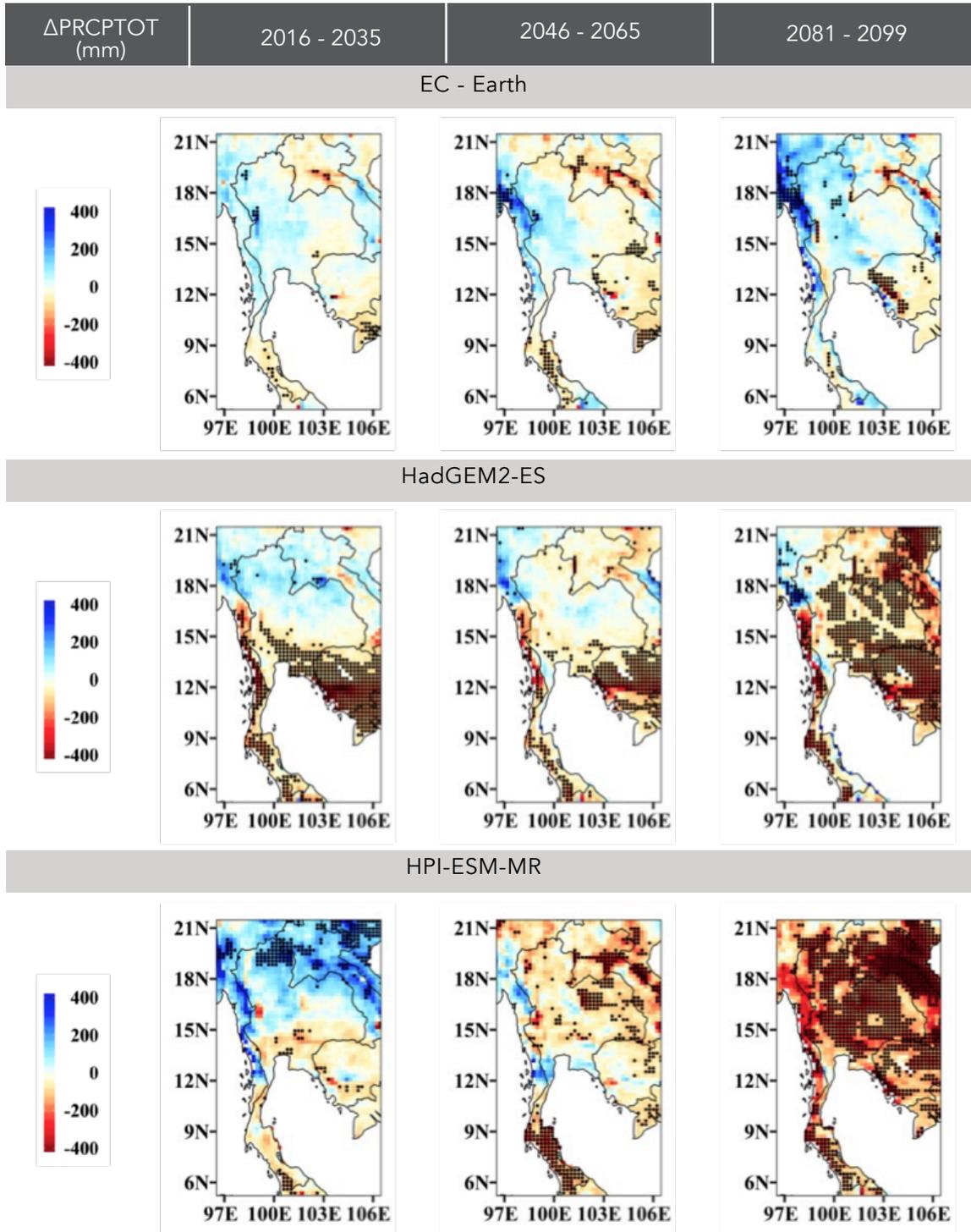


Figure 4-5: Projection of PRCPTOT anomaly under RCP4.5

Source: Thailand Science Research and Innovation (TSRI) and Ramkhamhaeng University Center of Regional Climate Change and Renewable Energy (RU-CORE) (2020)

### 4.2.3 Sectoral Impacts of Climate Change

Climate change has wide-ranging impacts on Thailand's economy, ecosystems, economic sectors as well as health and livelihoods, but the impacts are not uniform. Different sectors and regions in Thailand are affected differently by climate change. The impact chain analysis is used to understand the impacts of climate change on each sector. Impact chain is a tool, which helps in understanding, systemizing, and prioritizing factors that drive risk and vulnerability in each sector, and it takes a form of a cause-effect relationship. This tool provides a representation of how potential climate change risks can affect a system via direct and indirect impacts and leads to the prioritization of the most relevant climate change risks for deeper analysis and for identifying sector-specific adaptation measures (Eucker and Morales, 2016). The analysis results of climate change sectoral impacts using impact chain analysis are as follows:

#### 4.2.3.1 Water management sector

For the water management sector, the main climate hazards include extreme temperature, drought, coastal erosion, variation in rainy season, floods, and landslide (Figure 4-6). Both resources – upstream watershed, downstream river basin, and groundwater – and system and infrastructure are exposed to these hazards. Impacts in the water management sector include changes in water availability, disruption of water supply, agricultural harvest failure, disruption of water logistic, damage to infrastructure, as well as conflicts on water use among sectors.

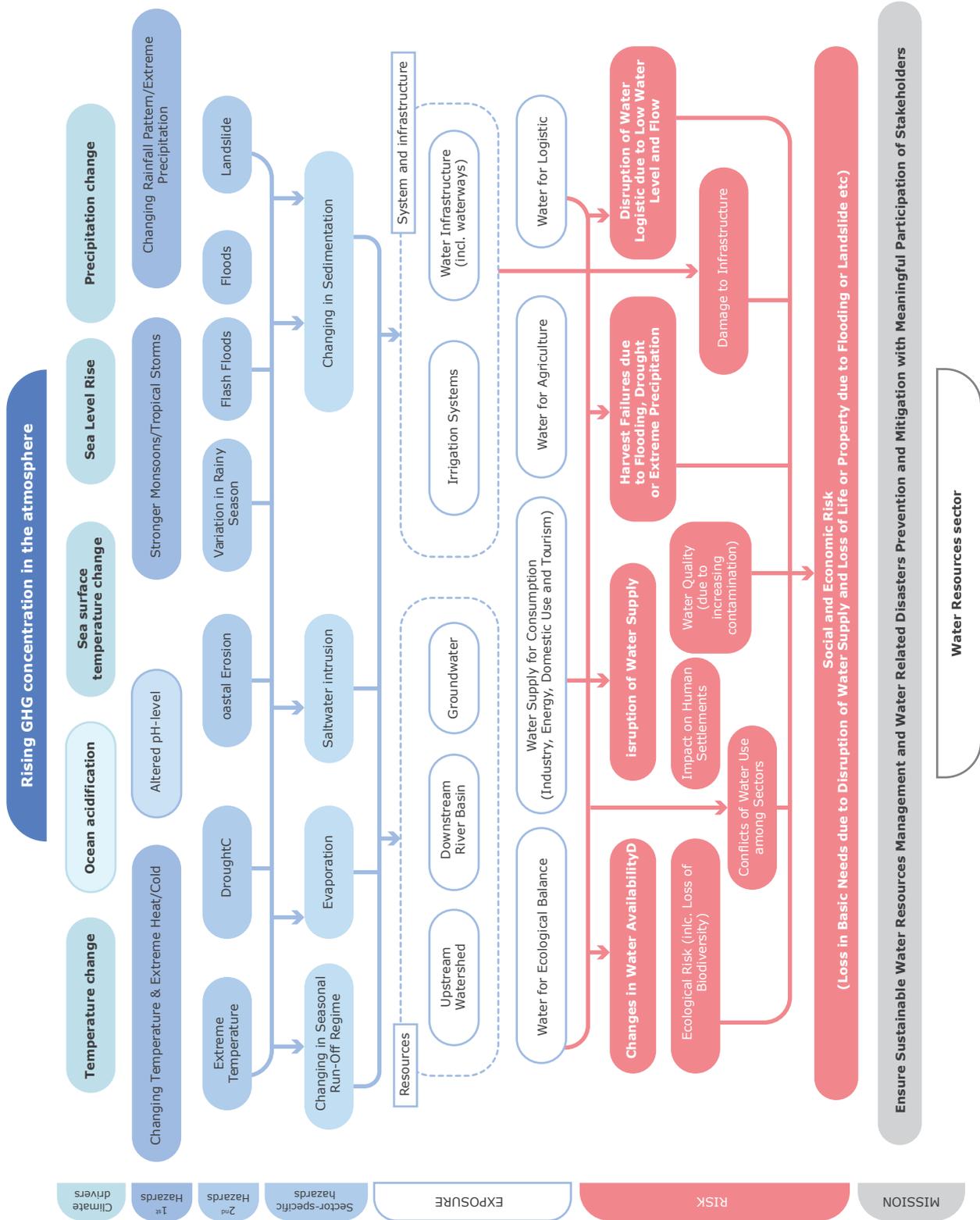


Figure 4-6: Impact chain analysis for water management sector in Thailand

Source: Office of Natural Resources and Environmental Policy and Planning (ONEP) and Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH (2016)

### 4.2.3.2 Agriculture and food security sectors

The main climate hazards in the agriculture and food security sectors include cold spells, extreme temperature, drought, coastal erosion, variation in rainy season and floods, and excessive rainfall (Figure 4-7). Different types of agricultural products – fisheries, livestock, and crops – are unequally and non-uniformly exposed. In addition, natural resources used in agriculture, particularly soil and water, are also affected by climate change. Examples of impacts of climate change on capture fisheries and aquaculture in Thailand include changes in fish species population as well as changes in quality and quantity of fisheries as health, growth, breeding, and habitat are interrupted. For livestock, there might be interruptions in the health, growth, and breeding of livestock, which in turn affect the quality and quantity of livestock. Climate change might affect crop production during the growing phases as cause post-harvest loss. Climate change might also indirectly impact agricultural production by decreasing soil fertility and water availability.

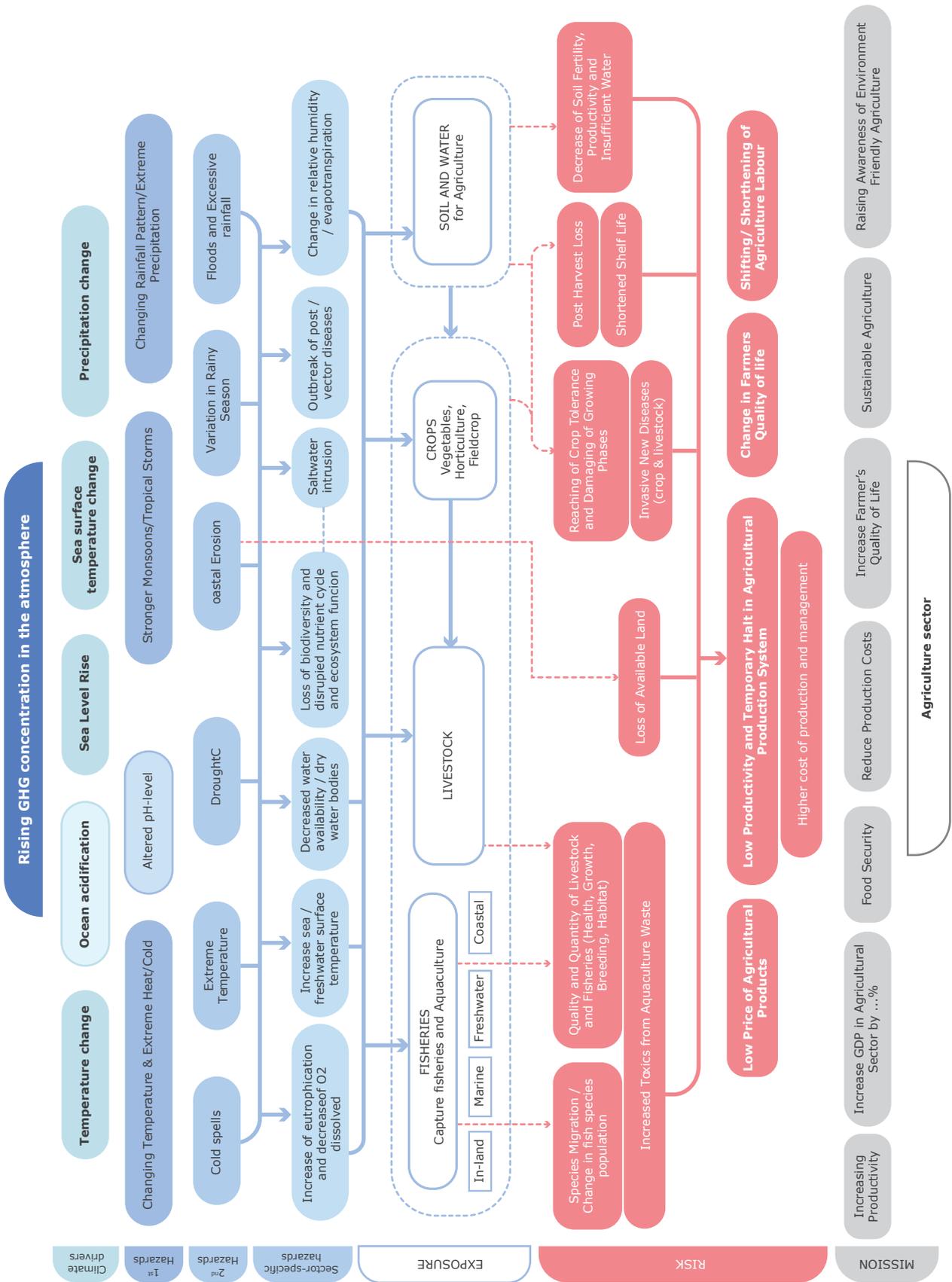


Figure 4-7: Impact chain analysis for agriculture and food security sectors in Thailand

Source: Office of Natural Resources and Environmental Policy and Planning (ONEP) and Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH (2016)

### 4.2.3.3 Tourism sector

The main climate hazards in the tourism sector include drought, storm surge/coastal flooding, variation in rainy season, flooding/flash floods, and landslides (Figure 4-8). These climate hazards adversely affect outdoor tourism activities, tourism destinations – both man-made attractions and natural attractions – and public and private services, such as traffic infrastructure, tourism facilities, water and energy supply, and waste management. Examples of impacts of climate change on tourism activities and destinations include disruptions of outdoor tourism activities, loss of cultural tourist attractions and amenities, loss of natural characteristics and attractiveness, and reduced diversity of natural resources. Examples of impacts of climate change on public and private services include interruption of the transport system, injuries and loss of life, disruption of public services, and conflicts with local communities over resource uses.

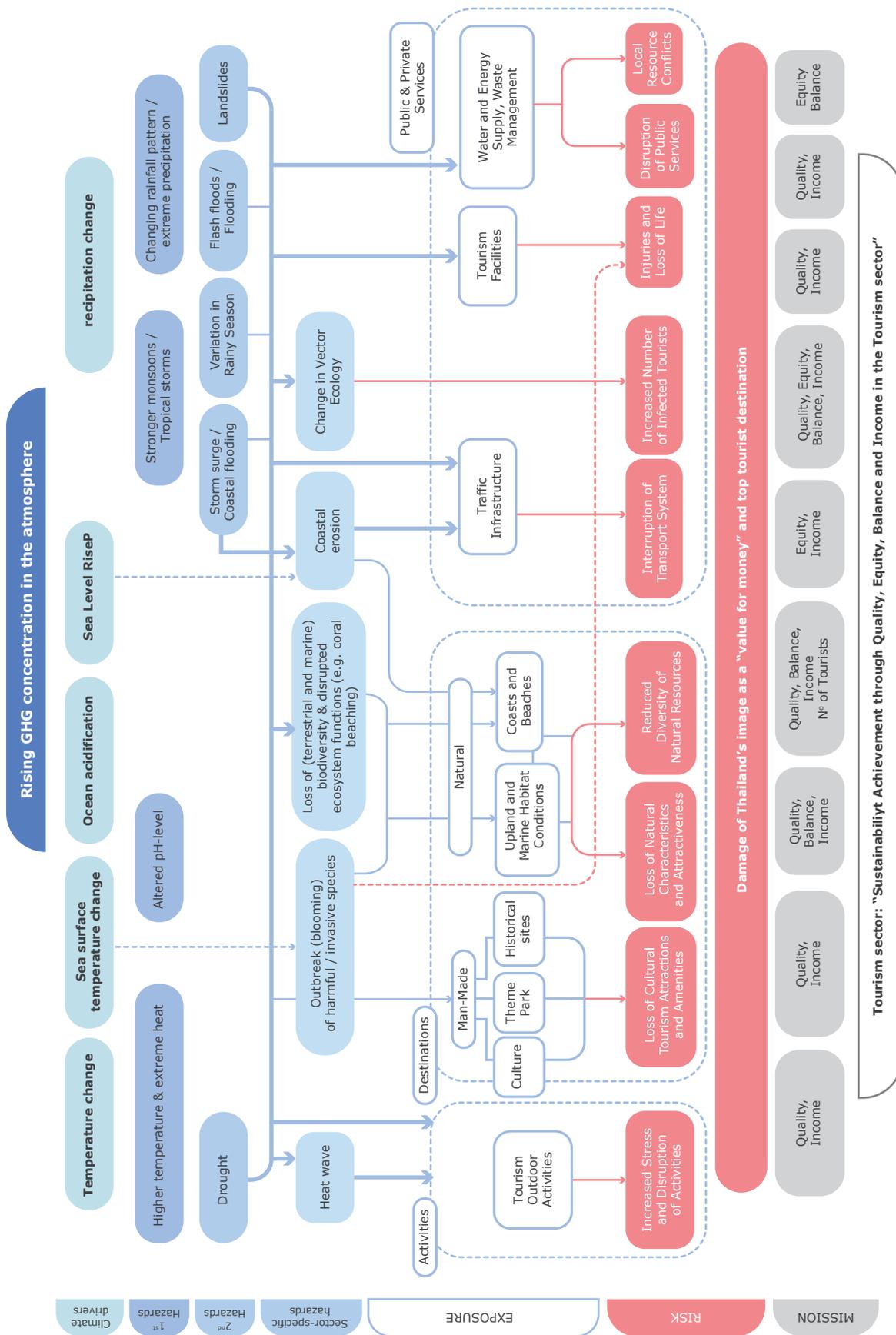


Figure 4-8: Impact chain analysis for tourism sector in Thailand

Source: Office of Natural Resources and Environmental Policy and Planning (ONEP) and Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH (2016)

### 4.2.3.4 Public health sector

The main climate hazards in the public health sector include cold spells, extreme temperatures, drought, coastal erosion, storm surge/coastal flooding, flooding/flash flood, and landslides (Figure 4-9). In terms of exposure, climate change affects health through diverse channels, including air quality, physical outdoor activity, nutrition quality and quantity, water quality and quantity, sanitation facilities in households and communities, health facilities and medical services, as well as physical security and integrity. Deteriorated air quality leads to respiratory diseases, diseases, loss of life, heat stress, and cardiovascular disease. Change in vector ecology because of climate change can lead to emerging and re-emerging diseases. Interrupted nutrition and water qualities and quantities can lead to malnutrition and increased spread of germs. In addition, the destroyed or damaged health facilities due to climate change can lead to disruption in medical services. Storm surge, flooding/flash flood, and landslides may cause injuries or loss of life.

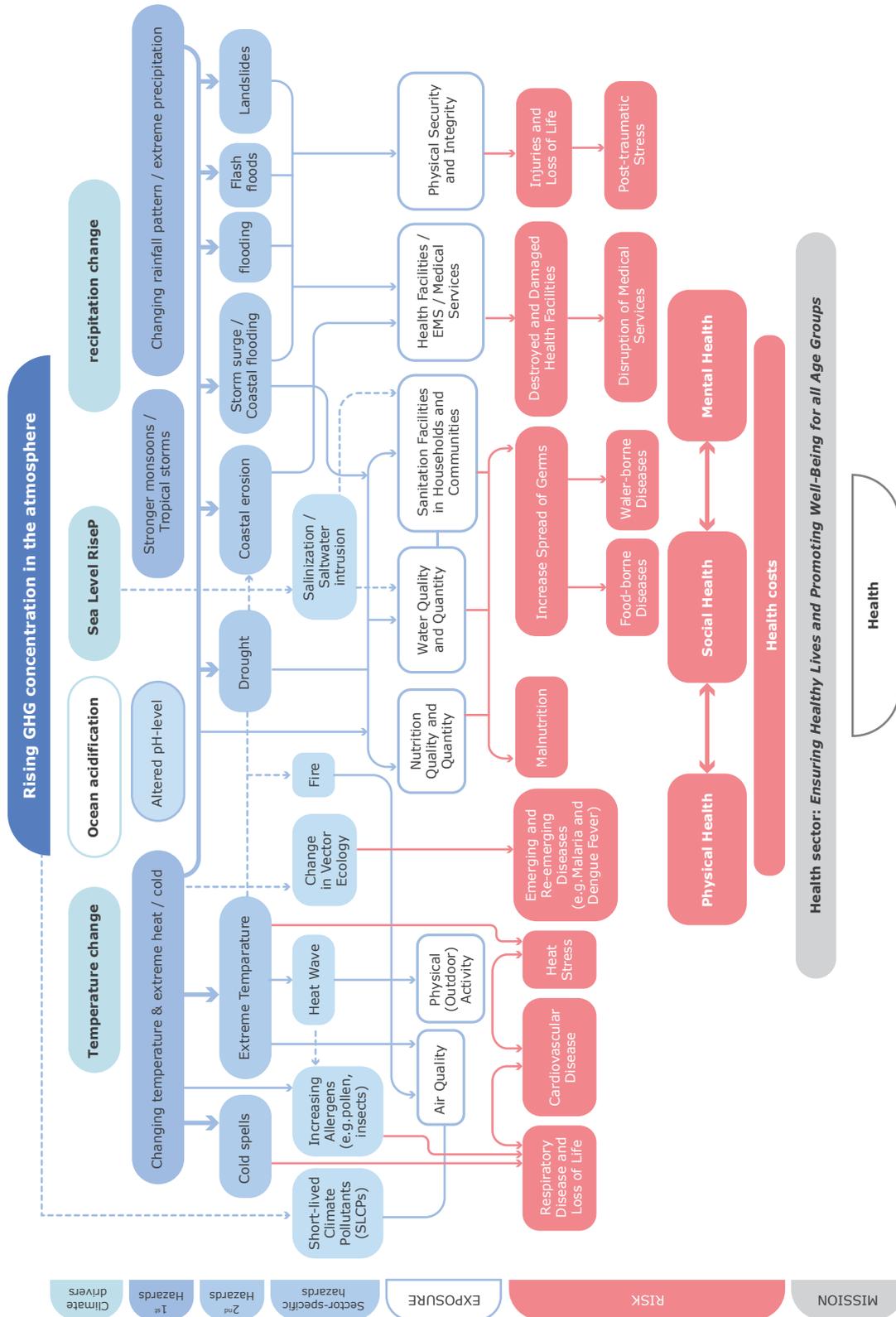


Figure 4-9: Impact chain analysis for public health sector in Thailand

Source: Office of Natural Resources and Environmental Policy and Planning (ONEP) and Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH (2016)

### 4.2.3.5 Natural resource management sector

The main climate hazards in the natural resource management sector include extreme temperature, drought, coastal erosion, storm surge/coastal flooding, variation in rainy season, landslides, floods, and excessive rainfall (Figure 4-10). The natural resources that are exposed to these climate hazards can be largely grouped into marine and coastal ecosystems, wetlands, and terrestrial ecosystems.

For marine and coastal ecosystems, examples of impacts include loss of coastal and marine species and ecosystems, decreased tourism demand, reduced fisheries productivity, changing livelihood of coastal population, and loss of natural nursery for species. For wetlands, examples of impacts include biodiversity loss, increased extinction of species, and food insecurity. For terrestrial ecosystems, examples of impacts include changing and shifting of habitat and interconnections between ecosystems and disturbing its functions and emerging diseases and their transmission from wildlife to livestock and humans.

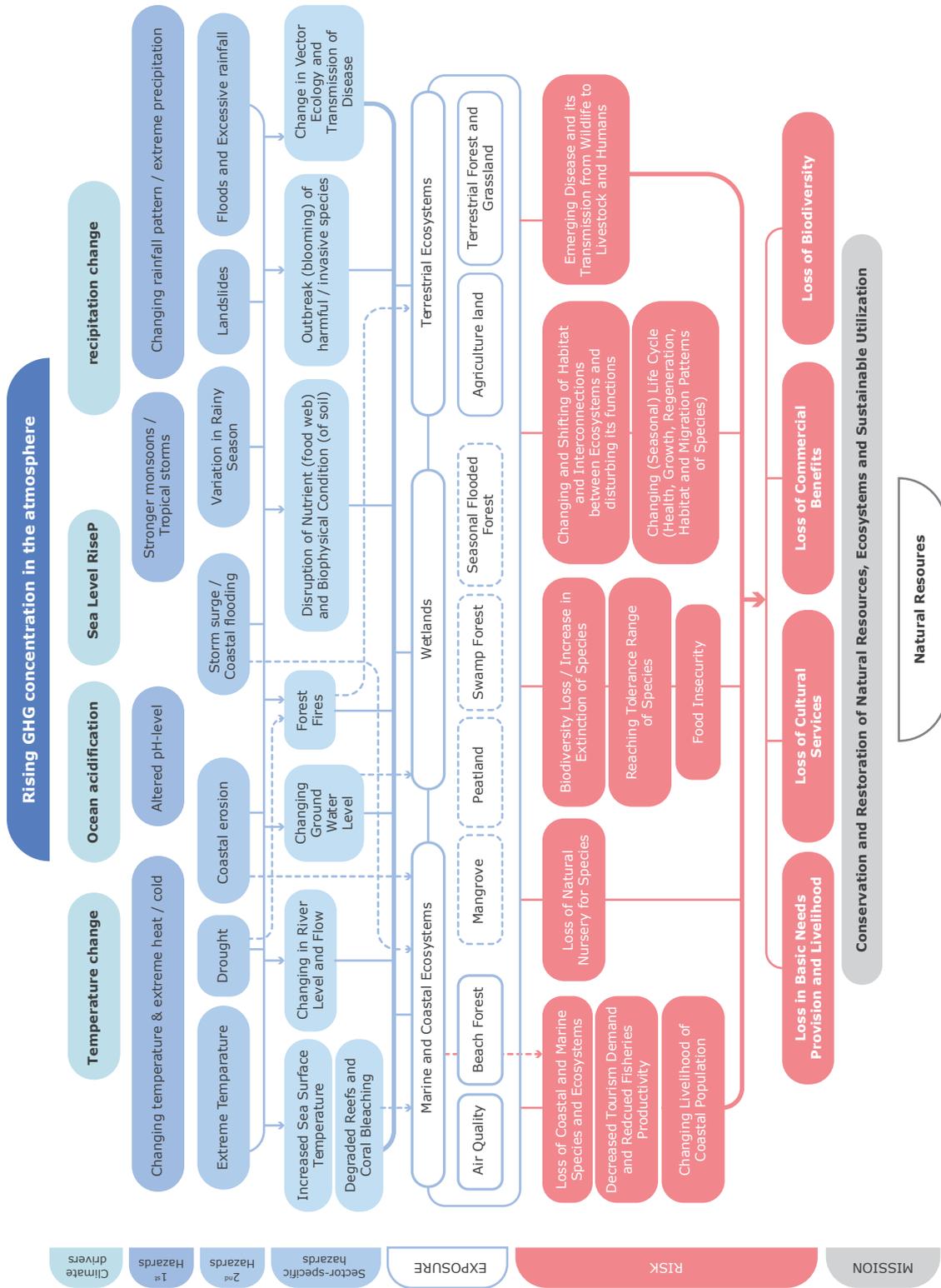


Figure 4-10: Impact chain analysis for natural resource management sector in Thailand

Source: Office of Natural Resources and Environmental Policy and Planning (ONEP) and Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH (2016)

### 4.2.3.6 Human settlement and security sectors

The main climate hazards in the human settlement and security sector include cold spells, extreme heat, drought, coastal erosion, storm surge/coastal flooding, flooding, flash floods, and landslides (Figure 4-11). Considering the exposure in the human settlement and security sectors, population, urban system and services as well as land use characteristics, spatial planning and infrastructure are exposed to the impacts of climate change. Examples of climate change impacts on population include injuries, loss of life and diseases. For the impacts of climate change on urban system and services, climate change can cause interruption of water supply for agriculture, industry and residential area as well as disruption of public services. For the impacts on land use characteristics, spatial planning and infrastructure, examples include damages and destruction of infrastructure and loss of public and private property.

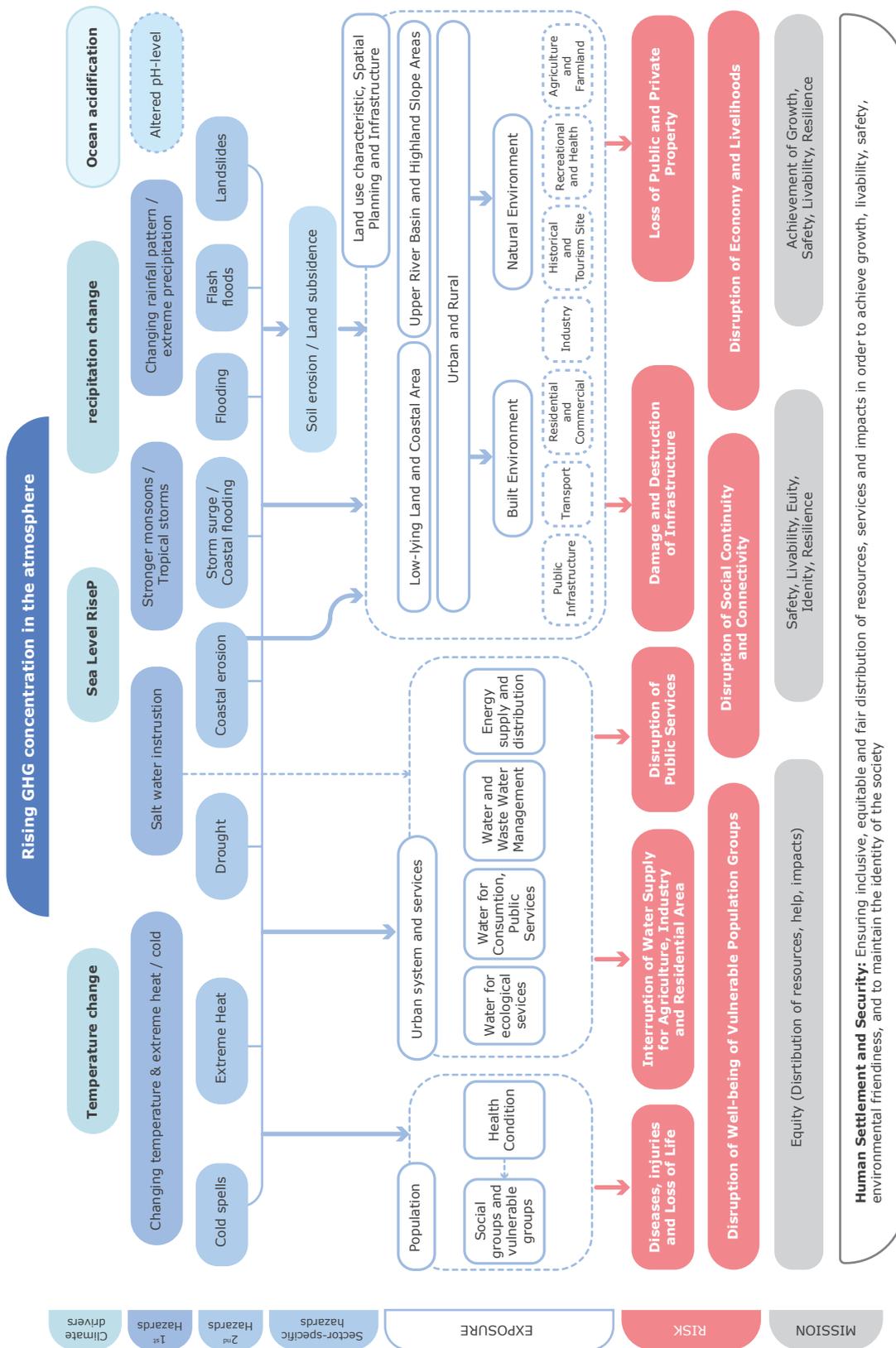


Figure 4-11: Impact chain analysis for human settlement sector in Thailand

Source: Office of Natural Resources and Environmental Policy and Planning (ONEP) and Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH (2016)

### 4.2.4 Methodology for Risk and Vulnerability Assessment

The risk and vulnerability assessments under this Fourth National Communication are based on the top-down approach, which is based on climate scenarios generated through the most updated version of the General Circulation Models (GCMs) available (Figure 4-12). The three GCM models used in this assessment include MPI-ESM-MR, EC-Earth, and HadGEM2-ES, and these three models are combined into “Ensembled.” Robust climate change scenarios are at the heart of the successful V&A assessment. To ensure that there are sufficient details for country-level V&A assessment, it is important that the GCMs are downscaled to a finer resolution for use at a national level. Dynamical downscaling of 3 models provided by the SEACLID/CORDEX SEA Phase II project: MPI-ESM-MR model, EC-Earth model, and HadGEM2-ES model were used, and 2 Representative Concentration Pathways (RCPs) were considered, i.e., RCP4.5 and RCP8.5. The future climate projections are under 4 timeframes 1970-2005, 2016-2035, 2046-2065, and 2081-2099.

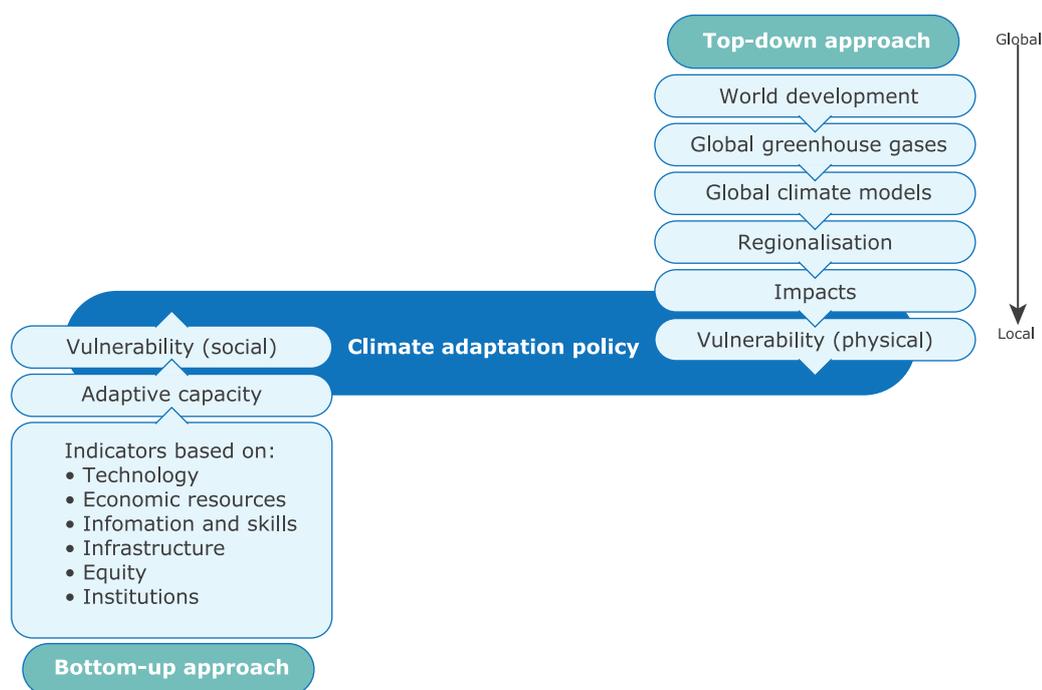


Figure 4-12: Top-down vs. Bottom-up approaches to vulnerability assessment

Source: UNFCCC “Guidelines for the Preparation of National Communications from Parties not included in Annex I to the Convention”

Vulnerability is separated into 2 categories, physical/biophysical vulnerability and inherent/social vulnerability. The former is the potential damage to a system caused by a specific event involving a physical hazard or disaster or climate catastrophe, whereas the latter is the state of the system that exists prior to exposure to danger or danger, which are indices indicating the internal workings of the system and explains the structures that make the society or ecosystem sensitive to external harm or damage. Their relationship can be summarized as follows:

$$\text{Biophysical vulnerability} = f(\text{hazard} \times \text{social vulnerability})$$

Biophysical vulnerability shares many characteristics with the framework for risk, which is the likelihood of danger or disaster and its consequences. Risks are calculated as follows:

$$\text{Risk} = \text{biophysical vulnerability} = \text{probability of hazards} \times (\text{loss/consequences})$$

The risk maps developed by ONEP and RU-CORE are based on the 2007 IPCC's definition of vulnerability: "Vulnerability is the degree to which a system is susceptible to and unable to cope with adverse effects of climate change, including climate variability and extremes." By this definition, vulnerabilities are a function of exposure, sensitivity, and adaptive capacity. Figure 4-13 shows the framework used to develop risk maps. It was mentioned earlier that the impacts and risks of climate change are uneven and non-homogeneous across sectors. These risk maps show that impacts and risks of climate change are also uneven and non-homogeneous across regions and time horizons. As will be shown later, different provinces and regions in Thailand are impacted differently by the risks of flooding, drought, and heat, and the impacts vary over time.

Risks are influenced by climate drivers and non-climate drivers. These two factors are calculated and weighed on their direct and indirect risks, and transformed into visual risk maps. The umbrellas under which risks are presented are heat, flooding, drought, and all three risks combined. Direct and indirect risks were calculated for 6 sectors: water management, agriculture and food security, tourism, public health, natural resource management, and human settlement.

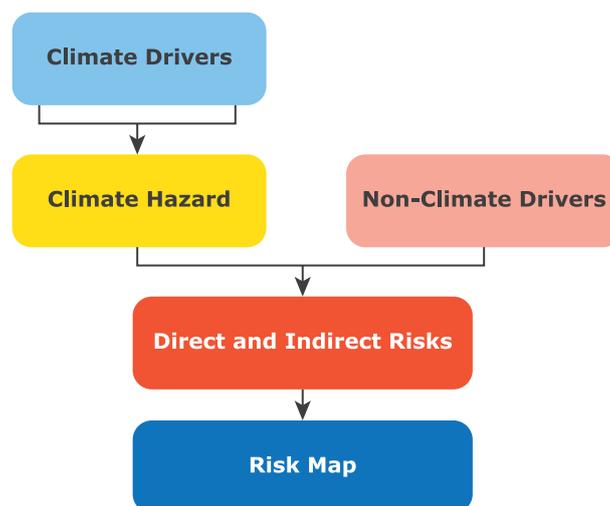


Figure 4-13: Risk map development framework

Source: Office of Natural Resources and Environmental Policy and Planning (ONEP) and Ramkhamhaeng University Center of Regional Climate Change and Renewable Energy (RU-CORE) (2021)

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For all the 6 sectors, 3 types of climate hazards are considered: high temperature (heat), drought, and flooding. Several climate indices are used in the calculation of risk indices. Examples of these climate indices are mean maximum temperature, annual contribution from wet days, maximum 1-day precipitation, and consecutive dry days. The number and nature of non-climate drivers vary across sectors, such as water demand and land area for the agricultural sector and number of tourists and number of tourism sites for the tourism sector. The numbers of non-climate indices in each sector are summarized in Table 4-1.

Table 4-1: Non-climate indices used in the calculation of risk indices

Sector	Heat	Flooding	Drought
Water management	11	24	28
Agriculture and food security	6	13	18
Tourism	3	12	9
Public health	9	10	10
Natural resources management	2	3	3
Human settlement and security	16	20	18

Source: Office of Natural Resources and Environmental Policy and Planning (ONEP) and Ramkhamhaeng University Center of Regional Climate Change and Renewable Energy (RU-CORE) (2021)

Each index was scaled to a province-level and then normalized to a value between 0-1 using the maximum-minimum normalization technique. All indices were added together using an additive model and normalized again to a value between 0-1. Both the climate and non-climate risks were then added together to create the risk index.

Process of risk map development started by adjusting the climate indices from the 25 x 25km grid to show province-level averages. Next, the heat, drought, and flood hazard indices were calculated. The heat, drought, and flooding hazard indices were used to calculate the combined hazard index. The non-climate indices were developed for each province. Next, non-climate indices were calculated regarding their relationship to each hazard type, namely heat, flooding, and drought. Lastly, combined risk indices are calculated, which are a product of the heat, flooding, and drought risk indices. All the risk maps for the 6 sectors and for 3 hazard types are presented in the Appendix. For each sector, two Representative Concentration Pathways (RCPs) are considered, i.e., the RCP4.5 and RCP8.5 scenarios. Four time horizons are considered, namely 1970-2005, 2016-2035, 2046-2065, and 2081-2099. The risk maps under three GCM models – MPI-ESM-MR, EC-Earth, and HadGEM2-ES – and “Ensembled” model are shown. In each sector, the risk maps for heat, flooding, and drought are presented as well as the overall risk map.

## 4.2.5 Climate change risks by sector

### 4.2.5.1 Water management sector

Water management is linked to climate change in many aspects. As mentioned earlier, climate change leads to changes in water availability, disruption of water supply, agricultural harvest failure, disruption of water logistic, damage to infrastructure, as well as conflicts on water use among sectors. Nevertheless, the impacts of climate change in the water management sector are non-homogeneous across regions and provinces in Thailand as shown in the following risk maps.

In assessing the risks of climate change in the water management sector, 7 categories of non-climate factors were considered: access to water resources, population, physical characteristics, areas at high risk of water-related disasters, socio-economic conditions, agricultural land conditions, and infrastructure. A total of 40 non-climate variables were used, divided into 11 variables related to heat, 20 related to flooding, and 28 related to drought. These variables are in accordance with the “Climate Risk Assessment for Ecosystem-based Adaptation: A guidebook for planners and practitioners” as well as expert opinions.

Figures A-1 in the Appendix shows the heat risk maps for the water management sector based on the Ensembled model under RCP4.5 and RCP8.5 and under 4 timeframes, i.e., 1970-2005, 2016-2035, 2046-2065, and 2081-2099. Central provinces, especially Bangkok and surrounding areas, and provinces in the Northeastern region, particularly Nakhon Ratchasima and Ubon Ratchathani, are at higher risk of heat than the rest of the country under both RCP4.5 and RCP8.5 pathways. Figure A-2 shows the flood risk map in the water management sector. Provinces at high risk of flooding under both RCP4.5 and RCP8.5 are scattered in the Central, Northeastern, Northern and Southern parts of Thailand, especially Nakhon Ratchasima, Nakhon Sri Thammarat, Bangkok, and Chiang Mai. For the drought risk map in the water management sector, Figure A-3 shows that the provinces at the highest risk of drought in the water management sector are Nakhon Ratchasima, Bangkok, and Khon Kaen. Generally, the northeastern region is at the highest risk of drought in water management sector. Figure A-4 presents the overall risk map for the water management sector. According to the overall risk maps, under both RCP4.5 and RCP8.5, the top 5 provinces at the highest risk are Nakhon Ratchasima, Bangkok, Ubon Ratchathani, Khon Kaen, and Nakhon Sawan. Most of these high-risk provinces, except Bangkok, are in the Northeastern regions, showing that the Northeastern region is relatively at higher risk in the water management sector than the rest of the country.

### 4.2.5.2 Agriculture and food security sectors

The agricultural sector faces many challenges, such as unstable commodity prices and adverse impacts of climate change. Agriculture is closely linked to climate change: on the one hand, agricultural sector emits greenhouse gases, and at the same time, agricultural production is affected by heat, floods, droughts, sea level rise, and other climate-related hazards. As mentioned earlier, fisheries and aquaculture, crops, and livestock are affected differently by climate change. Examples of impacts of climate

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change on capture fisheries and aquaculture include changes in fish species population as well as changes in the quality and quantity of fisheries. For livestock, the quality and quantity of livestock are affected by climate change. Climate change might affect crop production during the growing phases and cause post-harvest loss. Table 4-2 summarizes the risk factors and the impacts of climate change on crops, livestock, and aquaculture. However, impacts of climate change in the agriculture and food security sectors are non-homogeneous across regions and provinces in Thailand, as shown in the following risk maps.

**Table 4-2:** Examples of impacts of climate change on crops, livestock, fisheries and aquaculture in Thailand

Type of agriculture	Crops	Livestock	Fisheries and Aquaculture
Risk factors	<ul style="list-style-type: none"> <li>• Start of rainy season</li> <li>• Daily minimum- maximum temperatures</li> <li>• Off-season storms</li> </ul>	<ul style="list-style-type: none"> <li>• Temperature</li> <li>• Availability and quality of fresh water sources</li> </ul>	<ul style="list-style-type: none"> <li>• Temperature</li> <li>• Salinity</li> <li>• Amount of sediment</li> <li>• Light intensity</li> <li>• Acidity</li> </ul>
Impacts	Wet season rice: affected by early season rain	Pigs: heat stress can lead to increased water consumption and lower fertility	Shrimp: increased vulnerability to disease and stunted growth
	Dry season rice: affected by end-season temperature	Cows: higher temperatures can increase calf mortality rate and affect reproductive systems	Fish: high temperature can increase mortality and salinity can affect sex determination
	Cassava: excess precipitation can lead to rotting	Chicken: heat stress increases disease vulnerability	Crabs, shellfish, cephalopods: growth and mortality affected by temperature and salinity
	Sugar cane: longer dry season can lead to dehydration		
	Corn: affected by unpredictable start of the rainy season and spread of disease and pests		

For the agricultural sector, 19 non-climate factors were considered in the assessment, such as number of registered farmers, farmland size, areas prone to repeated drought and flooding, level of damages from flooding and drought. 5 indices are associated with heat hazard, 10 indices with flooding, and 16 with drought.

Figure A-5 in the Appendix shows the heat risk index map for the agricultural sector under the Ensembled model, RCP 4.5 and RCP8.5 pathways and 4 timeframes, i.e., 1970-2005, 2016-2035, 2046-2065, and 2081-2099. As shown in the figure, the top seven provinces most at risk of heat in the agricultural sector are in the Northeastern region of Thailand, namely Nakhon Ratchasima, Ubon Ratchathani, Buriram, Khon Kaen, Si Sa Ket, Surin, and Roi Et. Figure A-6 shows the flood risk index map for the agricultural sector. As shown in the figure, Nakhon Ratchasima, Khon Kaen, and Nakhon Sawan are among the provinces

with the highest flood risk. The provinces at the fourth and the fifth highest flood risk are Ubon Ratchathani and Nakhon Sri Thammarat, which are in the Northeastern and Southern parts of Thailand, respectively. For the drought risk maps, Figure A-7 shows that four out of 5 provinces at the highest risk of drought in the agricultural sector are in the Northeastern region, namely Nakhon Ratchasima, Ubon Ratchathani, Khon Kaen, and Buriram, while Nakhon Sawan is in the Central region. The overall risk maps for the agriculture and food security sectors are presented in Figure A-8. According to Figure A-8, the provinces at the highest risk in the agricultural sector are Nakhon Ratchasima, Ubon Ratchathani, Khon Kaen, and Buriram, which are in the Northeastern region of Thailand.

#### **4.2.5.3 Tourism sector**

Tourism sector has close connections to the environment and climate; thus, climate change affects tourism sector in various ways, both directly and indirectly. Since climate is one of the factors determining the suitability of locations for tourist activities and the driver for seasonality in tourism demand, climate change can lead to changes in the length and quality of climate-dependent tourist attractions. Climate change can lead to disruptions of outdoor tourism activities, loss of cultural tourist attractions and amenities, loss of natural characteristics and attractiveness, and reduced diversity of natural resources. Increases in the frequency or magnitude of extreme weather can also affect the tourism industry through increased infrastructure damage, additional emergency preparedness requirements, higher operating expenses, and business interruptions. Examples of impacts of climate change on public and private services include interruption of transport system, injuries and loss of life, disruption of public services, and conflicts with local communities over resource uses. Nevertheless, impacts of climate change in the tourism sector are non-homogeneous across regions and provinces in Thailand as shown in the following risk maps.

In Thailand's context, the important hazards are heat, flooding, and drought, with each tourist activity and tourist attraction facing different levels of risk. The key categories of non-climate drivers include number of tourists, tourist attractions by type, area characteristics, and economic impacts. However, each of the 3 climate hazards comprises of different indices.

Figure A-9 in the Appendix shows the heat risk maps for the tourism sector based on the Ensembled model under RCP4.5 and RCP8.5 and under 4 timeframes, i.e., 1970-2005, 2016-2035, 2046-2065, and 2081-2099. As shown in the figure, the top 3 provinces at the highest risk of heat in the tourism sector are Trat, Bangkok, and Phuket. For the flood risk maps, according to Figure A-10, the top 3 provinces at the highest risk of flooding in the tourism sector are Surat Thani, Chiang Mai, and Trat. For the risk of drought in the tourism sector, Figure A-11 shows the drought risk maps for the tourism sector. As shown in Figure A-11, the top 3 provinces at the highest risk of drought in the tourism sector are Nakhon Ratchasima, Bangkok, and Khon Kaen. In terms of overall risk in the tourism sector, Figure A-12 shows the overall risk index map for the tourism sector. According to Figure A-12, the provinces at the highest risk in the tourism sector are Bangkok, Surat Thani, and Trat under RCP4.5, and Bangkok, Surat Thani, and Phuket under RCP8.5.

### 4.2.5.4 Public health sector

Climate change affects human health and well-being both directly and indirectly. As mentioned earlier, the impacts of climate change on human health are as follows. Climate change affects health through changes in air quality, impacts on nutrition quality and quantity, water quality and quantity, sanitation facilities in households and communities, health facilities and medical services, as well as physical security and integrity. Examples of climate change impacts on health include respiratory diseases, heat stress, cardiovascular disease, emerging and re-emerging diseases, malnutrition and increased spread of germs, disruption in medical services, injuries, or loss of life. However, impacts of climate change in the public health sector are non-homogeneous across regions and provinces in Thailand as shown in the following risk maps. Four categories of non-climate indices considered in the public health sector are population demographic, health status, culture and quality of life, and sufficiency and accessibility to resources.

Figure A-13 in the Appendix shows the heat risk maps for the public health sector based on the Ensembled model under RCP4.5 and RCP8.5 and under 4 timeframes, i.e., 1970-2005, 2016-2035, 2046-2065, and 2081-2099. As shown in Figure A-13, the top 5 provinces at the highest risk of heat are Bangkok, Nakhon Ratchasima, Ubon Ratchathani, Buriram and Khon Kaen; thus, four out of five provinces at the highest risk of heat in the public health sector are in the Northeastern region of Thailand. For flood risk maps in the public health sector, Figure A-14 shows that the top 5 provinces at the highest risk of flood in the public health sector are Bangkok, Nakhon Ratchasima, Ubon Ratchathani, Nakhon Sawan and Chiang Mai.

Figure A-15 shows the drought risk maps for the public health sector. According to Figure A-15, the top 5 provinces at the highest risk of drought in the public health sector are Bangkok, Nakhon Ratchasima, Ubon Ratchathani, Khon Kaen and Buriram, which are from the Northeastern region of Thailand, except Bangkok. For the overall risk maps in the public health sector, Figure A-16 shows that the top 5 provinces at the highest risk in the public health sector are Bangkok, Nakhon Ratchasima, Ubon Ratchathani, Khon Kaen and Buriram, which are mostly from the Northeastern region of Thailand.

### 4.2.5.5 Natural resource management sector

Thailand has a rich abundance of natural resources, many of which are threatened by climate change. Effects such as temperature fluctuations, changes in precipitation, and sea level rise affect both terrestrial, wetland as well as marine and coastal ecosystems. Climate change affects the terrestrial ecosystems by threatening forests and wetlands. Heat and drought threaten both forests and wetlands, causing loss of settlements, species especially endemic species, and biodiversity. Mangrove forests, beaches, sea grass, and corals, which are parts of the marine and coastal ecosystems, are also threatened by the effects of climate change. For marine and coastal ecosystems, examples of impacts include loss of coastal and marine species and ecosystems, decreased tourism demand, reduced fisheries productivity, changing livelihood of coastal population, and loss of natural nursery for species. For terrestrial ecosystems, examples of impacts include changing and shifting of habitat and interconnections between ecosystems and disturbing its functions and emerging diseases and their transmission from wildlife to livestock and humans. Nevertheless, impacts of climate change in the

natural resource management sector are non-homogeneous across regions and provinces in Thailand as shown in the following risk maps.

In the natural resource management sector, 8 non-climate factors are used in the assessment, which can be divided into 2 factors for heat, 3 factors for flood and 3 factors for drought. Figure A-17 in the Appendix shows the heat risk maps for the natural resource management sector based on the Ensembled model under RCP4.5 and RCP8.5 and under 4 timeframes, i.e., 1970-2005, 2016-2035, 2046-2065, and 2081-2099. As shown in the figure, the top five provinces at the highest risk of heat in the natural resource management sector are Ubon Ratchathani, Chiang Mai, Tak, Lampang, and Kanjanaburi. For the flood risk maps in the natural resource management sector, as shown in Figure A-18, the top 3 provinces at the highest risk of flood in the natural resource management sector are Chiang Mai, Tak and Mae Hong Son. Figure A-19 shows the drought risk maps for the natural resource management sector. As shown in the figure, under the RCP4.5, the top three provinces at the highest risk of drought are Ubon Ratchathani, Nakhon Ratchasima and Udon Thani, while under the RCP8.5, the top three provinces at the highest risk of drought are Ubon Ratchathani, Nakhon Ratchasima and Chiang Mai. For the overall risk map in the natural resource management sector, Figure A-20 shows the overall risk maps for the natural resource management sector. According to Figure A-20, the top 3 provinces at the highest risk of flood in the natural resource management sector are Chiang Mai, Ubon Ratchathani and Tak. The fourth and the fifth places under RCP4.5 go to Lampang and Kanjanaburi, respectively. While the fourth and the fifth places under RCP8.5 go to Kanjanaburi and Lampang, respectively.

#### **4.2.5.6 Human settlement and security sectors**

According to Noor and Fatima (2011), climate change and human settlement are linked through several dimensions, such as health, water sources, city infrastructure. As mentioned earlier, some examples of climate change impacts on human settlement include injuries, loss of life, diseases, interruption of water supply, disruption of public services, damages and destruction of infrastructure and loss of public and private property. Yet, these impacts of climate change on human settlement are non-homogeneous across regions and provinces in Thailand as reflected through the following risk maps. There are 2 types of risk factors in the development of risk maps for human settlement sector: climate risk, such as heat, flooding and drought, and non-climate risk such as urban sprawl and population density.

Figure A-21 in the Appendix shows the heat risk map for the human settlement and security sector based on the Ensembled model under RCP4.5 and RCP8.5 and under 4 timeframes, i.e., 1970-2005, 2016-2035, 2046-2065, and 2081-2099. According to Figure A-21, the top 5 provinces at highest risk of heat are Bangkok, Nakhon Ratchasima, Samut Prakan, Buriram and Chonburi, which are largely in the Northeastern and Central regions. Figure A-22 shows the flood risk map for the human settlement and security sector. According to Figure A-22, under RCP4.5, the top 5 provinces at highest risk of flood are Bangkok, Nakhon Ratchasima, Chiang Mai, Nakhon Sri Thammarat and Chiang Rai. However, under RCP8.5, the top 5 provinces at highest risk of flood are Bangkok, Nakhon Ratchasima, Nakhon Sri Thammarat, Chiang Mai and Samut Prakan. For the drought risk

maps for the human settlement and security sectors, according to Figure A-23, the top 3 provinces at the highest risk of drought in the human settlement and security sector are Bangkok, Nakhon Ratchasima and Khon Kaen. The fourth and the fifth places under RCP4.5 go to Samut Prakan and Ubon Ratchathani, respectively, while under RCP8.5, the fourth and the fifth places go to Roi Et and Samut Prakan, respectively. For the overall risk map for the human settlement and security sector, as shown in Figure A-24, the top 4 provinces at the highest overall risk in the human settlement and security sector are Bangkok, Nakhon Ratchasima, Samut Prakan and Khon Kaen both under RCP4.5 and RCP8.5. However, the fifth rank under RCP4.5 goes to Ubon Ratchathani, while the fifth rank under RCP8.5 goes to Ayutthaya.

### 4.3 Implementation of Adaptation Actions and Plans

#### 4.3.1 Water management sector

In the past, most water resource management strategies implemented in Thailand have been concentrated on the structural measures, as well as finding new water reserves and community-based water management.

##### 4.3.1.1 Structural adaptation measures

###### 1. Designating areas as flood detention

Certain areas of the country are designated as flood detention, such as Bang Rakam District in Phitsanulok province or Bang Ban District in Ayutthaya province. In Thailand, flood detention areas are conceived as agricultural lands which are intentionally inundated for a short period of time to protect downstream areas from flooding. By storing water in this flood detention areas, flood movement is slowed. Farmers in the basin areas are instructed to shift their crop calendars accordingly and receive some compensation from the Royal Irrigation Department, either in cash or in kind. For in-kind compensation, farmers who shifted their crop calendar are ensured to have water for their cultivation. However, there are currently no laws that determine the level of in-cash compensation.

###### 2. Water diversion tunnels

These tunnels connect different drainage basins to drain water from one to another to collect and reserve them. Examples include the Prasae-Khlong Yai project and the Khlong Yai-Dok Krai-Nong Pla Lai project in the Eastern part of Thailand. Water from the Prasae River that is supposed to end up flowing into the sea is diverted and stored in the Nong Pla Lai Reservoir.

###### 3. Solving saltwater intrusion

The Khlong Lat Pho Floodgate Project and Bang Pakong Dam are examples of structural measures that help to prevent flood and push saltwater out of the waterways and nearby irrigation systems. However, the latter led to coastal erosion and so was unsuccessful.

### 4.3.1.2 Non-structural adaptation measures

#### 1. Community water management

The Hydro-Informatics Institute (Public Organization) and the local communities jointly drafted water management plans with the goal of creating water reserves for use during the dry season. This enables the community to have income during the dry season, such as by planting crops with low water requirement, and strengthens the community by creating a water management network. At present, there are over a thousand such networks, including notable ones such as the Baan Lim Thong in Buriram province and Baan Sala Din in Pathum Thani province.

#### 2. Establishment of an early warning system

The Thai Meteorological Department and the Royal Irrigation Department work together to develop a database, combine data from the National Hydroinformatics Data Center, and develop models for forecasting daily and seasonal rain. However, there needs to be further development for higher spatial resolution, as currently estimates can only be made at the provincial level rather than the district level.

### 4.3.2 Agriculture and food security sectors

Climate change and climate variability have direct impacts on agricultural production. From drought and flooding to saltwater intrusion, which affects increasingly large areas, the impacts on the Thai agricultural sector are worsening; therefore, it is very crucial that the agricultural sector in Thailand adapt to climate change. Adaptation measures in the agricultural sector are categorized into crops, livestock, and fisheries.

#### Crops

**1. Improving crop varieties** that are resistant to pest or drought-tolerant crops to increase yield and reduce costs of production. Relevant governmental agencies have been developing and testing these new crop varieties to ensure that they can be grown in different environment and growing contexts, as well as promoting marketing for those crops. This includes using crop models, which simulate different areas' circumstances such as soil quality and type, temperature, and water quality.

**2. Plantation management** such as adjusting fertilizer and pesticide use, using larger-scale farming to reduce costs, and changing crop calendar. For example, in the Bang Rakam District in Phitsanulok province, farmers will strategically shift their crop calendar by planting rice early to avoid the flooding season.

#### 3. Development of biotechnologies for farmers

**4. Improving infrastructure for farmers** especially regarding water supply, such as improving irrigation systems to cover a larger area and digging wells.

### Livestock

**1. Closed-system farming** for livestock such as cows and buffaloes to improve management of pastures, feeding, and manure, as well as to prevent this livestock from exposing to high temperature

**2. Development of heat-resistant livestock**

### Fisheries

**1. Shifting the method of fish rearing** from rivers and canals to cages or closed systems. This enables better water management and testing.

**2. Management of physical environment and water quality** that affect coastal fishing

For the agriculture and food security sector, the highlighted adaptation measure is under the Thai Rice NAMA project. Summary of the good practices and lessons learned from this is contained in Box 1.

#### **Box 1: Good Practice for Climate Change Adaptation in Agriculture and Food Security Sector**

In the agricultural sector, one adaptation measure to be highlighted as good practice is under the Thai Rice NAMA project. In irrigated rice production, flooding of paddy fields leads to significant emissions of methane, which has a global warming potential (GWP) 28 times higher than carbon dioxide according to IPCC Fifth Assessment Report (AR5), and involves excessive use of water. The implementation strategies under the Thai Rice NAMA project involves 4 main technologies, i.e., laser land leveling, alternate wetting and drying (AWD), site-specific nutrient management, straw & stubble management) and integrated pest management. The AWD is a water controlling technique originally developed to save irrigation water use in paddy field (Bouman and Tuong 2001). This technique controls surface water level not to fall below a soil depth of 15 cm. Water consumption and methane emission were reported to be effectively reduced (e.g., LaHue et al. 2016). As water shortage especially in the dry season is common in Thailand, available water for rice field irrigation is becoming limited. In addition, extreme climatic events, such as drought and shift in rainfall distribution pattern, have been widespread in recent decades and imposed a significant threat to water resources management, especially for rice cultivation in the future (IPCC 2012; Thailand Research Fund (TRF) 2016). Therefore, the AWD technique helps in mitigating for GHG emissions and increasing water use efficiency in rice cultivation.

### 4.3.3 Tourism sector

Several climate change adaptation measures in the tourism sector have been proposed, namely shifting from natural and climate-dependent tourist attractions and activities to man-made attractions or tourism activities that do not rely on suitable climate, such as gastronomic tourism, cultural tourism, etc., development of early warning system, development of climate-resilient infrastructure around the tourism sites, etc. The climate change adaptation measures in the tourism sector can in fact take various forms, ranging from technical adaptation to research or managerial adaptation. Technical adaptation puts emphasis on using technology to adapt to climate change, such as early warning systems, weather forecasts, storm-resistant buildings, and rainwater recycling systems. Examples of managerial adaptation measures are water conservation, closing tourism sites at certain times of the year, and using weather forecasts to plan for different tourist activities. For educational measures, examples include educating tourists and tourism businesses on how to adapt to and reduce the impacts of climate change, such as training hotel staff and tourists about how to save water. For research-based adaptation measures, examples in Thailand include tracking coral bleaching and seawater quality. For adaptation measures that emphasize behavioral changes, in the case of Koh Mak Island in Trat province, tourists and tourism businesses are encouraged to change their behavior by conserving water.

At present, several relevant government agencies in Thailand are implementing climate change adaptation in tourism sector. For examples, the Ministry of Tourism and Sports is supporting the transition toward man-made tourist attractions. The Fine Arts Department has projects that rehabilitate the historical tourist attractions from natural disasters, especially flood. However, looking into the future, potential adaptation measures would be promotion of community-based and creative tourism using local history, cultures, and uniqueness of the tourist destination to draw visitors and add value to the location. As opposed to mass tourism, visitors can have a more personal experience and gain a deeper understanding of the place they are visiting. It also lessens the pressure on natural resources.

### 4.3.4 Public health sector

Adaptations to climate change in the public health sector consist of 2 levels, namely individual level, and system level. Climate change adaptation at the individual level refers to situation in which people are given knowledge on how to protect themselves from climate-related hazards, while adaptation at the systems level, includes developing databases, studying the relationship between climate change and area-specific vulnerabilities, warning systems, and surveillance. Thailand has developed and used various technologies in the public health sector to adapt to climate change. Examples are presented in Table 4-3. For the public health sector, the highlighted adaptation measure is heat warning system as shown in Box 2.

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Table 4-3: Adaptation technologies in the public health sector

Technology	Details
1. A simple, community-level extreme weather alert tool	An easy to use, affordable tool that can measure temperature, relative humidity, heat, and health impact level that shows results in real time and records data continuously.
2. Heat and smog early warning system in the upper north area	A system that uses information from 112 measuring stations in 9 provinces in the upper Northern region of Thailand for forecasting heat index and PM <sub>10</sub> . The warning criteria is divided into 4 categories and the results shown on Google Maps.
3. Thermal index processing program	This program will import temperature and relative humidity data between 10:00 AM and 7:00 PM from 74 Meteorological Department monitoring stations using the API to calculate and display the heat index. The results are shown on Google Maps.
4. A simple toolkit for monitoring heat at the community level.	The tool kit consists of (1) a thermometer and a relative humidity meter, (2) a WBGT chart, and (3) a table of health effects. The measurements are fast and simple, and the results can be instantly communicated to the community.
5. Development of heat health warning criteria and systems for Thailand.	The maximum temperature 3 days in advance from the Meteorological Department is compared with the health impact monitoring value from heat. The temperatures are divided into 4 levels, which are surveillance level (35-38 °C), alarm level (38.1-40.0 °C), danger level (40.1-43.0 °C) and very dangerous level (43.1°C). The information is then communicated to the public.
6. Community-level heat warning system	This system uses the same criteria as number 5. above, and is operated in March. The process is as follows: (1) Prepare the working group, details of the weather forecast, identify vulnerable groups, and alert the warning network (2) if the alarm is at level 2, the system will issue 1 warning. If it is at level 3, 3 warnings will be issued daily through channels such as the Village Health Volunteers and public announcements. In addition, when the temperature is higher than 40 °C, home visits will be made.
7. Health Data Center	A big data system consisting of 6 components as follows: (1) Population health information (2) Health status, infection of significant communicable diseases (3) Service use rate of in/outpatients (4) Accessibility of the public health services (5) Maternal and infant health and nutrition (6) Reported mortality rate in 298 disease groups.
8. Emergency and disaster response systems in medicine and public health	This system has an operation side consisting of medical and public health professionals and a coordination side operated by the central government to connect public health agencies at all levels. There is an Emergency Medical Service, Medical Emergency Response Team (MERT), mini-MERT, and Mental Health Crisis Assessment and Treatment Team (MCATT).
9. Infectious Diseases Surveillance System	This system is a surveillance and utilization system at all levels to detect anomalies, respond to emergencies and improve public health programs that address critical issues from the grassroots to the national level. The infectious disease surveillance system covers nine diseases, some of which are linked to climate change.
10. Mosquito nets	Mosquito nets are used widely and are effective at reducing infection and death rates from malaria.

**Box 2: Good Practice for Climate Change Adaptation in Public Health Sector**

For the public health sector, examples of good practice for climate change adaptation are the development of criteria and mechanism for heat warning as well as the heat warning system at the community level in Thailand. The first part is related to the development of heat health warning criteria and heat warning system. Under this project conducted by the Department of Health, Ministry of Public Health, research on the health impact of heat is used in setting up critical threshold for temperature that should trigger heat warning. In addition, this project also involves development of measures to mitigate the health impacts of heat on the general Thai population and the vulnerable groups, such as elderly, young children, etc. The second related project is the project that emphasizes the heat warning system at the community level. Under this project, manual for heat surveillance and warning was developed and heat warning is issued to relevant government agencies and public through the Department of Health website and Facebook fan page of the Department of Health.

**4.3.5 Natural resources management sector**

Most natural resource management adaptation measures consist of conservation, restoration, and sustainable utilization, as well as encouraging participation of different sectors related to natural resources, mainly those under the Ministry of Natural Resources and Environment. These include the Department of National Parks, Wildlife and Plant Conservation, responsible for forests and mangroves in protected areas and national forest reserves, the Department of Marine and Coastal Resources, responsible for marine and coastal areas, and the Natural Resources and Environmental Policy and Planning office, responsible for preserving biodiversity and climate change planning and policies. The actions taken by these agencies to adapt to climate change include:

**1. Establishing protected areas** both on land and at sea, such as national parks and wildlife sanctuaries, and establishing protected areas while allowing sustainable use especially in areas with ecological vulnerabilities. Doi Luang Chiang Dao, a mountain in Chiang Mai, is one example of this; more are added regularly.

**2. Forecast and warning systems** such as warning for forest fires by the Department of National Parks, Wildlife and Plant Conservation and Forestry Department and coral bleaching warning by the Department of Marine and Coastal Resources.

**3. Modeling climate change long-term impacts on forest ecosystems** in the form of a research project at the local level with the aim of establishing buffers and natural connecting corridors.

**4. Long-term resource monitoring** to gather data for management planning, both for terrestrial ecosystem and marine and coastal ecosystem.

**5. Developing technological infrastructure to conserve and sustainably utilize biodiversity** such as the National Biobank that contributes information to the Thailand biodiversity infrastructure (TH-BIF) and the Genome Bank that stores credible biodiversity data for species conservation and research, such as the Sarus Crane.

### 4.3.6 Human settlement and security sectors

Adaptation to climate change in the human settlement and security sector takes place at 3 main levels, namely individual/household, community, and city-wide.

#### 1. Adaptation at the individual/household level

The adaptation actions at the individual or household level depend on the awareness and situation of the individual or household, such as raising the floor of the house, building a flood prevention wall, having a second home, etc.

#### 2. Adaptation at the community level

Examples of climate change adaptation at the community level are making a walkway along the riverbank or planning to allocate community areas to accommodate the impacts of climate change. However, adaptation at the community level requires information and mechanisms to support participation, such as financing mechanism to support adaptation action. Thailand has funding systems/funds to support climate change adaptation, such as loan dedicated for post-disaster renovation. The Stable Home Project of the Community Organizations Development Institute also provides funding for home improvements to reduce the impact of disasters and the development of infrastructure, facilities and public services.

#### 3. Adaptation at the city level

As urbanization increases, cities are adapting to cope with the impacts of climate change, such as creating public spaces, green areas, and infrastructure systems such as dams and drainage systems.

For the human settlements and security sector, an example of a city in Thailand which has concrete actions on climate change adaptation in human settlement is Udon Thani province (see Box 3).

#### **Box 3: Good Practice for Climate Change Adaptation in Human Settlement and Human Security Sector**

Udon Thani is a city with high economic expansion due to the increasing population. As a result, the need for water is increased as well, coupled with climate pressure. Consequently, Udon Thani faces problems with urban flooding, periods of rain and water shortages, which sometimes lead to conflicts among water users. As a result, urban services such as waterworks, waste disposal and wastewater management are at risk of not being able to support the rapid growth of the city of Udon Thani. In response, Udon Thani has established a data center system to inform decision making by integrating space utilization planning and the design of institutions that can adapt and respond to future climate change risks, including brainstorming with stakeholders from various sectors in the district in city planning. Their recommendations are as follows:

(1) **Water management** such as improving reservoirs or creating new microcities for urban areas, development of integrated rainwater management to meet the increasing demand for water supply.

(2) **Wastewater treatment plants** placement in appropriate areas.

(3) **Network of green areas** that connects to water sources and gives better access.

(4) A **“dynamic plan”** in the Thai planning system to support sustainable development in flood-prone areas.

(5) **Developing incentive mechanisms** to stimulate local government organizations to provide reliable, standardized information.

(6) **Establishment of an expert organization** that can provide reliable information and integrate adaptation ideas into law, to create effective enforcement in city planning.

#### 4.4 National adaptation priorities, strategies, policies, plans, goals, and actions

Given that Thailand is among the ten countries most vulnerable to climate risk over the 2000–2019 period, Thailand has put climate change adaptation at the top national agenda. Thailand has formulated the Climate Change Master Plan (2015–2050), which is a long-term policy framework to enhance low carbon emission and climate resilient society. The Climate Change Master Plan (2015–2050) was approved by the Cabinet on 14<sup>th</sup> July 2016. The Climate Change Master Plan (2015–2050) sets out 3 key strategies including climate change adaptation, greenhouse gas mitigation and low carbon development, and enabling environment for climate change management. Under the climate change adaptation strategy, adaptation measures and guidelines for 6 sectors were developed, namely water resources management, agriculture and food security, tourism, public health, natural resource management, and human settlement and security.

To provide clearer guidelines and framework on climate change adaptation, ONEP developed the National Adaptation Plan (NAP). The main objective of the NAP is to provide guidance for mainstreaming climate change adaptation at sectoral and sub-national level as well as guidance for budget allocation to finance climate change adaptation related projects and programs. The NAP was approved by the National Climate Change Committee on 19<sup>th</sup> November 2018. The vision of the NAP is “Thailand is resilient with adaptive capacity to climate change impacts; and moves toward sustainable development.” The NAP is composed of 3 missions: 1) to build climate-resilient development, by enabling the integration of climate change adaptation guidelines and strategies in all sectors at all levels; 2) to strengthen capacity and awareness of development partners at all levels to implement policies and plans on climate change effectively; and 3) to develop databases, research, knowledge, and technology to support climate change adaptation. Moreover, guidelines and measures of the NAP provide framework for climate change adaptation actions and the foundation to support relevant agencies to take actions. They are divided into 6 key sectors related to the adaptation strategy under the Climate Change Master Plan (2015–2050), which are 1) water management, 2) agriculture and food security, 3) tourism, 4) public health, 5) natural resources management, and 6) human settlements and security. Table 4 contains a summary of targets and approaches for climate change adaptation in each sector.

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Table 4-4: Targets and approaches for climate change adaptation under the NAP

Sectors	Targets	Approaches
Water management	Increased water security and decreased losses and damage from water-related disasters	1.Upstream management 2.Midstream and downstream management 3.Downstream management 4.Support mechanisms for water management
Agriculture and food security	Productivity and food security maintained amidst climate change risks and impacts	1.Cropland Management 2.Livestock farm management 3.Fisheries and aquaculture management 4.Support mechanisms for agriculture and food security
Tourism	Strengthened capacity of the tourism sector toward climate-resilience and sustainable development	1.Natural attractions management 2.Man-made attractions management 3.Support mechanisms for tourism
Public health	Effective public health systems to manage risks and reduce impacts from climate change established	1.Prevention of climate change impacts on health 2.Support mechanisms for public health
Natural resources management	Sustainable management of biodiversity resources to respond to climate change impacts	1.Terrestrial ecosystems management 2.Wetland ecosystems management 3.Marine and coastal ecosystems Management 4.Support mechanisms for natural resources management
Human settlements and security	Enhanced capacity of individuals, communities, and cities, to adapt to climate change impacts appropriately according to the local context	1.Metropolises and cities management 2.Towns and communities management 3.Support mechanisms for human settlements and security

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

Provided that climate change adaptation is a long-term process and takes time, the period of implementation under NAP is designed to be aligned and consistent with the National Strategy and the National Economic and Social Development Plan. The implementation period can be divided into 3 periods, namely the preparation period (2018-2021), the implementation period (2022-2026) and the achieving goals period (2027-2037). The preparation period emphasizes on laying a foundation and pushing policy actions. The implementation period puts emphasis on the development mechanisms and capacity building. Finally, the achieving goals period puts emphasis on actions to achieve outcomes and goals. Figure 4-14 shows the underlying principles and the objectives for climate change adaptation in each of the 6 sectors. The key principles include sufficiency economy, sustainable development, human right and gender responsiveness, community-based adaptation, proactive principle, resource efficiency, good governance and public participation, local wisdom, and ecosystem-based adaptation.

To ensure efficiency and effectiveness in implementation of sectoral and area-based climate change adaptation, sectoral focal points were determined. Details of these focal points are contained in Table 5. Relevant agencies in these sectors are now in the process of formulating specific sectoral plans to address climate change. For example, with funding from BMU and collaboration between FAO, UNDP and the Office of Agricultural Economics, the agriculture sector is developing an updated and more robust climate change strategy and action plan for agriculture to align to the Climate Change Master Plan (2015-2050) and as sectoral input into the NAP. Similarly, the Health National Adaptation Plan phase 1 (2021-2030), which is also aligned with the Climate Change Master Plan (2015-2050), places great emphasis on the development of National Public Health and Climate Change System: Promotion, Prevention, Treatment, and Rehabilitation.

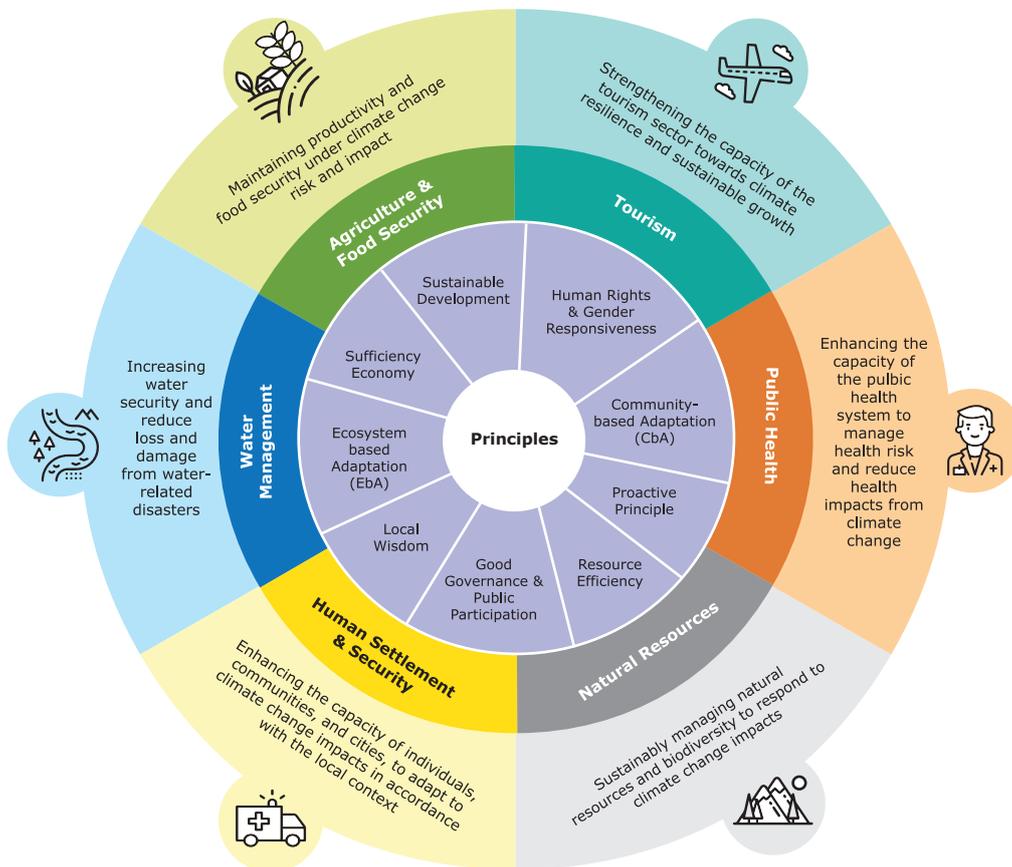


Figure 4-14: Key principles and goals of climate change adaptation in each sector

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

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Table 4-5: Sectoral focal points for climate change adaptation under the NAP

Sectors	Sectoral Focal Points
Water management	Office of the National Water Resources
Agriculture and food security	Office of Agricultural Economics, Ministry of Agriculture and Cooperatives
Tourism	Department of Tourism, Ministry of Tourism and Sports
Public health	Department of Health, Ministry of Public Health
Natural resources management	Office of the Permanent Secretary of Ministry of Natural Resources and Environment, Ministry of Natural Resources and Environment
Human settlement and security	Department of Public Works and Town & Country Planning, Ministry of Interior

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

In addition to the Climate Change Master Plan (2015–2050) and the National Adaptation Plan, there are sectoral plans that are linked to climate change adaptation, i.e., the Health National Adaptation Plan (HNAP), Phase 1 (2021–2030) in the public health sector and the Agriculture Strategic Plan on Climate Change (ASPCC) 2017–2021 in the agriculture and food security sectors. Brief information about these two sectoral plans are as follows.

### Health National Adaptation Plan (HNAP)

The Health National Adaptation Plan (HNAP), phase 1 (2021–2030) provides crucial guidelines enabling the multisectoral partnership to strengthen and build health resilience from climate change. This plan consists of 4 strategies and details of these strategies are contained in Table 4-6.

Table 4-6: Strategies under the Health National Adaptation Plan (HNAP) Phase 1 (2021–2030)

Strategies	Goals	Approaches and Implementation
1. Strengthening community and their skills in adaptation and health literacy to cope with health risks from climate change	The citizens have health literacy and skills to take care of themselves and their community. <ul style="list-style-type: none"> <li>Vulnerable groups receive climate-related health protection and are able to adapt promptly.</li> </ul>	To develop know-how and participation from the community in climate-related health prevention and treatment <ul style="list-style-type: none"> <li>To enhance the primary health care system in order to develop skills, increase participation, and improve the quality of life for the people in the community</li> </ul>
2. Integrating the resources of all sectors to proficiently drive public health implementation climate change	Public health management at all levels is effective and efficient in response to climate change.	<ul style="list-style-type: none"> <li>To coordinate with all sectors across the country to drive public health implementation for climate change</li> <li>To integrate resources within public health sector and other sectors to drive public health policies</li> <li>To strengthen Thailand as a center for climate-related health risk management in ASEAN</li> </ul>

**Table 4-6:** Strategies under the Health National Adaptation Plan (HNAP) Phase 1 (2021-2030) (cont'd)

Strategies	Goals	Approaches and Implementation
3. Strengthening public health preparedness for climate change to support economic and social development and security	The risk areas are equipped with public health management for climate change on an international standard.	<ul style="list-style-type: none"> <li>• To increase management efficiency and capacity of the public health system to support the risk areas from climate change</li> <li>• To support climate change-related public health management according to sustainable development framework</li> </ul>
4. Developing the national public health system in response to climate change on an international standard	<ul style="list-style-type: none"> <li>• Public health facilities are efficiently developed.</li> <li>• Innovations for climate change-related public health management are available.</li> <li>• The costs of climate change-related health issues decrease.</li> </ul>	<ul style="list-style-type: none"> <li>• To build leadership, good governance, and fiscal system to respond to climate change</li> <li>• To build mechanisms and develop public health laws and regulations to manage climate change-related health risks</li> <li>• To develop information technology and health surveillance system to monitor and assess health impacts</li> <li>• To develop medical technologies and innovations for patients with climate change-related diseases</li> </ul>

Source: Health National Adaptation Plan, Phase 1 (2021 – 2030)

The vision under the Agriculture Strategic Plan on Climate Change (ASPC) 2017-2021 is “Thailand’s agriculture has climate resilience and contributes to mitigating climate problems under the sustainable development pathways.” The Agriculture Strategic Plan on Climate Change 2017-2021 has 4 strategic issues. Details of each strategic issue are contained in Table 4-7.

Table 4-7: Strategies under the Agriculture Strategic Plan on Climate Change 2017-2021

Strategic issues	Goals	Strategies	Development guidelines
1. Database, knowledge, and technology – collection, development, and building up databases, knowledge and technology to raise awareness of climate change	Have the database, knowledge, technology and awareness to cope with climate change	Strategy 1.1: Collect, develop and building the database to cope with climate change	1.1.1 Gathering information, knowledge and local wisdom from research and scholarly work related to climate change adaptation in agriculture and synthesize information for decision making that are consistent with the changing context in the agricultural sector 1.1.2 Promote participatory research 1.1.3 Develop the collection system for greenhouse gas accounting in the agricultural sector
		Strategy 1.2: Create and develop technologies to combat climate change	1.2.1 Develop maps of climate risk 1.2.2 Develop the accurate weather index 1.2.3 Develop early warning systems that are easily accessible 1.2.4 Promote participatory research to contribute to the development of technologies related to precision agriculture and improvement of breeding 1.2.5 Promote the integration of technologies to link and use across systems
		Strategy 1.3: Raise the awareness on climate change	1.3.1 Preparation of promotional materials to raise awareness of climate change impacts to each target group 1.3.2 Organize the forum for knowledge exchange and dissemination of research results 1.3.3 Promote the transfer of information, knowledge and technology developed for climate change adaptation to the highly vulnerable provinces 1.3.4 Develop the manual of adaptation guideline for farmers, private sector and related businesses
2. Adaptation Actions – increasing the ability of farmers, farmers’ institutions, and related businesses to adapt to climate change	Enhancing the efficient use of agricultural resources and adaptation of agriculture in the context of current climate change	Strategy 2.1: Water management to reduce the impact of climate change	2.1.1 Promote participation in the integration of water management in agriculture and other sectors 2.1.2 Develop research that links agriculture with water management 2.1.3 Promote the increase of efficiency and development of irrigation infrastructure 2.1.4 Promote the construction of water reservoirs/ponds for rainwater harvesting of farmers 2.1.5 Promote the development of performance indicators for efficiency of water use in agriculture
		Strategy 2.2: Soil sustainable management	2.2.1 Prevent soil degradation 2.2.2 Rehabilitation of degraded soils by providing an assessment of soil and land degradation, and restore soil conditions 2.2.3 Maintaining ecosystem services from soil, adequacy of water and water quality 2.2.4 Promote soil fertility to its natural maximum level 2.2.5 Promote training, develop knowledge, and create innovation for sustainable soil management 2.2.6 Increase awareness on importance of soil
		Strategy 2.3: Strengthening the climate resilience for adaptation	2.3.1 Use the developed climate-risk maps 2.3.2 Study the appropriate climate risk insurance packages 2.3.3 Promote the development of the appropriate climaterisk insurance. 2.3.4 Develop the climate-resilient index for the agricultural sector to climate change 2.3.5 Promote integrated farming and sustainable agriculture 2.3.6 Promote studies analyzing the costs and benefits of alternatives using precision agriculture 2.3.7 Promote technology transfer for precision agriculture combined with local wisdom 2.3.8 Promote the transfer of knowledge to farmers 2.3.9 Promote the transfer of adaptation guidelines

**Table 4-7:** Strategies under the Agriculture Strategic Plan on Climate Change 2017-2021 (cont'd)

Strategic issues	Goals	Strategies	Development guidelines
		Strategy 2.4: Develop measures to support the adaptation of farmers and businesses	2.4.1 Develop fair and appropriate measures to compensate for those who have been negatively affected by water distribution 2.4.2 Promote the development of measures, mechanisms, and proper infrastructure to support the adaptation 2.4.3 Promote the development of monitoring and evaluation system and the guidelines in coping with the international trade and investment measures
3. Mitigation Actions – contributing to reducing greenhouse gas emissions and developing an environmentally friendly growth model	Greenhouse gas emissions in the agricultural sector are reduced.	Strategy 3.1: Modify agricultural technology that is environmentally friendly and contributes to the reduction of greenhouse gas emissions	3.1.1 Promote and support low carbon soil management 3.1.2 Promote, support and enhance potentials of producing crops, livestock and fisheries, as well as managing residues, animal manure and waste in the appropriate approach to reduce greenhouse gas emissions 3.1.3 Promote the production of biofuels 3.1.4 Promote and encourage farmers to obtain the Good Agricultural Practice (GAP) 3.1.5 Reduce the burning in agricultural production processes 3.1.6 Promote low-carbon postharvest management
		Strategy 3.2: Marketing for low-carbon products	3.2.1 Develop mechanisms to create incentives for producing and consuming of low-carbon agricultural products 3.2.2 Campaign, encourage and support changing the consumption behavior toward low-carbon agricultural products 3.2.3 Create production standard and standard for low-carbon agricultural products and food 3.2.4 Promote and provide market to support low-carbon agricultural and food products 3.2.5 Study the establishment of the unified-standard center for agricultural production and matching the certified low carbon products to buyers
4. Driving mechanism – strengthening the capacity of agriculture managers to cope with climate change	Driving the climate change strategic plan in agriculture to achieve its goals with higher level of effectiveness and efficiency	Strategy 4.1: Strengthen human resources and developmental partners	4.1.1 Create the training curriculums on climate change 4.1.2 Convey knowledge and skills related to climate change 4.1.3 Develop the action plan for human resource development on climate change and development under low-carbon to all related bodies

Source: Agriculture Strategic Plan on Climate Change (ASPCC) 2017-2021

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In terms of disaster management, two main mechanisms are in place in Thailand, namely the Disaster Prevention and Mitigation Act 2007 and the National Plan on Disaster Prevention and Mitigation 2021-2027. The core concepts behind the National Plan on Disaster Prevention and Mitigation 2021-2027 are the Disaster Risk Reduction (DRR) and the Build Back Better and Safer. The National Plan on Disaster Prevention and Mitigation 2021-2027 puts high emphasis on building capacity of local administration and community engagement in disaster management, which will contribute to resilience, sustainable disaster management and compliance with international guidelines. The National Plan on Disaster Prevention and Mitigation 2021-2027 is consistent with the Sustainable Development Goals (SDGs), the Sendai Framework for Disaster Risk Reduction 2015-2030, the National Strategy 2018-2037, the Master Plan under the National Strategy 2018-2037, the 12<sup>th</sup> National Economic and Social Development Plan, the Disaster Prevention and Mitigation Act 2007 and the Smart DRM for 3s: SEP-SDGs-SFDRR. There are 5 strategies under the National Plan on Disaster Prevention and Mitigation 2021-2027 with details as shown in Table 4-8.

**Table 4-8:** Strategies under the National Plan on Disaster Prevention and Mitigation 2021-2027

Strategy	Details of Strategy
Strategy 1: Disaster risk reduction	Guidelines for policies, measures, activities and strategies to reduce the probability of adverse impacts from disaster
Strategy 2: Increasing efficiency in the management system and application of disaster innovation	Using management system and innovation to enhance capacity in disaster prevention and disaster risk management. Emphasis is placed on people-centered approach and engagement of stakeholders.
Strategy 3: Supporting international partnership in management of disaster risk	Enhancing the disaster management in accordance with the international practices and guidelines
Strategy 4: Integrated emergency management	Encountering with disaster and relieving impacts from disasters
Strategy 5: Enhancing sustainable rehabilitation	Restoration of public infrastructure and livelihood of disaster affected communities during the post-disaster period to ensure building back better and safer and resilience city or community

Source: National Plan on Disaster Prevention and Mitigation 2021-2027

#### 4.5 Adaptation Priorities and Barriers

The barriers and challenges in the implementation of adaptation can be divided into two types, i.e., sector-specific challenges and cross-cutting challenges. Table 4-9 summarizes a summary of barriers and challenges in the implementation of adaptation actions in each sector.

Table 4-9: Barriers and challenges in the implementation of adaptation actions in each sector

Sector	Barriers and Challenges
Water management	<ul style="list-style-type: none"> <li>Given that there are several government agencies involved in the water resource management, integration and coordination in the execution and implementation of adaptation actions play a crucial role. However, at present, there is still limited integration and coordination among water management related agencies.</li> </ul>
Agriculture and food security	<ul style="list-style-type: none"> <li>Thai farmers lack knowledge in adapting to climate change and cannot access technologies that help them adapt to climate change</li> <li>Thai farmers lack access to capital or finance that is necessary for implementing adaptation actions</li> </ul>
Tourism	<ul style="list-style-type: none"> <li>Tourists and tourism businesses lack knowledge of the impact of climate change on the tourism sector as well as knowledge on how to adapt to climate change.</li> <li>Inadequate dissemination and communication of climate change impacts to domestic and international tourists as well as the tourism businesses.</li> <li>Tourism businesses lack access funding to finance the adaptation activities and the preparation of climate-resilient infrastructure.</li> </ul>
Public health	<ul style="list-style-type: none"> <li>Public health personnel still lack awareness and knowledge of the relationship between climate change and public health.</li> <li>Limited research on the climate-related diseases</li> <li>Lack of central database on the impacts of climate change on human health both at the national and local level</li> </ul>
Natural resource management	<ul style="list-style-type: none"> <li>Limited knowledge and research on the impacts of climate change on ecosystems – both terrestrial and marine and coastal ecosystems.</li> <li>Environment-related government agencies at the local level lack funding, personnel and knowledge to implement adaptation measures to prevent natural resources and ecosystems from impacts of climate change.</li> </ul>
Human settlement and security	<ul style="list-style-type: none"> <li>Lack of downscaled climate change data at the local level to be used for climate change adaptation planning</li> </ul>

The cross-cutting barriers and challenges in the implementation of adaptation measures in Thailand are as follows:

- **Limitation of knowledge:** the personnel that are key to the implementation of adaptation measures lack knowledge of the impacts of climate change and the appropriate adaptation measures.

- **Lack of continued financial support:** some multi-year adaptation projects lack continued financial support, slowing down the progress of adaptation actions.

- **Lack of central database:** different government agencies have their own climate change data and lack coordination and integration of data on climate change projection and impacts.

- **Lack of national climate information center:** Thailand does not have national information center that compiles climate-related information.

- **Lack of access to adaptation technologies:** not all adaptation technologies are accessible by stakeholders

### 4.6 Recommendations and Support Needed

So far, there have been several adaptation initiatives undertaken in water management, agriculture, tourism, health, ecosystem, and human settlements and security in Thailand, being those at the policy and planning level or actions on the ground. However, there have also been barriers and challenges encountered in terms of insufficient institutional capacities, limited knowledge and understanding of climate change adaptation, ineffective system coordination, fragmentation of projects with discontinued funding supports, and inadequate monitoring and evaluation system. Given the implementation challenges combined with projected climate risks in both the near and far future, it is essential that the whole national system for climate change adaptation be strengthened to effectively and timely address the current and emerging “Shocks” in order to prevent losses and damages to its economy, society, and environment. The section below puts forward key recommendations for addressing the barriers and challenges earlier indicated.

#### 4.6.1 Key recommendations

##### 1. System and Mechanism

Although the National Adaptation Plan (NAP) and related adaptation strategic plans have been well formulated to provide a clear policy direction and guidance for climate adaptation actions across sectors in Thailand, they need to be supported with a system that is unified and effective, being able to connect all related agencies with well-functioning coordination mechanisms, common and accessible databases and research information, knowledge sharing and innovation platforms, network of experts, financing plans, and M&E system. Currently, the existing system has not well functioned, and both general knowledge and technical capacities of related government agencies in respect of climate adaptation have not been aligned to one another, resulting in fragmentation of programme and projects formulated, budget allocated, and investments undertaken. Insufficient coordination among agencies has currently hindered synergy for collective efforts, and also efficiency of resource utilization (e.g. personnel, finance, etc.).

The national M&E system should be established to assess overall implementation challenges and constraints, and to provide policy makers and main stakeholders with accurate, evidence-based reporting, lessons learned, and knowledge sharing of ongoing interventions with early indications of progress or challenges in the achievement of results.

The existing capacity building program for government agencies should be reviewed and strengthened to be more strategic, aimed at enhancing their comprehensions and competencies in designing and formulating adaptation related programmes and projects, integrating climate change adaptation into their existing functional programmes/projects, and being able to demonstrate adaptation co-benefits of their budget requests to the policy makers and budget related agencies. Essentially, there is a need to evaluate how the existing capacity building programme currently functions and how it can be improved to enhance the nation-wide adaptation capacities.

## **2. Budget**

With the current and future climate change risks projected, adaptation efforts require greater amount of budget due to increases in frequency and magnitude of impacts as well as multi-year investment requirements. However, the government budget is fairly constrained as Thailand is projected to face multi-facet challenges in the future, worsening the prospect for financing climate change adaptation. In this regard, the Thai government must be more innovative and strategic in fund mobilization and utilization to support adaptation actions.

In terms of fund mobilization, it is essential that innovative financing measures resting on fiscal and monetary instruments (e.g., taxes, bonds, etc.) as well as private innovative financing scheme (e.g., crowd funding) be initiated and experimented with an aim to supplement the existing public budget that is too small to accommodate the larger scale and magnitude of climate impacts. An emphasis should be placed on strategic short, medium, and long-term financing plans to determine suitable financing sources (e.g., domestic, international, private) and appropriate types for different interventions.

With regards to fund utilization, it is more efficient and effective if such limited government budget is geared toward investments that

- Are potentially beneficial to all related agencies; for example, investments in the central database system, climate downscaling, technical capacity building, and risk and vulnerability analysis. These types of investments would enhance cross-utilization by different agencies and can support their designs and formulation on effective policy and programme;
  - Target vulnerable regions/population/sectors specified in the risk map analysis;
  - Introduce technology that can be applicable and adaptable to different contexts;
  - Emphasize adaptation measures that can be implemented with low investment costs, but are highly shock responsive and also widely accessible to the public at large; and
- Generate good practices, lessons learned, and knowledge sharing, leading to upscaling, replication, and empowering innovation capacities.

### 4.6.2 Support Needed

Based on the above recommendations to strengthen Thailand's climate change adaptation system to effectively address the current and future climate risks, key areas urgently required for technical support can be identified as follows:

#### **1. Data system**

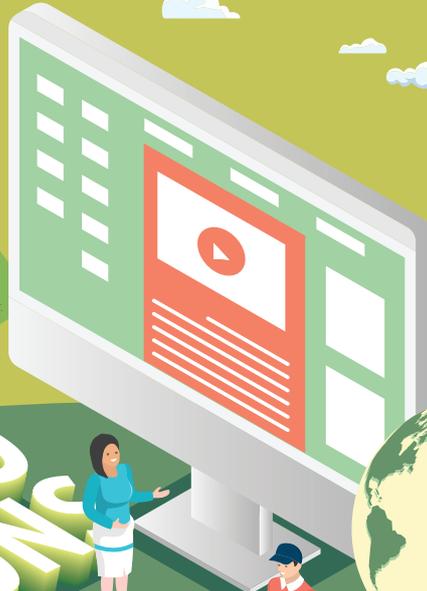
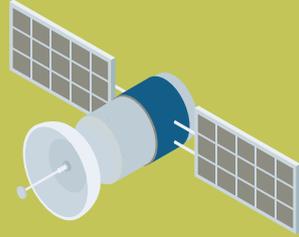
Technical support is required to strengthen the nationwide data system for climate change adaptation across different spatial scales and sectors which is reliable and up-to date, publicly available, and accessible by both national and sub-national government and non-government agencies. Normally, there are different stages for climate adaptation planning and implementation starting from (i) assessing climate impacts, vulnerability, risks, and resilience, (ii) planning for adaptation, (iii) implementing adaptation measures, and (iv) monitoring and evaluation (M&E) of adaptation measures. Each stage also requires different combinations of observed, forecast/projected, and historical climate and socio-economic data. Hence, there are still ample rooms for technical support to enhance both the provision of data (e.g., quality, availability, facilities, management, etc.) and the uptake/utilization of such data (e.g., capacity to interpret and analyze climate data for planning, programming, and decision making) across key adaptation sectors.

#### **2. Monitoring and Evaluation System**

Technical supports for designing and establishing the national monitoring and evaluation (M&E) system for climate change adaptation are essential for the long-term success and effectiveness of adaptation actions that are in line with the National Adaptation Plan and Strategy. Importantly, the M&E for climate change adaptation is different from other regular M&E in a sense that the time frames associated with climate change and the associated adaptation outcomes are likely to be longer. Moreover, there is uncertainty associated with the magnitude and nature of climate change, particularly at the local level, which can influence monitoring results and the ways in which they are evaluated. In addition, a continually changing climate means that traditional approaches to measuring change, such as comparing monitoring results to static baseline conditions, may not be possible, and a moving baseline must be considered. In this regard, there are challenges associated with the M&E for adaptation e.g., knowledge and understanding of budget and policy related agencies with respect to the long time scale of climate change and its impacts, capacities of related government agencies to formulate practical M&E process, etc., and thus technical supports are required to address such challenges.

### **3. Financing mechanisms**

Different venues for adaptation financing are essential for addressing the current constraint of the government budget. Normally, several adaptation actions require substantive upfront investments for climate-resilient infrastructure, and these may not yield immediate benefits (due to the longer time frame associated with climate change) envisaged by budget-related agencies and donors. Moreover, adaptation investments, in nature, tend to be public goods that cannot easily leverage finance from the private sector unless they are directly impacted. Also, several international climate-related funds target mitigation rather than adaptation activities as the former yield immediate results that can be realized now e.g., investments in energy efficiency improvements offer immediate energy cost savings. Therefore, it is essential that Thailand receives technical support to enhance the capacities of both finance and climate-related agencies to initiate innovative financing measures that could sustainably support adaptation investments in the future.



NET ZERO EMISSIONS



# CHAPTER 5

## OTHER INFORMATION AND RELEVANT ACTIVITIES

# CHAPTER 5: OTHER INFORMATION AND RELEVANT ACTIVITIES

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*Climate actions entail other relevant activities that complement and empower the implementation of mitigation and adaptation measures. These activities include technology development and transfer; research and systematic observation; education, training, public awareness, public participation, and public access to climate information; capacity building; and information sharing and networking.*

*To illustrate, Thailand cannot successfully implement mitigation and adaptation measures without having efficient climate technology or accurate climate knowledge and data to fully consider the vulnerability of the current situation and enable proper climate policy and decision-making process. Plus, the governmental agencies, the private sectors, and the public cannot embrace fundamental change in their practices and ways of living to reach carbon neutrality and climate resilience unless they have access to comprehensive and accurate climate knowledge and information.*

*This chapter depicts the policy frameworks, key activities, and international cooperation of Thailand's climate actions beyond mitigation and adaptation measures. First, it describes Thailand's development of climate technology database and roadmaps, key technology development, and its technology transfer mechanism. The climate technology roadmaps and development align with key sectors stated in Thailand's NDC and Thailand's NAP. Second, it reveals Thailand's research and systematic observation in climate variable sectors: atmospheric, terrestrial (i.e., land and water), and oceanic domains. Third, it articulates Thailand's Actions for Climate Empowerment (ACE) under Article 6 of the UNFCCC, the core foundation for addressing climate change. The ACE involves not only climate knowledge diffusion but also the environmental rights of the public to participate and access climate information. Fourth, it covers a capacity-building framework, national initiatives, and international cooperation. Finally, it explains how ONEP acts as a primary entity for climate information sharing and how Thailand cooperates and collaborates with international communities at bilateral, regional, and multilateral levels to address climate change issues.*

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## 5.1 Technology Development and Transfer

### 5.1.1 Climate Technology Database and Roadmap

As emphasized in the Convention and the Paris Agreement, technology development and transfer are essential elements supporting national climate actions, both for mitigating and adaptation measures. Climate technologies can facilitate GHG emission reduction and improve climate resilience. Aiming to promote technology development, Thailand founded the National Science and Technology Development Agency (NSTDA) and the Office of National Higher Education Science Research and Innovation Policy Council (NXPO), public agencies affiliated with the Ministry of Higher Education, Science, Research and Innovation (MHESI). The NXPO, or former National Science Technology and Innovation Policy Office (STI), is the National Designated Entity (NDE) of Climate Technology Centre and Network: CTCN under the Convention. Following the research

project on Technology Needs Assessment (TNAs) and Technology Action Plans (TAPs) for Climate Change Mitigation/Adaptation 2012, the NXPO has further elaborated Climate Mitigation Technology Database and Roadmap 2019 and Adaptation Technology Roadmap 2022.

Source: 1) Office of National Higher Education Science Research and Innovation Policy Council (NXPO) 2) National Science and Technology Development Agency (NSTDA)

Aligning with Thailand's Nationally Determined Contribution Roadmap on Mitigation 2021-2030, the Climate Technology Database and Roadmap 2019 was formulated for energy, transport, IPPU, and waste sectors with different key technology fields. The energy and transport sectors require technology development in 5 fields (i.e., public electricity and heat production; manufacturing industries and construction; oil and natural gas, energy consumption in residential, commercial, and agricultural sectors; and road transport) which mainly focus on the energy management system, energy efficiency, fuel switching, heat and power recovery, and renewable energy. The technology development in the IPPU sector centers on cement production, targeting material efficiency and recycling. The technology development in the Waste sector focuses on solid waste disposal on land and wastewater handling, targeting energy management systems, material efficiency and recycling, and energy efficiency.

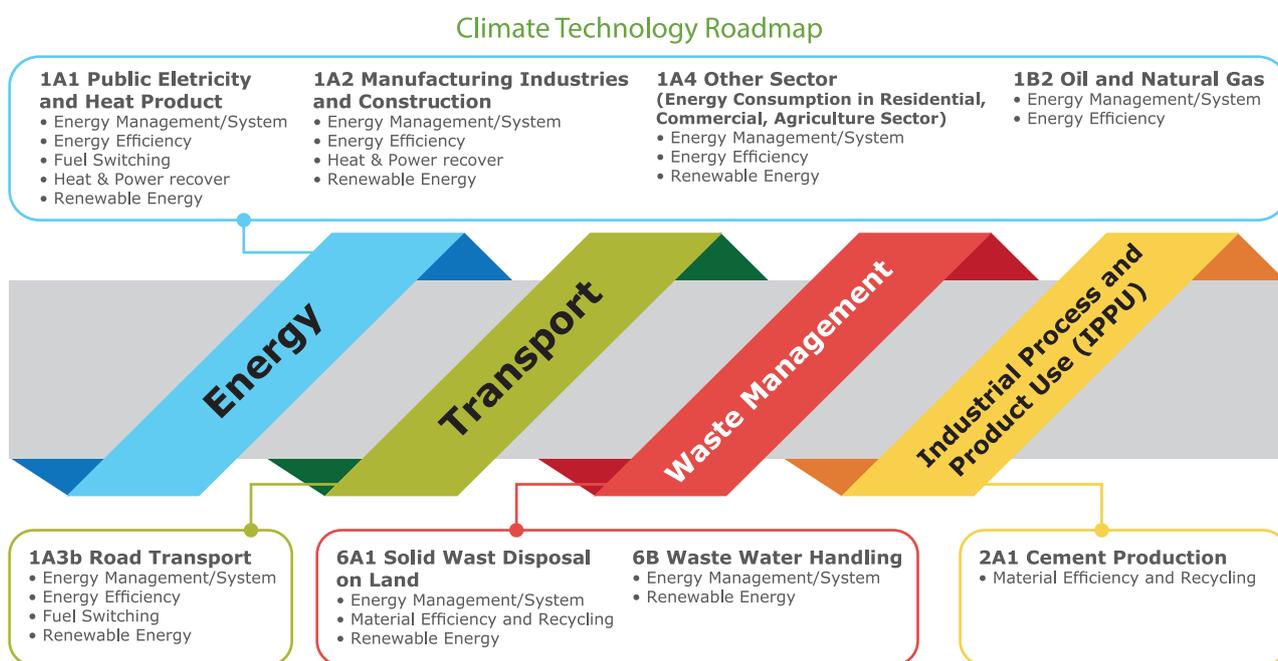


Figure 5-1: Overview of Climate Mitigation Technology Roadmap

Source: Climate Mitigation Technology Database and Roadmap 2019, Office of National Higher Education Science Research and Innovation Policy Council (NXPO)

## CHAPTER 5

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The roadmap laid out GHG mitigation options, targets, capacity gaps and barriers, technology options, current technology support, and resources in each technology development field.

For Energy and Transport sectors, the target technology can be exemplified as follow:

- *Public electricity and heat production: smart grid, energy storage, clean power plant, nuclear power plant, fuel cell, combined heat and power, and renewable energy*
- *Manufacturing industries and construction: motor and driving system, bioenergy, and burner, boiler, and steam system*
- *Oil and natural gas: enhanced oil injection and management and utilization*
- *Energy consumption in residential, commercial, and agricultural sectors: energy management in building, electrical appliances, bioenergy, solar heat, and solar PV*
- *Road transport: Internal Combustion Engine (ICE), electric vehicles, hydrogen and fuel cell, and bioenergy*

For the IPPU sector in cement production focusing on material efficiency and recycling, the target technology is clinker substitution. For the Waste sector, the target technology can be exemplified as follows:

- *Solid waste disposal on land: waste-to-energy, waste management and utilization, Refuse Derived Fuel (RDF), and reduce-reuse-recycle*
- *Wastewater handling: biogas and Vent/Flare Gas Recovery System (FGRS)*

# THAILAND'S FOURTH NATIONAL COMMUNICATION

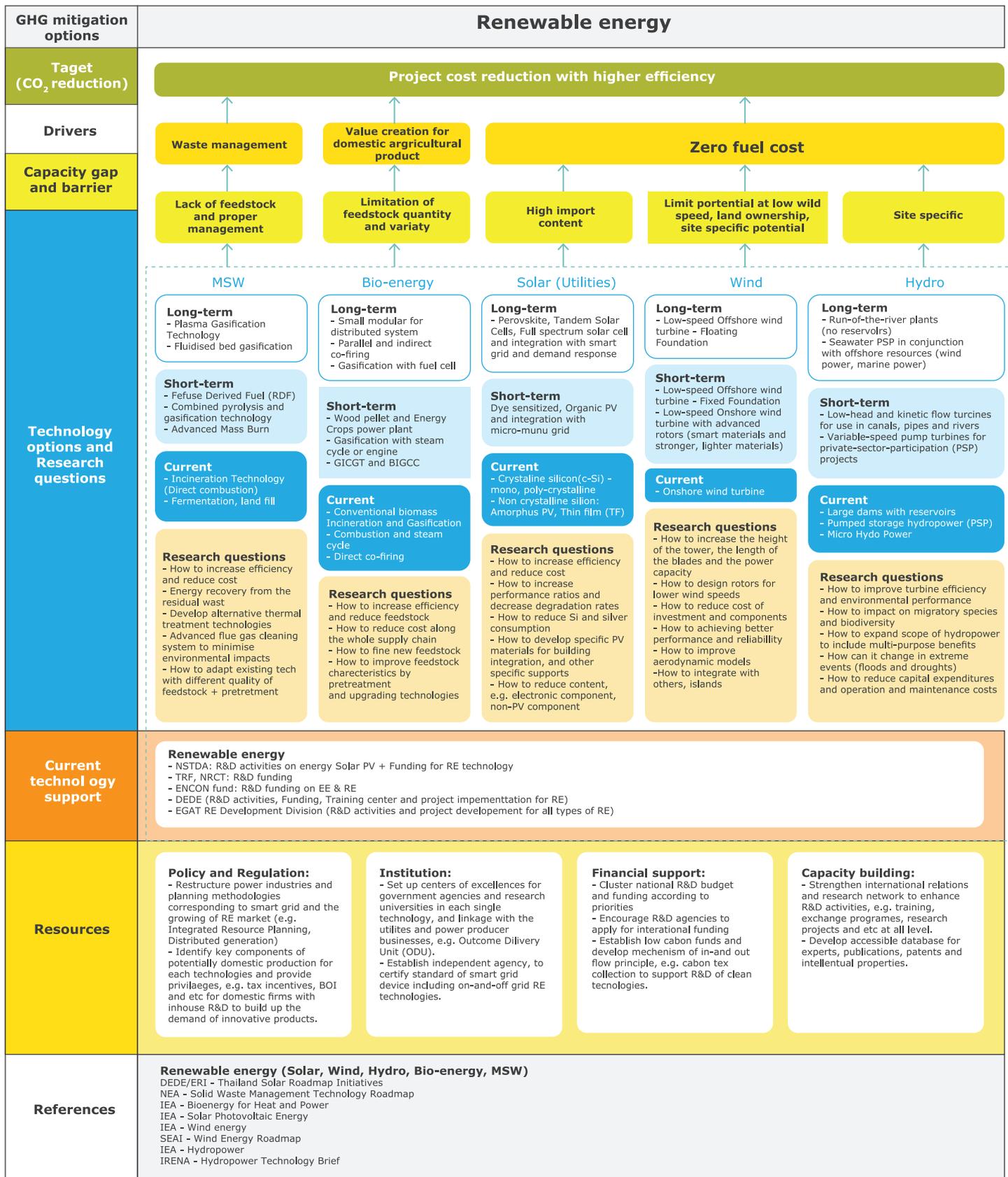


Figure 5-2: Climate Mitigation Technology Roadmap in Public Electricity and Heat Production (Renewable Energy Sector)

Source: Climate Mitigation Technology Database and Roadmap 2019, Office of National Higher Education Science Research and Innovation Policy Council (NXPO)

The Adaptation Technology Roadmap 2022 identifies technology assessment, options, and priorities. It develops the technology database in the six priority sectors for adaptation as identified in Thailand's NAP and illustrated in Chapter 4 "Vulnerability and Adaptation": water management, agriculture, tourism, health, natural resources management, and human settlement and security. Technology development priorities in each sector are as follows:

- **Water Management:** (1) development of water situation forecasting and early warning systems technology, (2) water retardation and flood retention technology, and (3) groundwater management in conjunction with surface water uses in drought-prone areas technology

- **Agriculture:** Climate Change adaptation technology of agriculture and food security for precision farming for solving problems in the short, medium-term, and long term is, therefore, necessary under the framework of Bio-Circular-Green Economic Model, Sustainable Development Goals (SDGs) and Philosophy of Sufficiency Economy (SEP) and related theories.

- **Tourism:** (1) Encourage different types of innovative tourism attractions and activities to attract diverse tourist groups, (2) Development of seasonal tourism destinations to support all-year-round tourism, and (3) Development of accurate and precise early warning system.

- **Health:** (1) extremely hot weather early warning system, (2) an extensive public health database which is an integrated database, and 3) network creation for warning, disease surveillance, and good-practice community model to increase the efficiency of the existing implementation and readiness for coping with emerging diseases.

- **Natural Resources:** (1) ecosystem-specific climate forecasting technologies, which include short-term climate variability prediction and early warning systems and long-term climate change projection of impacts on ecosystems; (2) technologies to continuously measure and systematically assess ecosystems integrity including observation technologies on physical and biological variables, and database technology; (3) technologies to support conservation and restoration of ecosystems, habitat, species, and biodiversity such as geo-informatics technology, advanced biotechnology and bioinformatics.

- **Human Settlement and Security:** 1) technology for planning and society preparedness for urban changes, such as climate adaptation planning and infrastructure planning; 2) the technology for resilient and adaptive human settlements, such as information technology for flood adaptation and disaster or actionable intelligence policy platform (space technology) for resilient spatial planning; 3) technology for risk assessment, such as flood risk assessment for different sizes of cities.

*Source: Climate Technology Roadmap and Database: Adaptation, Office of National Higher Education Science Research and Innovation Policy Council (NXPO), Office of Natural Resources and Environmental Policy and Planning (ONEP), RU-CORE Ramkhamhaeng University, Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ)*

### 5.1.2 Technology Development

Following the Climate Mitigation Technology Database and Roadmap 2019 and Adaptation Technology Roadmap 2022, Thailand continues to develop technologies necessary for addressing climate change. The development of climate mitigation technology centers on GHG emission reduction, particularly in the energy sector, to achieve carbon neutrality and net-zero emission according to the national targets and increase competitiveness in global trade. For instance, EGAT and DEDE emphasize the significance of energy transition toward clean and renewable energy sources with the development of solar, wind, water, hydrogen, and waste and wastewater power generation. EGAT also seeks to enhance the transition of transport fuel consumption by developing the electric vehicle services such as EV-related technology and charging stations. The development of climate adaptation technology targets the technologies that increase resilience, strengthen forecasting and warning systems, and lessen the climate change impacts, improving production efficiency and sustainable natural resources exploitation. In particular, the LDD develops adaptation technology in the agriculture sector, such as Geoinformatics or AquaCrop program to sustain agricultural production in the high climate risk condition. Some examples of technology development projects are illustrated in Table 5-1.

Table 5-1: Examples of technology development projects in Thailand

Sector	Agency	Project	Technology Description
Energy	EGAT	<ul style="list-style-type: none"> <li>• Hydro-Floating Solar Hybrid</li> <li>• Grid Modernization</li> <li>• Hydrogen power</li> </ul>	Aiming to reach "EGAT Carbon Neutrality" in 2050 with the "Triple S" strategy, EGAT increases renewable energy production from Hydro-Floating Solar Hybrid from 2,725 MW to 5,325 by 2037. EGAT also plans to invest in grid modernization to support the increased renewable energy in the system and ensure the overall security of energy production.
Energy/ Transport	EGAT	EGAT EV Business Model: EleXa Application, EleX by EGAT, EV Charger, and BackEN	EGAT aims to support fossil fuel transition to renewable energy by promoting electrical vehicle (EV) usage. Thus, EGAT founds the EV services: <ol style="list-style-type: none"> <li>1.EleXa application to navigate and reserve charging stations</li> <li>2.EleX by EGAT charging stations</li> <li>3.EV Charger and BackEN to manage charging stations within 24 hours</li> </ol>
IPPU	EGAT	RAC NAMA	EGAT, in collaboration with GIZ, enhances the capacity to decrease GHG emissions in the industrial use of refrigeration and air-conditioning (RAC) technologies via the "Cooling Innovation Fund." Using the most energy-efficient technologies and natural refrigerants with very low global warming potential (GWP), the "green cooling" approach minimizes the negative environmental impacts of RAC appliances and helps to save energy cost. Through widespread dissemination of green cooling technologies, the RAC NAMA project aims to decrease the emissions in the sector by 0.9 MtCO <sub>2</sub> eq per year by 2020.

## CHAPTER 5

Table 5-1: Examples of technology development projects in Thailand (cont'd)

Sector	Agency	Project	Technology Description
Renewable Energy	DEDE	Solar, Wind, Water, and Waste and Wastewater Power Generation	DEDE promotes power generation from renewable energy sources: solar, wind, water, and waste. DEDE employs solar energy for power generation and solar for heat generation (solar drying and solar hot water systems). For wind power, the implementation is limited due to the high investment cost in materials and equipment. For waste, DEDE developed a prototype of a biogas production system from waste at a community level, supporting up to 15 tons of organic waste per day. Energy production from waste has been promoted using two systems—the biogas production system and Refused-Derived-Fuel (RDF). Wastewater, particularly wastewater from the agro-industrial sector, is to be treated by the anaerobic system generated by product biogas with different levels of methane contents. Methane has flammable properties that can be used in renewable energy production.
Agriculture	LDD	Geoinformatics' Technology	LDD employs geoinformatics technology to improve and develop a model of water usage, humidity in the soil, and calendar of rice cultivation in the areas with a high risk of drought.
Agriculture	LDD	AquaCrop program version 5	LDD employs the AquaCrop program to predict the crops' production yield (rice and corn) under the mid-to-high GHG emission level using Representative Concentration Pathway (RCPs) 6.0 and 8.5.
Health	DEQP	Early warning system of heatwave and haze	The early warning system of heatwave and haze consists of two elements: the heat index (HI) calculated from the temperature and humidity forecast and the intensity of particle 10 (PM <sub>10</sub> ) from the Weather Research Forecast (WRF-CHEM). The warning indicators are sorted into four levels: <ul style="list-style-type: none"> <li>• Moderate: (HI 27-32 °C and PM<sub>10</sub> 0-50 µg/m<sup>3</sup>)</li> <li>• Warning: (HI 32-41 °C and PM<sub>10</sub> 50-120 µg/m<sup>3</sup>)</li> <li>• Dangerous: (HI 41-54 °C and PM<sub>10</sub> 121-350 µg/m<sup>3</sup>)</li> <li>• Hazardous: (HI&gt;54 °C and PM<sub>10</sub>&gt;350 µg/m<sup>3</sup>)</li> </ul>

Source:1) Electricity Generating Authority of Thailand (EGAT) 2) Department of Alternative Energy Development and Efficiency (DEDE) 3) Land Development Department (LDD) 4) Department of Environmental Quality Promotion (DEQP)

### 5.1.3 A Mechanism for Technology Transfer

To facilitate and accelerate climate technology development and transfer, the COP 2010 established the Technology Mechanism, comprising two bodies: the Technology Executive Committee (TEC) and the Climate Technology Centre and Network (CTCN). The CTCN is responsible for providing technical assistance at the request of developing countries on technology issues, creating access to information and knowledge on climate technologies, and fostering collaboration among climate technology stakeholders via its network of regional and sectoral experts. The Office of

National Higher Education Science Research and Innovation Policy Council (NXPO), or former National Science Technology and Innovation Policy Office (STI), is the National Designated Entity (NDE) of CTCN under the Convention. Its tasks are developing a Climate Technology Database and Roadmap for Thailand and coordinating with CTNC and other regional and international technology entities, enabling national climate technology development and transfer. In addition, to promote low-carbon technology development and circular economy as parts of Thailand NDC's goal, NXPO provides funding for technology research and development and low-rate interest loans to private business sectors.

*Source: Office of National Higher Education Science Research and Innovation Policy Council (NXPO)*

## 5.2 Research and Systematic Observation

Articulated in Article 4.1 (g) and Article 5 of the Convention and the Preamble of the Paris Agreement, research and systematic observations are significant parts of climate policy development and implementation. Research and systematic observations are vital processes for developing climate system data archives and understanding climate change causes, effects, magnitude, and timing based on the best available scientific knowledge to adopt effective and progressive measures in response to climate threats.

In compliance with the Convention, Thailand prioritizes the development of science, technology, and knowledge as one of the primary strategies for addressing climate change. The 11<sup>th</sup>, 12<sup>th</sup>, and draft 13<sup>th</sup> National Economic and Social Development Plans (2012-2037) seek to promote research and systematic observations in two aspects: 1) developing high skilled personnel and researchers and supporting systematic and continuous research covering all aspects of natural disasters and climate change in Thailand; 2) enhancing the efficiency of systematic observations and warning systems to ensure the data precision, system coordination, risks coverage, and advance notification to all vulnerable groups.

These objectives are reflected in the National Research Policy and Strategy (2018-2021) and the Action Plan (2020-2022) formulated by the National Research Council of Thailand (NRCT). This leading agency guides the country's development and public policy by using research and integrating and administering the national research budget leading up to the concrete utilization. Its core functions include funding research and innovations, managing national databases and indicators on science and research, initiating and supporting key research programs, and disseminating research knowledge to relevant stakeholders. Similarly, Thailand Science, Research, and Innovation (TSRI) was founded to encourage and support research and innovation involving science, technology, social sciences, humanities, and interdisciplinary subjects. The goal of TSRI is to extend the country's body of knowledge and drive its development through public policy implementation and the utilization of research and innovation products for socioeconomic purposes in a balanced and sustainable manner. To realize these goals, relevant government agencies have conducted research and initiated observation systems in climate variable domains: atmospheric, oceanic, and terrestrial domains.

*Source: 1) National Research Council of Thailand (NRCT) 2) Thailand Science, Research, and Innovation (TSRI)*

### 5.2.1 Atmosphere/Satellite

The Thai Meteorological Department (TMD) operates under the World Meteorological Organization (WMO) framework. Aligning with the WMO Strategy Plan, the TMD's Action Plan 2020-2024 aims to enhance the monitoring, observing, and forecasting systems ensuring that the meteorological data and service are "Actionable, Accessible, and Authoritative: AAA" to cope with natural disaster and detrimental climate change impacts. One of the WMO core strategies is ensuring the efficiency of the Global Climate Observing System (GCOS) by implementing a fully integrated observation system that will result in a clear observation standard with accuracy.

At present, TMD has 128 meteorological and atmospheric observing stations and 105 automatic observing stations. Some are upper air stations, but most are surface stations operated 8 synoptic times daily at 00UTC, 03UTC, 06UTC, 09UTC, 12UTC, 15UTC, 18UTC, and 21UTC to provide climate data such as atmospheric pressure, air temperature, humidity, and wind speed. All stations are equipped with standard meteorological instruments, e.g., wet-bulb dry-bulb glass thermometers, wind anemometers, Class-A evaporation pans, and rain gauges. Agro-meteorological stations include soil thermometers. Data are recorded manually at the station in a log book and on a PC to be sent as WMO-coded messages to the headquarter in Bangkok to be further distributed via GTS and kept as archives in the climatological data section. Real-time automatic weather reports are available to the forecasters and public (via web) and separately archived. Data quality assurance/control is performed in real-time (on message programming) and non-real-time (manually audits). Observers are directed to refreshing courses, training, or seminar periodically.

Furthermore, Marine Meteorological and Upper-air Observations, a sub-division of the TMD's Meteorological Observations Bureau, is responsible for observing, analyzing, and forecasting marine meteorological data as well as studying the air-sea interaction phenomena. Also, the TMD and the Marine Department have signed a Memorandum of Understanding (MOU) on meteorological operations to coordinate, link, and exchange meteorological data. This cooperation is an integration of operations for joint development in providing channels to 1) obtain weather data and sea conditions measured and observed from the vessels at sea (weather observing data from ships at sea) to process meteorological information for forecasting and early warning systems; 2) provide meteorological information to the vessels promptly which will enable the vessels to make an accurate decision for navigation.

In addition, Thailand has employed satellite remote sensing observations in various climate-related activities such as verifying heatwaves, hotspots of forest fires, and areas vulnerable to climate hazards. The Geo-Informatics and Space Technology Development Agency (GISTDA), a government agency overseeing the development of geo-informatics, space technology, and satellite operations, is developing the implementation of the Thailand Earth Observation System Phase 2 (THEOS-2). THEOS-2 consists of one primary satellite and one small satellite with the multispectral

sensor as a core function. This function is highly linked to Essential Climate Variable. To support evident-based policy for sustainable development, GISTDA is developing an Actionable Intelligence Policy or "AIP," which combines many spatio-temporal inputs, including THEOS-2 products, with scenario simulations to generate multiple outcomes from alternating area-based policies.

*Source: 1) Thai Meteorological Department (TMD) 2) Meteorological Observations in Thailand, JMA/WMO Workshop on Quality Management in Surface, Climate and Upper-air Observations in RA II (Asia), Songkran Aksom, Director, Meteorological Observation Bureau, Meteorological Department 3) Geo-Informatics and Space Technology Development Agency (GISTDA)*

## **5.2.2 Land**

The Office of the National Land Policy Board has approved the draft National Policy and Plan on Land and Land Resources Management (2023-2037), setting a framework to enhance optimal land utilization and the balance of the natural ecosystem in accordance with the sustainable development which also contributes indirectly to climate change mitigation and adaptation. The priority is to study problems and analyze the situation where lands are abandoned and seek to design and create mechanisms, measures, or incentives for converting those lands into forest or agricultural areas.

*Source: The Office of the National Land Policy Board*

### **5.2.2.1 Agriculture**

The Strategic Plan for Agricultural Research and Development (2023-2028), approved by the Committee of Agricultural and Cooperative Development Policy and Plan, seeks sustainable resource management to reduce GHG emissions and adapt to climate change impacts, aligning with climate change mitigation and adaptation policies. To achieve the goal, the Agricultural Research Development Agency aims to fund research projects concerning: 1) sustainable and low-emission agriculture; 2) water management for agriculture and enhance capacity, plans, and measures, to cope with natural disasters and climate impacts. The research on agriculture mainly focuses on climate change impacts on the agriculture sector, climate mitigation such as the potential of GHG emission reduction in newly developed agricultural practices, and climate adaptation such as agriculture in drought conditions. Key research projects are described in Table 5-2.

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Table 5-2: Examples of agriculture research

Research/ Observation	Timing	Objectives	Brief Description	Expected Results / Indicators
Research and development of microorganisms reinforcing plant growth in drought conditions	2021-2022	To select and test the efficiency and dosage of microorganisms that reinforce plant growth in drought conditions	Select and test the efficiency and dosage of microorganisms that: <ul style="list-style-type: none"> <li>• Embed nitrogen producing siderophore to increase the resistance to plant disease</li> <li>• Dissolve phosphates producing exopolysaccharides to reinforce plant growth in drought conditions</li> </ul>	Prototypes of microorganism groups that reinforce plant growth in drought conditions
Comparative research on severe climate change effects on land resources, agricultural products, environment	2016-2020	<ul style="list-style-type: none"> <li>• To conduct comparative research and establish a database for planning and implementing land and water conservation measures and other adaptation measures</li> <li>• To conduct comparative research of mathematic formula and Morgan, Morgan, and Finney model from soil erosion</li> </ul>	Conduct comparative research of soil erosion in the basin area of Mae Poy and Huayluek Chiangdao Chiangmai Province by using four methods: Pin technique, Mathematic formula, Morgan, Morgan, and Finney model, and weighing the sediment	<ul style="list-style-type: none"> <li>• Measures for water and land resources conservation to enhance food security</li> <li>• Create awareness of climate change effects</li> <li>• Reduce the cost of agricultural production</li> </ul>
Research on how land and water management in wet-and-dry rice paddies reduce GHG emissions	2018-2019	To study and observe the decrease in Methane emission in wet-and-dry rice paddies	Planting rice using the wet-and-dry method in 105 fields in Suphanburi, Anghong, and Nakhonpathom employing Randomized Complete Block Design (RCBD)	<ul style="list-style-type: none"> <li>• Data on Redox potential and Methane emission from rice paddies</li> <li>• Data on rice production, growth rate, investment cost, and profit</li> <li>• Data on nutrients in the soil, microorganisms, and carbon stock in rice paddies</li> <li>• Building capacity for farmers to manage water and land for agricultural production</li> </ul>
Promoting the production of organic fertilizer from agricultural residues 2018-2022	2018-2022	<ul style="list-style-type: none"> <li>• To incentivize farmers to avoid burning crops residues</li> <li>• To promote the production of organic fertilizer from crop residues</li> <li>• To reduce and prevent fire and haze hotspots</li> </ul>	<ul style="list-style-type: none"> <li>• Mark target areas from the previous satellite data and burn traces to find the hotspots ratio</li> <li>• Implement education, training, and awareness-raising measures to incentivize farmers to avoid burning crops residues and promote the production of organic fertilizer from crop residues</li> </ul>	<ul style="list-style-type: none"> <li>• Decrease burning, haze, and emissions from crop residues burning in targeted areas</li> <li>• Decrease hotspots by 20% compared to data in 2017</li> <li>• During the peak of air pollution, the quality of air is improved by 20% compared to data in 2017</li> <li>• Decrease agricultural wastes</li> <li>• Increase soil organic matters by 0.02%</li> </ul>

Source: 1) Land Development Department 2) Agricultural Research Development Agency

### 5.2.2.2 Forest

Forest Land Management Office (FLMO) was established by the Royal Forest Department, with its core function to systematically observe, assess, and record land use activities and changes in forest areas. The collected data is used for forest management policy planning. From 2017 to 2019, the FLMO has observed and assessed the status of forest resources in Thailand by utilizing satellite data of Sentinel-2, operated by the European Space Agency, and LANDSAT 8, operated by the National Aeronautics and Space Administration (NASA), to record high-resolution forest images. The data and images were verified, analyzed, and used to categorize forests and formulate forest type mapping and database. In addition, the Forest and Plant Conservation Research Office was founded as a focal point for research and development with its objective to enhance research in the fields complying with the strategies and core functions of the Department of Natural Parks, Wildlife, and Plant Conservation. The commitment to address climate change under the Convention is one of the strategies laid out in its action plans. Various research projects focusing on climate change impacts and the carbon sequestration capacity of forest were implemented, as illustrated in the Table 5-3.

Source: 1) Final Report of Forest Information Preparation Project 2017-2019 by the Royal Forest Department  
2) Department of Natural Parks, Wildlife, and Plant Conservation

Table 5-3: Examples of research in the forest sector

Research/Observation	Timing	Objectives	Brief Description	Expected Results / Indicators
Development of an eco-forest model to reduce the impact of sea-level rise and coastal erosion	2021-2022	To develop a coastal eco-forest model to reduce the impacts of sea-level rise and coastal erosion and to evaluate survival and tree growth rate in the experimental plot area	The project aims to create eco-forests that replicate natural forest growth and regeneration. The concept of densely and randomly planting with various coastal species was also employed. Three groups of tree structures (perennials, low trees, and shrubs) with 9 species were selected to plant in the experimental plot area. This study could be utilized as a learning center for eco-forestation models to reduce the impacts of sea-level rise and coastal erosion and the biodiversity and apply knowledge from the results in other areas	The evaluation of the survival and growth rates of the trees from the 8-month follow-up period showed a 96% of survival rate. The species with the highest growth rate as determined by height and diameter were Casuarina junghuhniana (Son Pradipat), Hibiscus tiliaceus (Por Talay), and Thespesia populnea (Pho Talay), respectively. These results showed that these three species were fast growth and had the potential to be applied in ecological forest planting to reduce the impact of sea-level rise and coastal erosion.

Table 5-3: Examples of research in the forest sector (cont'd)

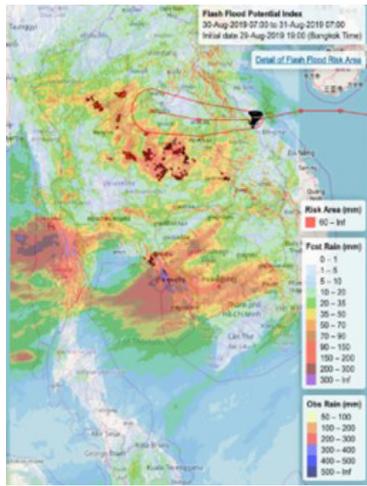
Research/ Observation	Timing	Objectives	Brief Description	Expected Results / Indicators
Forest reaction to climate change along the longitude 101 East	2018-2019	To develop new knowledge on the CO <sub>2</sub> absorption capacity of tropical forest	The Science Faculty of Chulalongkorn University commenced the study on the CO <sub>2</sub> absorption capacity of tropical forests, mainly the secondary forest, which are typical forests in the Southeast Asia region. The study aims to enhance understanding and utilize data for planning forest conservation and increasing forest areas, aligning with climate change strategy and plan.	Generate new knowledge and understanding of the CO <sub>2</sub> absorption capacity of tropical forest
Series of Research on carbon capture and storage capacity of different types of forests in Thailand	2021-2022	To understand and assess the different capacities of forests in capturing and storing CO <sub>2</sub>	A series of research was conducted to assess the forests' capacity to capture and store CO <sub>2</sub> , the impacts of climate change on the forest ecosystem, and the level of carbon stored. The research was conducted in various areas, particularly in Thailand's national parks.	<ul style="list-style-type: none"> <li>• Understand the climate change impacts on forest ecosystem</li> <li>• Determine vulnerability and adaptation of natural forest</li> <li>• Suggest and recommend mitigation measures.</li> </ul>

Source: 1) the Forest and Plant Conservation Research Office, Department of Natural Parks, Wildlife, and Plant Conservation 2) Agricultural Research Development Agency 3) Research Report of Environmental Research and Training Center 2018-2020, Department of Environmental Quality Promotion

### 5.2.3. Water

Three primary agencies taking part in observing and managing water resources in climate-related variables are the Office of the National Water Resources (ONWR), the Royal Irrigation Department (RID), and the Hydro and Agro Informatics Institute (HII). The ONWR, operated under the Water Resources Act 2018, is in charge of systematically regulating and managing integrated national water resources management policies. Its mandates include studying and analyzing water situations and operating as a single command center for water management at critical times. Under the Irrigation laws, the RID aims to achieve, collect, store, control, distribute, drain, or allocate water for agricultural, energy, household consumption, or industrial purposes. In the 20-year Irrigation Strategy (2017-2037), the RID seeks to utilize technology to enhance water management efficiency and improve disaster prevention mechanisms. Playing a complementary role, the HII acts as a data warehouse and knowledge library to support efficient water management and expanded applications by building and developing networks with more than 40 agencies. Its missions include enhancing research and developing technology and innovation water resource information and national water repository optimization. The programs and initiatives on water research, systematic observation, and warning systems performed by the ONWR, RID, and other related agencies can be illustrated in Table 5-4.

Table 5-4: Examples of research in the forest sector

Research/ Observation	Timing	Objectives	Brief Description
Smart Water Operation Center: SWOC (RID)	<ul style="list-style-type: none"> <li>- To collaborate with all relevant sectors and gather information on precipitation rate, climate, and real-time water status in all sources</li> <li>- To utilize those data for assessing and forecasting water situation in achieving effective water management</li> </ul>	<p>The center consists of the following main tasks:</p> <ol style="list-style-type: none"> <li>1) Collecting data as a database center for all types of water resources</li> <li>2) Analyzing data using Isohyets Map and sharing water data with all stakeholders to promote proper decision making and effective risk management</li> <li>3) Reporting data with an integrated approach and monitoring real-time water situation via web and mobile applications</li> </ol>	<p>Example of success:</p> <ul style="list-style-type: none"> <li>- Despite being hit by three tropical storms in 2017, due to the forecasting of SWOC, Thailand managed to avoid floods by preparing areas of 265,000 rai as a reservoir, irrigating, draining, and diverting water.</li> <li>- By the end of 2018, SWOC, in collaboration with TMD and HII, had already observed the formation of tropical storm "Pla Buek" in the southern part of Thailand. Thus, by informing the stakeholders in advance, the responsible authorities had accurate data to make the necessary decision to minimize the damage in vulnerable areas.</li> </ul>
Water Resources Management Operation Center (OWNR)	<ul style="list-style-type: none"> <li>-To observe and report real-time water situation</li> <li>- To create an early warning system to notify vulnerable communities of upcoming rainstorms or floods</li> </ul>	<p>The center operates in all provinces of Thailand with four main tasks:</p> <ol style="list-style-type: none"> <li>1) Monitoring precipitation, climate, water level, and humidity</li> <li>2) Forecasting storms route, precipitation, floods, and waves</li> <li>3) Water mapping</li> <li>4) Water statistic</li> </ol>	
Flash Flood Forecasting and Warning System (HII)	To provide a flash flood forecast and early warning system in 24 hours	<p>Flash flood occurs quickly due to heavy rainfall (with high intensity) and saturated soil, and it evolves rapidly with high peak and is hard to predict. Thus, the forecasting system is employed in vulnerable and high-risk areas to track situations every hour and give early warning 24 hours before. The result shows a visualized flash flood potential index and detail of the flash flood risk area.</p>	

Source: 1) Office of the National Water Resources (ONWR) 2) Royal Irrigation Department (RID) 3) Hydro Informatics Institute (HII)

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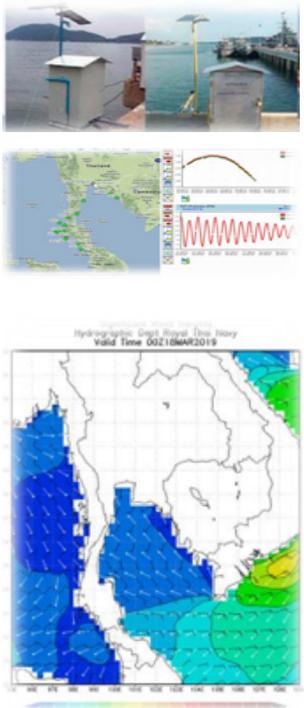
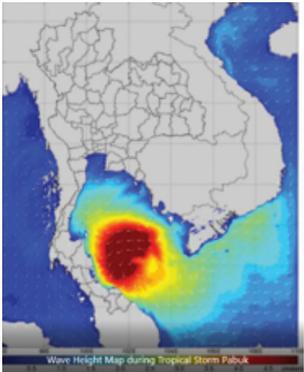
### 5.2.4 Marine

The Department of Marine and Coastal Resources (DMCR) is the principal agency in charge of marine and coastal resources management and conservation. Its core functions relating to climate variables include 1) observing, monitoring, and evaluating the condition of marine and coastal resources and areas; 2) restoring and preventing coastal erosions; 3) studying, researching, and developing the conservation and restoration of coastal marine resources. In addition, the Hydrographic Department within the Royal Thai Navy (HDRTN) has mandates covering hydrographic and oceanographic surveys, tidal prediction, aids to navigation maintenance, marine environment, nautical charts and publications, standard timekeeping, marine meteorological forecasting, and other activities for the safety of navigation to support both public and military need in the Gulf of Thailand and the Andaman Sea. The HII also contributes to developing a forecasting and early warning system in the Gulf of Thailand. Various research and observation projects can be illustrated in Table 5-5.

Table 5-5: Marine research and systematic observation

Research/ Observation	Objectives	Brief Description	Expected Results/Indicators
Research and observation on oceanography and the change of seawater temperature due to climate change effects 2019-2021	<ul style="list-style-type: none"> <li>- To track changes in sea temperature in the coastal area, Andaman Sea, and the Gulf of Thailand</li> <li>- To track changes in oceanography for estimating the effects of climate changes on the marine ecosystem</li> <li>- To update the real-time marine database for establishing climate adaptation measures and marine resources management plans</li> </ul>	Track changes in sea temperature in the coastal area, Andaman Sea, and Gulf of Thailand using Temperature Logger (54 stations) and track changes in oceanography using Conductivity Temperature and Depth (CTD 225 stations)	<ul style="list-style-type: none"> <li>- Sea temperature from October 2018 to September 2019 is 26.9-33.2 °C, and an annual average temperature is 29.9 ± 1.1°C</li> <li>- Sea temperature from October 2019 to September 2021 is 25.2 – 33.5°C, and an annual average temperature is 30.1 ± 1.2 °C</li> <li>- The temperature higher than 30.5 °C can affect the corals' conditions.</li> </ul>
Research and observation on coral bleaching and other coral diseases caused by climate change impacts 2019-2021	<ul style="list-style-type: none"> <li>- To study factors and proper usage of factors indicating the resisting capacity of corals to climate change effects</li> <li>- To study the capacity of corals to resist and tolerate changes in sea temperature and other climate change effects for restoring bleached corals and establishing good coral management</li> </ul>	<ul style="list-style-type: none"> <li>- Analyze long-term data in the area such as types of corals, the severity of coral bleaching, and the survival rate of corals</li> <li>- Field study on factors affecting the coral capacity to recover, such as diversity of corals, size-frequency of Porites Lutea (Helmet-shaped coral colony), predators of corals, and coral diseases.</li> <li>- Monitor coral areas that are prone to be affected by the rise of sea temperature by engaging scuba diver networks or other social networking</li> </ul>	<ul style="list-style-type: none"> <li>- Coral bleaching impacts are more severe in the Gulf of Thailand than in the Andaman Sea.</li> </ul> <p>The severity of bleaching depends on coral types because each type has different resistance levels and tolerance to temperature and overall environmental changes.</p>

Table 5-5: Marine research and systematic observation (cont'd)

Research/ Observation	Objectives	Brief Description	Expected Results/Indicators
Hydrographic and oceanographic surveys and Marine Meteorological Activities (HDRTN)	For tide prediction, tide gauge program, sea level determination, marine climate observation	<p>The HDRTN provides a tide table on 29 sites within Chao-Phraya River, the Gulf of Thailand, and the Andaman Sea for tide prediction. The tide prediction uses raw data from HDRTN, Port Authority of Thailand, and Marine Department tide gauge networks. Two tide gauges have been upgraded along the Chao-Phraya River. In the Andaman Sea, eight radar tide gauges are already installed. Tide gauges in the Gulf of Thailand are seven radar tide gauges, one acoustic tide gauge, and two buoy tide gauge</p> <p>HDRTN has established a couple of automatic weather stations along the Thailand coast to observe air temperature, relative humidity, air pressure, wind, precipitation, rainfall, and visibility in cooperation with meteorological authorities. The action maximally realized the integration of resources and information sharing and serving directly to the mariners.</p>	
Forecasting and Early Warning System for the Gulf of Thailand (HII)	To launch forecasting stations, create water level maps, wave maps, and surge	<p>The forecasting system consists of the hydrodynamic model "Delft3D FM" and wave model "SWAN." All forecasting models are controlled by the Flood Early Warning System, which aids the preparation of information to feed into the model and result visualization. The result shows the forecast three days in advance. From the forecast of Pla Buek tropical storm in 2018, the forecasting model was 60% accurate, indicating the proper efficiency and can be relied on in case of emergency.</p>	

Source:1) Department of Marine and Coastal Resources (DMCR) 2) Thailand National Report for the Meeting of the North Indian Ocean Hydrographic Commission 2019, Hydrographic Department within the Royal Thai Navy 3) Hydro Informatics Institute (HII)

### 5.2.5 Participation in Global Research and Observation Systems

#### **World Meteorological Organization and Global Climate Observing System (GCOS)**

WMO facilitates and promotes the establishment of an integrated Earth System observation network to provide weather, climate, and water-related data. WMO also facilitates the establishment, maintenance, and continuing expansion of this global network, the activities of which are coordinated within the Global Observing System (GOS) of the WMO World Weather Watch (WWW). The WMO co-sponsored Global Climate Observing System (GCOS) and Global Ocean Observing System (GOOS) also play a major role in improving the collection of required data for the development of climate forecasts and climate change detection.

Thailand adhered to the Convention of the World Meteorological Organization (WMO) in 1949, became the nineteenth member of the organization, and has actively participated in the Global Climate Observing System (GCOS) with the Thailand Meteorological Department (TMD) as a national focal point. Some TMD's meteorological and atmospheric observing stations are assigned to be part of the Regional Basic Synoptic Network (WMO-RBSN), Regional Basic Climatological Network (RBCN), GCOS Surface Network (GSN), GCOS Upper Air Network (GUAN), Global Atmospheric Watch (GAW), and Regional Basic Observing Network (RBON).

In addition, Thailand by the TMD has also collaborated with the WMO in various projects concerning climate observation and warning systems. For instance, the TMD has joined the Flash Flood Guidance System (FFGS) project for Southeast Asia of the WMO under the CREW-SeA Canada Program Development. This project aims to provide advice and improve the efficiency of various regional meteorological agencies in forecasting and warnings of flash floods in Southeast Asia. Co-hosted with the ASEAN Secretariat and the WMO, the TMD organized the 13th ASEAN Climate Outlook Forum (ASEANCOF) or ASEANCOF-13 under the framework of the ASEAN Subcommittee on Meteorology and Geophysics (ASEAN-SCMG) to provide knowledge and skills in observing, forecasting, and disseminating severe climate information to ASEAN member states.

*Source: 1) Thai Meteorological Department (TMD) Annual Report 2020 2) Global Climate Observing System (GCOS) 3) World Meteorological Organization*

#### **Committee on Earth Observation Satellite (CEOS)**

Committee on Earth Observation Satellite (CEOS) was established in 1984 to coordinate and harmonize Earth observations, enabling the user community to access and use data. CEOS initially focused on interoperability, common data formats, the inter-calibration of instruments, and common validation and inter-comparison of products. Over time, the circumstances surrounding the collection and use of space-based Earth observations have changed. Therefore, CEOS has evolved, become more complex, and expanded the number and scope of its activities. CEOS now focuses on validated requirements levied by external organizations, works closely with other satellite coordinating bodies (e.g., the Coordination Group for Meteorological Satellites), and continues its role as the primary forum for international coordination of space-based Earth observations. Currently, CEOS has 34 organizations from 24 countries as key members and 29 international cooperation organizations as its associates with their own observation satellites.

The Geo-Informatics and Space Technology Development Agency (GISTDA), the main space organization of Thailand operating within the Ministry of Higher Education, Science, Research and Innovation (TISI), has become a member of CEOS since 2001. In 2009, GISTDA served as a CEOS Chair. At the CEOS Plenary 2021 International Conference, GISTDA was again elected to serve as CEOS Chair, commencing in November 2022.

The CEOS Chair is a senior space agency official that serves a one-year term as the primary interface for all external coordination. The Chair reports to CEOS Agency Principals at the annual CEOS Plenary session and ensures that their guidance and direction are appropriately reflected in CEOS activities and priorities. The Chair also presides over the Troika, which consists of three entities: the Chair him/herself, the future CEOS Chair, and the past CEOS Chair. The Troika is a leadership mechanism the Chair can use to discuss important topics.

Thailand's position as a CEOS Chair will be an opportunity to reveal the potential of Thailand's space technology and geospatial in the global arena. In particular, Thailand commits to adopting space technology to address the climate change problem in line with the CEOS' guidelines and mission.

*Source: 1) Geo-Informatics and Space Technology Development Agency (GISTDA) 2) Committee on Earth Observation Satellite (CEOS)*

### **Southeast Asia Regional Climate Downscaling Project (SEACLID)/Southeast Asia Regional Climate Downscaling (CORDEX-SEA)**

CORDEX-SEA is the 14<sup>th</sup> domain of CORDEX, a program of the World Climate Research Programme (WCRP). CORDEX advances and coordinates the science and application of regional climate downscaling through global partnerships. In CORDEX Global climate model (GCM), outputs are "refinement" to produce "high-resolution climate change scenarios." High-resolution climate change scenarios are the basic requirement for climate change impact, vulnerability, and risk assessment studies at local and regional scales.

The Southeast Asia Regional Climate Downscaling (SEACLID) was established as a collaborative project in regional climate downscaling involving several collaborators from various countries within the Southeast Asia region, adopting a common domain, and obtaining climate information for the Southeast Asia region. SEACLID is mainly funded by the Asia-Pacific Network (APN)'s ARCP programme. Initial member countries include Indonesia, Malaysia, the Philippines, Thailand, Vietnam, Cambodia, and Lao PDR. In addition to the original member countries, collaborators from several countries, including Australia, the United Kingdom, South Korea, Hong Kong SAR, Sweden, Germany, and Japan have joined the project. This project has involved many collaborators from 14 countries and 19 institutions. For Thailand, the main collaborators are Ramkhamaheng University Center of Regional Climate Change and Renewable Energy (RU-CORE) and Chulalongkorn University.

SEACLID has been streamlined and integrated into the World Climate Research Programme (WCRP)'s Coordinated Regional Climate Downscaling Experiment (CORDEX) and renamed as SEACLID/CORDEX Southeast Asia (CORDEX-SEA). SEACLID / CORDEX-SEA aims to downscale a number of CMIP5 GCMs for the Southeast Asia region through a task-sharing basis among the institutions and countries involved. The SEACLID/CORDEX-SEA

product enhances the scientific understanding of regional climate change. Consequently, this project increase peer-reviewed publications on regional climate change, impacts, and policy-related aspects and narrows knowledge gaps in the region. The first Phase of CORDEX-SEA was completed in 2018 with the successful downscaling of 11 GCMs with 7 RCMs. To date, more than 20 publications have been published from this project. The SEACLID/CORDEX Southeast Asia Phase 2 focuses on the High-resolution Analysis of Climate Extremes over Key Areas in Southeast Asia. The project has also led to the establishment of the Southeast Asia Regional Climate Information System (SARCCIS), a data portal for sharing CORDEX-SEA data with end-users. SARCCIS is a data node of the ESGF, hosted by the Ramkhamaheng University Center of Regional Climate Change and Renewable Energy (RU-CORE).

*Source: 1) Ramkhamaheng University Center of Regional Climate Change and Renewable Energy (RU-CORE) 2) The Southeast Asia Regional Climate Downscaling (SEACLID)/ Coordinated Regional Climate Downscaling Experiment - Southeast Asia (CORDEX Southeast Asia), Universiti Kebangsaan Malaysia by Prof. Fredolin Tangang and the Asia-Pacific Network for Global Change Research (APN)*

### **The Asia-Pacific Network for Global Change Research (APN)**

APN is an intergovernmental network of 22 countries working toward an Asia-Pacific region that is successfully addressing the challenges of global change and sustainability. The Asia-Pacific Network supports research and science-based response strategies, including climate change. It also focuses on linking scientific outcomes with policy mechanisms applicable to all levels of governance and societal sectors in each country. Thailand is a member of APN network, with National Research Council of Thailand and Chulalongkorn University acting as national Focal Points and Subregional Committees. From 1998-2021, there are about 196 climate change projects and publications relating to climate change in Thailand and the regional context, such as Climate and land-use change impacts on spatiotemporal variations in groundwater recharge: A case study of the Bangkok Area, Capacity building for measuring multi-hazard livelihood security and resilience in the Lower Mekong Basin, Integrated highland wildfire, smoke, and haze management in the Upper Indochina region, and Climate change risk assessment and adaptation for loss and damage of urban transportation infrastructure in Southeast Asia

*Source: The Asia-Pacific Network for Global Change Research (APN)*

### **Asia-Pacific Advanced Network (APAN)**

Asia-Pacific Advanced Network (APAN) is a non-profit international consortium established in 1997. Its membership is open to any organization, corporation, national, or international body. APAN was designed to be a high-performance network for the research and development of advanced next-generation applications and services. APAN provides an advanced networking environment for the research and education community in the Asia-Pacific region and promotes global collaboration. Its objectives are to

- *coordinate and promote network technology developments and advances in network-based applications and services*
- *coordinate the development of an advanced networking environment for research and education communities in the Asia-Pacific region*
- *encourage and promote global cooperation*

To achieve the objectives, the Consortium carried out the following activities: holding meetings, workshops, and conferences; exchanging technical information among its community and beyond; arranging and organizing education and training workshops; and promoting and encouraging regional connectivity. APAN is a key driver in promoting and facilitating network-enabled research and education activities. These include research collaboration, knowledge discovery and sharing, telehealth, and natural disaster mitigation.

APAN's member from Thailand is Thailand Research Education Network Association established since 2007 to coordinate among researchers and users of research and education networks and promote/support research projects and activities. From 2018-2021, Hydro and Agro Informatics Institute (HII) has also joined APAN network conferences in two working groups, the Disaster Mitigation Working Group (DMWG) and the Agriculture Working Group (AgWG) to report on the progress of the work.

*Source: Asia-Pacific Advanced Network (APAN)*

### **5.3 Education, Training, and Public Awareness**

#### **5.3.1 Policy and Institutional Framework for the Implementation of Article 6 of the Convention**

Stipulated in Article 6 of the Convention and Article 12 of the Paris Agreement, climate education, awareness, training, public participation, public access to information, and international cooperation are the core foundations for effective development and implementation of climate policies and actions. These commitments under the Convention can be referred to as Action for Climate Empowerment (ACE). In the UNFCCC process, ACE is delivered through work programs. The latest program adopted at COP26 in Glasgow reconfirms the significance of wide-range stakeholder engagement, collaboration, and partnerships. By recognizing the critical role of youth and their right to engage in decisions and action on climate change, the program focuses on youth engagement in ACE implementation.

Adhering to the Convention, Thailand has integrated ACE components in various national legal-based and policy-based instruments such as Thailand's Climate Change Master Plan 2015-2050, Thailand's Nationally Determined Contribution (NDC), and other relevant national, sectoral, and local climate plans. For the institutional arrangement, the Department of Environmental Quality Promotion (DEQP) within the Ministry of Natural Resources and Environment (MONRE) was appointed as an ACE national focal point to develop, execute, and coordinate ACE-related policies and implementations. DEQP has prepared a draft Capacity Building for Climate Actions 2021-2025 as a foundation for its operation framework. Aligning with ACE goals and Education for Sustainable Development (ESD), DEQP's operations aim to ultimately transform people's behavior and enhance their understanding and capacity to cope with climate impacts, according to the Convention and NDCs. DEQP, as ACE's national focal point, has initiated and implemented various projects and activities to achieve ACE's goals. In addition to DEQP's initiatives, many governmental entities also set out policies to

implement ACE activities fostering climate education, raising public awareness, and providing training relating to their different core functions such as science, technology, and renewable energy.

Source: Department of Environmental Quality Promotion (DEQP)

### 5.3.2 Initiatives and Programs under Article 6 of the Convention

#### 5.3.2.1 Education

Climate change issues are incorporated into Thailand's education policies and schools' curricula from the primary to higher levels, targeting youth engagement at the initial stage of learning. The Office of the Basic Education Commission (OBEC), under the supervision of the Basic Education Commission Board, developed the Basic Education Core Curriculum 2008 (BECC), which included environmental education for sustainable development in the Science Strand, one of the key learning standards and indicators. In this strand, it focuses on the Change Processes of the Earth Standard topic, seeking to develop an understanding of various processes on the Earth's surface and interior; the relationship between various processes causing changes in climate, topography, and form of the Earth; having an investigative process for seeking knowledge and scientific reasoning; communicating acquired knowledge that could be applied for practical purposes.

In addition, Thailand seeks to ensure inclusive and equitable quality education and promote lifelong learning for all according to SDG 4. The achievement of SDG benefits the objective of climate education by ensuring the resilience and adaptive capacity of those most vulnerable to climate impacts—the youth, the disabled, and the poor. For instance, Thailand has provided financial support for poor students using digital tools and government funds, including the Education Equality Fund (EEF). Modern technology has been applied to ensure equality in education, such as increasing access to high-speed internet for schools in far-off areas. Thailand has also used the Information System for Equitable Education, or iSEE, to target and monitor groups of students eligible for financial support. Proxy Means Tests, innovative educational tools, have been applied to find 2 million vulnerable students at the pre-primary and early secondary school level. Education for disabled children has been improved to foster inclusive learning. This has included projects that develop inclusive learning for all disabled students in schools, projects that foster non-traditional learning for students with hearing disabilities, and a project to provide sign-language interpreters in schools.

Furthermore, Thailand actively engages in climate actions to improve climate resilience relating to *SDG 13—Take Urgent Action to Combat Climate Change and its Impacts*. One of the key actions is to increase knowledge and awareness of climate change. Thailand has integrated the knowledge of climate change into the national core curriculum and indicators and standards for three subjects: (1) mathematics, science, and geology; (2) social studies, religions, and culture; and (3) physical and health education.

The Department of Environmental Quality Promotion (DEQP) published the Environmental Studies Activity Manual. The manual contains climate change knowledge for teachers to use as a teacher's manual and for the interested public. These manuals were distributed to

related organizations and schools in the network. DEQP, together with Thailand Research Fund and Bangkok University, implemented the project “YouthEN for Climate Change Forum 2019” to enhance the capacity of young generation in terms of climate change knowledge, including the role of youth in the global community. With the support from Global Environment Facility (GEF) through the United Nations Development Programme (UNDP), DEQP and TGO organized the “ACE Youth Camp 2020” to enhance knowledge, exchange learning experiences, brainstorm ideas on low-carbon city innovations, build capacity, and expand the youth climate network.

Source: 1) Office of the Basic Education Commission (OBEC) 2) Thailand's Voluntary National Review on the Implementation of the 2030 Agenda for Sustainable Development 2021, Ministry of Foreign Affairs 3) Department of Environmental Quality Promotion (DEQP) Annual Report 2020: Thailand's Action for Climate Empowerment

Key programs on climate education can be illustrated in Table 5-6. below

Table 5-6: Examples of climate education programs

Agency	Policy/Plan	Project	Timing	Brief Description
DEQP	Action for Climate Empowerment (ACE) and Proactive Capacity Building Plan	Education programs	2017	<p>DEQP initiated educational programs as follows:</p> <ul style="list-style-type: none"> <li>• Eco-school 291 participants</li> <li>• Green Scout 31 networks</li> <li>• Green Youth promoting natural conservation in 12 universities</li> <li>• ACE Youth Camp focusing on carbon-neutral pathways</li> </ul> 
		E-Learning Programs	2020	DEQP developed an e-learning system online and offline with 21 courses focusing on climate change, energy, and technology. The system is accessible for public use.
		Draft Roadmap for climate change capacity building	2020-2024	DEQP, in collaboration with the Ministry of Education, promotes courses and activities on climate change within and beyond the school system. DEQP also prepared the Climate Change Education handbook for teachers to use as a guideline in their teaching programs.

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Table 5-6: Examples of climate education programs (cont'd)

Agency	Policy/Plan	Project	Timing	Brief Description
IPST (Science and Technology)	IPST Action Plan "Strengthening Environmental Science Study on Climate Change" 2019-2022	Earth System Science	2019-2022	Under the Institute for the Promotion of Teaching Science and Technology (IPST), the GLOBE division developed climate change contents in the basic science curriculum to enhance students' understanding of Earth System Science (Land, Water, Climate, including climate change) through an authentic science learning experience in a natural setting. The goal is to seek environmental solutions and methodologies by integrating science, mathematics, and technologies to achieve environmental sustainability.
		Climate Education Media and Tools	2021	IPST formulated three climate education tools for primary and secondary schools: Handbook on Climate Change and Agricultural Fluctuation, field guide on Mosquito Mapping, and Climate Change Challenge game.
DEDE (Renewable Energy)	Alternative Energy Development Plan	Campaign and transfer knowledge on renewable energy and efficiency	2015-2036	DEDE campaigns and transfers knowledge on renewable energy and efficiency via Technology Transfer Division/academic service center to public and private sectors, local communities, and education institutions.

Source: 1) Department of Environmental Quality Promotion (DEQP) 2) Institute for the Promotion of Teaching Science and Technology (IPST) 3) Department of Alternative Energy Development and Efficiency

### 5.3.2.2 Training

Aligning with the ACE program, many governmental agencies have arranged and provided training programs on climate change issues relating to climate-related sub-sectors with key roles contributing to climate actions, such as teachers, electrical engineers, technical and managerial personnel, community leaders, and government officials. The training objective is to develop practical and technical skills and knowledge required for adequately addressing and responding to climate change issues. Key training activities include national initiatives and collaborative projects with bilateral partners. Examples of training activities are illustrated in Table 5-7.

Table 5-7: Examples of climate training programs

Agency/ Sector	Policy and Plan	Project	Timing	Brief Description
EGAT (Energy)	Thailand's NDC Roadmap	NDC Action Plan (Energy Sector) on Education, Training, and Public Awareness	2018-2030	Following the second strategy of the Long-term GHG mitigation plan 2018-2030, EGAT has provided education and training on climate change to various stakeholders inside and outside the agency. For instance, EGAT created many publications (e.g., GHG management, EGAT Green Credit, Carbon Neutrality, and GHG mitigation) on social media platforms. EGAT also initiates the "EGAT GO GREEN" project to increase public awareness of climate change impacts and induce changes in daily life routines. According to the third strategy, EGAT also acts as a focal point of climate mitigation for GHG reduction in the energy sector.

Table 5-7: Examples of climate training programs (cont'd)

Agency/ Sector	Policy and Plan	Project	Timing	Brief Description
Bangkok (Sustainable City)	Bangkok Development 20-year Roadmap phase III	Training on climate change issues and Earth Hour 60+	2022-2030	The Environment Department of Bangkok has annual training sessions on climate change fundamental issues for internal agencies and relevant activities for exchanging knowledge of climate change with public sectors in Bangkok at least once a year.
IPST (Science and Technology)	IPST Action Plan "Strengthening Environmental Science Study on Climate Change" 2019-2022	GLOBE Mosquito Habitat Mapper Training	2019	IPST held 4 operational training courses for 2,098 students and teachers to raise awareness of the health impacts of climate change, particularly the diseases from mosquitoes that tend to increase due to higher temperature and intense precipitation.
		Climate change training	2019-2021	<ul style="list-style-type: none"> <li>• Training sessions on environmental science for 180 teachers from 88 schools</li> <li>• Training sessions on GLOBE Trees Around Us—the significance of trees and seasonal change—for 1,893 participants</li> <li>• Training sessions to provide climate knowledge and teaching methodology for teachers from 61 schools</li> </ul>
ONEP	Thailand's NDC Roadmap	Strengthen Thailand's expertise to support long-term GHG mitigation planning	2021	Office of Natural Resources and Environmental Policy and Planning (ONEP) by the Climate Change Management Coordination Division conducted a model training for forecasting the future of land use change to support the assessment of greenhouse gas emissions in the agricultural sector, forest, and land use. This training aims to develop and empower the country's experts in the development of models for GHG emissions analysis and to visualize the future of GHG emissions reduction and GHG reduction technology. ONEP has assigned the Academic Service Center of Chulalongkorn University to be a consultant for the project.
		Integrating climate change issues into the preparation of a provincial development plan	2020	ONEP and GIZ GmbH organized a training program on the integration of climate change issues to prepare provincial development plans for officials of the Regional Environment Agency, Office of Natural Resources and Environment and provincial office.

Source: 1) Electricity Generating Authority of Thailand 2) Institute for the Promotion of Teaching Science and Technology 3) Environmental Department Bangkok Metropolitan Administration

### 5.3.2.3 Public Awareness

In recent years, the level of public awareness on climate change issues in Thailand has increased significantly due to continuous efforts of various stakeholders to implement awareness-raising activities, the publication of scientific reports, the intense global climate movement, and accessible online media and social media platforms. Aligning with the ACE program, DEQP and other government agencies regularly launch public awareness campaigns on climate change, which extend well beyond formal education or training programs through social media, electronic communication, and events or by partnering with urban and rural local communities. The activities and campaigns aim to inform the

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public about the causes and impacts of climate change and actions that the public can contribute to addressing climate change. The DEQP also developed assessment tools, such as surveys on knowledge, attitudes, behavior, and practices to establish public awareness of climate issues, which can serve as a basis for further work on climate education, training, and awareness-raising. The key activities are illustrated in Table 5-8.

Table 5-8: Example of public awareness-raising activities

Agency	Policy/Plan	Project	Timing	Brief Description
DEQP	Action for Climate Empowerment (ACE) and Proactive Capacity Building Plan	Climate Change Awareness Index (CCAI)	2018	DEQP developed the Climate Change Awareness Index (CCAI) to evaluate awareness in three dimensions—knowledge, concerns, and behaviors. CCAI has a 0-1 scale to assess people's awareness via a web application that provides easy access and prompt result. The evaluation will be used to set future goals and plans for environmental education.
		Municipality Climate Change Action Indicator: MCCA	2018	DEQP conducted a study to evaluate a municipality's level of awareness and understanding of climate change issues. As a result, DEQP plans to enhance further the municipality's understanding of the Paris Agreement and climate change mitigation measures.
EGAT (Energy)	Energy conservation	Energy labeling Schemes: Energy Saving No.5 and Energy Efficiency for House and Green Schools	Present	EGAT employs energy labeling schemes to raise public awareness on energy consumption and conservation, promote Circular Economy, decrease energy consumption, reduce energy importation, and reduce GHG emissions.
OTP (Transport)	Thailand's NDC Roadmap	NDC Action Plan (Transport Sector)	2021-2030	OTP creates a roadmap for promoting public awareness and participation in reducing GHG emissions and building the capacity of human resources within the agency.
IPST (Science and Technology)	IPST Action Plan "Strengthening Environmental Science Study on Climate Change" 2019-2022	GLOBE projects on Raising awareness of the environment and climate change	2019-2021	<ul style="list-style-type: none"> <li>• Campaigning and creating a short film displaying the relations between climate change impacts and the increased mosquito population and how to prevent mosquito diseases</li> <li>• Creating infographics on water footprint "Valuing Water" and "what not to do for a sustainable world" (No forest burning, no deforestation, reduced energy consumption, etc.)</li> <li>• IPST organized an environmental science camp for students and teachers to enhance awareness of sustainable natural resource consumption, causes of environmental degradation, and climate change impacts.</li> </ul>

Source: 1) Electricity Generating Authority of Thailand (EGAT) 2) Institute for the Promotion of Teaching Science and Technology 3) Department of Environmental Quality Promotion (DEQP) 4) Office of Transport and Traffic Policy and Planning (OTP)

Furthermore, government agencies and environmental organizations use market-based instruments "Green Label" or "Carbon Label" to promote environmentally friendly production and consumption of energy, products, and services. For instance, the Electricity Generating Authority of Thailand (EGAT) employs "Energy Saving Label No.5"

and “Energy Efficiency for House and Green Schools” to raise public awareness of energy efficiency and conservation, promote Circular Economy, decrease energy consumption, reduce energy importation, and reduce GHG emissions. Also, Thailand Environment Institute (TEI), in association with the Ministry of Industry, launched the “Green Label” in 1994. The Green Label is an environmental certification awarded to specific products shown to have minimum detrimental impacts on the environment compared with other products serving the same function. The Thai Green Label Scheme applies to products and services, not including foods, drinks, and pharmaceuticals. Moreover, the Green Leaf Foundation runs the “Green Leaf Label” to certify hotels and tourism activities that ensure energy efficiency, environmental protection, pollution reduction, and natural resources conservation in their management and services. For the carbon labels, Thailand Greenhouse Gas Management Organization (TGO) developed carbon label projects for products and corporates, as described in Chapter 3. TGO also developed the label “CoolMode” which represents the label certifying cool, comfortable, and easy-to-clean clothes. Wearing “CoolMode” clothes can help reduce energy use in air conditioners and washing machines as well as reduce water consumption.



Figure 5-3: Examples of green labels and carbon labels in Thailand

Source: 1) Electricity Generating Authority of Thailand (EGAT) 2) Thailand Environment Institute (TEI) 3) The Federation of Thai Industries 4) Thailand Greenhouse Gas Management Organization (TGO)

### 5.3.2.4 Public Participation

Those affected by the decision have a right to be involved in the decision-making process. Providing the public with an opportunity to share their views and perspectives in decision-making processes enhances the quality of decisions. It often results in a high compliance rate with the policy or regulation being implemented. Thai Constitution 2017 guarantees the right of public participation in environmental management according to Section 57 (2) and the environmental policy-making process in Section 65.

As a result, public participation in the policy-making process is the key commitment that has been carried out in various climate policy development, such as stakeholders' consultation and engagement during the preparation of the 13<sup>th</sup> National Economic and Social Development Plans, Thailand's Nationally Determined Contribution (NDC), National

## CHAPTER 5

Adaptation Plan (NAP), and UNFCCC's related reports. In particular, public hearings have been organized for the preparation process of Thailand's National Communications to the UNFCCC, Biennial Update Reports, Mid-Century, Long-Term Low Greenhouse Gas Emission Development Strategy (LTS), and updated Thailand's Nationally Determined Contribution (NDC).

For public participation in environmental management, Section 57 stated that the State shall conserve, protect, maintain, restore, manage, and use or arrange for utilization of natural resources, environment, and biodiversity in a balanced and sustainable manner, provided that the relevant local people and local community shall be allowed to participate in and obtain the benefit from such undertaking as provided by law.

Following this founding, DEQP and other governmental entities have enhanced public participation in activities and measures relating to climate actions and environmental sustainability. Some activities are depicted in the Table 5 9.

Table 5-9: Examples of public participation activities

Agency/ Sector	Policy and Plan	Projects	Timing	Brief Description
DEQP	Action for Climate Empowerment (ACE) and Proactive Capacity Building Plan	Zero Waste Community-Zero Waste School	2019-2021	Zero Waste Community-Zero Waste School was initiated within the sustainable waste management project. The participants were local governments, local communities, and schools developing mechanisms and action plans to recycle and reduce waste production and GHG emissions from waste. From 676 locations, the overall waste reduction was 94,012 tons, and GHG emissions decreased by 218,107.84 tCO <sub>2</sub> eq.
		G Green Standard	2019-2021	DEQP strengthens public participation in environmental management, particularly climate change actions, by developing the G Green service standard for: <ul style="list-style-type: none"> <li>• Green production</li> <li>• Green hotel</li> <li>• Green office</li> <li>• Green religion</li> <li>• Green national park</li> <li>• Green Restaurant</li> <li>• Green Upcycle</li> <li>• Green Area</li> <li>• Sustainable City</li> </ul>
DOF	National Waste Management Master Plan 2016-2021	Net Free Seas	2019-2022	Department of Fisheries, together with the Environmental Justice Foundation (EJF), initiated pilot projects to recycle and reuse fishing nets in 47 coastal communities with more than 700 participants. The projects aimed to reduce marine plastic pollution caused by shredded fishing nets. The communities managed to collect shredded fishing nets in the area and sell them at 10 THB/kg to transform them into microplastics, reusing them to produce other items. This operation aligned with the principle of Circular Economy. The overall waste reduction was 14,000 kg. Each community can participate, recommend, and decide how to manage income earned from the project.

Table 5-9: Examples of public participation activities (cont'd)

Agency/ Sector	Policy and Plan	Projects	Timing	Brief Description
		Waste Free Seas	2021-2030	Department of Fisheries, with the participation of the National Fisheries Association of Thailand and all relevant stakeholders, set up a waste management system in the coastal areas and fisheries communities. The objective is to enhance community participation in marine resource conservation and waste management. Fishing vessels are encouraged to avoid using undegradable containers and dumping those in the sea. The operation requires fishing vessels to collect, record, and report the amount of waste collected. All registered ports have a spot to sort wastes to reuse and recycle. As of 2021, overall collected waste from the sea totaled to 182,876 kg, consisting of fishing nets, plastic bottles, glass bottles, and other waste.

Source: 1) Department of Environmental Quality Promotion (DEQP) 2) Department of Fisheries

### 5.3.2.5 Public Access to Information

ACE reinforces that information on the climate crisis should be readily accessible and freely available to the public, so they are equipped with the tools to play an active, meaningful role in climate policy and action. Thus, the right of public access to information and the state's duty to disclose information are necessary for enhancing public awareness of climate change and ensuring the state's transparency and good governance.

This right is endorsed in many legal instruments and climate-related policies and plans in Thailand. Section 59 of the Thai Constitution 2017 stated that the State shall disclose any public data or information in the possession of a State agency, which is not related to the security of the State or government confidentiality as provided by law and shall ensure that the public can conveniently access such data or information. This right is also guaranteed by the Official Information Act 1997 to ensure transparency and good governance in the administration. In Section 6 of the Enhanced and Conservation of the National Environmental Quality Act 1992, any individual has the right to obtain information and news from the government in matters related to the enhancement and conservation of environmental quality.

In compliance with these legal foundations and the ACE program, Thailand has constantly improved its performance in enabling public access to climate information in the following elements:

- Increase the availability and accuracy of the information, academic publications, law and regulations, and other related materials
- Widely disseminate information on climate change and improve public access to information at all administrative levels by using various channels and mechanisms adapting to communities, groups, and individuals
- Ensure that the information provided is up to date

The most effective communication mechanism for disseminating up-to-date climate-related information, research, work progress, and target achievement is government agencies' official web-based or social media platforms in charge of climate-related tasks. For instance, ONEP, a national focal point of the UNFCCC, provides a database for the national GHG Inventory, a risk database system by area, and other climate-related information. Environmental Research and Training Center (ERTC), under the supervision of DEQP, compiles all research on climate change issues from 2007 to 2018 (in total of 1,389 articles) in these six areas: the science of climate change, GHG emissions, and elimination, climate change impacts, climate change mitigation, climate change adaptation, climate change policy. All articles are grouped and shared via its official website.

*Source: 1) Office of Natural Resources and Environmental Policy and Planning 2) Department of Environmental Quality Promotion (DEQP)*

### 5.3.3 Regional and International Cooperation to Promote Education, Training, and Public Awareness

As regional and international cooperation can strengthen and accelerate the national implementation of ACE works, Thailand has joined forces with regional and international communities to foster the exchange of good practices and lessons learned from ACE implementation.

As an ASEAN member state, Thailand participates in the ASEAN Working Group on Environmental Education (AWGEE), a subsidiary body under the ASEAN Senior Official on the Environment (ASOEN), leading the technical and operational implementation of AWGEE Action Plan 2016-2020. The AWGEE was established as a consultative forum to promote coordination and collaboration among ASEAN sectoral bodies and dialogue partners to ensure a well-coordinated and integrated approach to promoting environmental education in the ASEAN Member States (AMS) and ASEAN Dialogue Partners (Australia, Canada, China, European Union, India, Japan, Republic of Korea, New Zealand, Russia, and the United States). According to the 11<sup>th</sup> AWGEE meeting in 2019, key activities of member states include:

- *ASEAN Eco-Schools Program aims to create a school culture geared toward environmental protection and preservation through management, commitment, and infusion into the curriculum, co-curriculum, and greening and cleaning activities.*
- *ASEAN Green Higher Education Program, led by the Philippines and Thailand, aims to generate baseline data on eco-friendly initiatives of colleges and universities in the ASEAN Region, including (i) a review on the state of the greening of higher education institutions among AMS; (ii) review the ASEAN Eco-schools Guidelines to include a higher education category; and (iii) target the inclusion of a higher education category in the NEXT ASEAN Eco-schools Awards.*
- *ASEAN Plus Three Youth Environment Forum (AYEF) is organized regularly to promote awareness and enhance the participation and cooperation of youth in environmental protection efforts. The hosting of the AYEF is on a voluntary basis. A Philippine delegate was sent to Singapore in 2018, and Thailand volunteered to host the 2019 AYEF.*

At the international level, Thailand steadily participates in the annual in-session ACE Dialogues under the UNFCCC, a regular forum for Parties and other stakeholders to share their experiences and exchange ideas, good practices, and lessons learned regarding ACE implementation.

In addition, Thailand also participates in two flagship networks that serve as parts of the Education on Sustainable Development (ESD) project launched by the United Nations University Institute for the Advanced Study of Sustainability (UNU-IAS): Regional Centres of Expertise on Education on Sustainable Development (RCEs) and the Promotion of Sustainability in Postgraduate Education and Research Network (ProSPER.NET).

The first is a global network of Regional Centres of Expertise on Education on Sustainable Development (RCEs), a network of existing formal (schools and universities), non-formal, and informal organizations (e.g., NGOs, media, and community leaders.) that facilitate learning toward sustainable development in local and regional communities. Its goals are: 1) Re-orient education toward SD, covering existing programs/subjects from the point of ESD, and designing and integrating SD in curricula. ESD programs are tailored to address issues and the local context of the community in which they operate; 2) Increase access to quality education that is most needed in the regional context; 3) Deliver trainers' training programs and develop methodologies and learning materials for them; and 4) Lead advocacy and awareness-raising efforts in public about the importance of educators and the essential role of ESD in achieving a sustainable future. RCEs promote the long-term goals of ESD, such as environmental stewardship, social justice, and improvement of the quality of life.

The second is a network of higher education institutions called the Promotion of Sustainability in Postgraduate Education and Research Network (ProSPER.NET), an alliance of leading universities in the Asia-Pacific region committed to integrating sustainable development into postgraduate courses and curricula. ProSPER.Net was founded in June 2008 within a broader international agenda that recognizes the importance of education and research to help build a more sustainable future. Five universities from Thailand are members of ProSPER.Net: Asian Institute of Technology, Chulalongkorn University, King Mongkut's University of Technology Thonburi, Mahidol University, and Prince of Songkla University. These universities provide extensive programs and research collaborations on sustainable development and climate change.

Furthermore, Thailand is a member of Global Learning and Observations to Benefit the Environment (GLOBE), an international effort to bring students, science teachers, scientists, and local communities together to carry out research on Earth System Science (ESS), including climate change context. The Institute for the Promotion of Science and Technology (IPST) was appointed as Thailand's GLOBE coordinator. With GLOBE collaboration, IPST implemented numerous activities promoting climate education, training, and public awareness. IPST works closely with teachers and students in schools within the Education Office of the Bangkok Metropolitan Administration and the Ministry of Education, universities in different regions of the country, pertinent departments in

the Ministry of Science and Technology, Ministry of ICT, Ministry of Natural Resource and Environment, Ministry of Agriculture and Cooperatives, Kirdkao Observatory, and the Thai Homeland Institute.

*Source: 1) ASEAN Working Group on Environmental Education (AWGEE) 2) Regional Centres of Expertise on Education on Sustainable Development (RCEs) 3) Promotion of Sustainability in Postgraduate Education and Research Network (ProSPER.NET) 4) Global Learning and Observations to Benefit the Environment (GLOBE)*

### 5.4 Capacity Building at the National and Sub-Regional Levels

#### 5.4.1 Policy and Institutional Framework for the Implementation of Article 11 of the Paris Agreement

Capacity-building is a fundamental building block for ensuring the successful implementation of climate policies and actions. It enables individuals, government agencies, private sectors, and societies to effectively address climate change issues by employing mitigation or adaptation measures. Capacity-building is involved in many Articles of the Convention, such as Articles concerning climate adaptation, research, technology transfer, education, and training. The Paris Agreement further emphasized the significance of capacity-building in Article 11, which defines capacity-building-related goals, guiding principles, and procedural obligations for all Parties. It urges developed countries to support capacity building in developing countries and developing country Parties to communicate progress on implementing capacity-building plans regularly, policies, actions, or measures. Since the establishment of the Convention in 1992, the institutional architecture addressing capacity building in the UNFCCC process has been evolving. At COP21, the Paris Committee on Capacity-Building (PCCB) was established as a newly constituted body to address current and emerging capacity needs and gaps and further enhance capacity-building efforts. The PCCB has been tasked with managing and overseeing the capacity-building work plan for the period 2016–2020. At COP24, the Capacity-building Hub was formed to be a space for representation, collaboration, and knowledge sharing. At COP26, the 3<sup>rd</sup> Capacity-building Hub emphasized several issues, including 1) the inclusion of women and youth, multiple languages, and all traditionally marginalized voices is key to success; 2) Locally owned, long-term, sustainable capacity-building is highly favorable to the traditional method of ad hoc, foreign-led, temporary initiatives.

Thailand sets a high priority on enhancing capacity-building in climate actions and sustainable development. Thus, capacity-building has been incorporated into many national, sectoral, and local government plans and programs, such as the National Economic and Social Development Plans, National Adaptation Plan, and Thailand's Nationally Determined Contribution. Thailand's Climate Change Master Plan (CCMP) 2015-2050 also targets achieving climate resilience, developing capacity, and enhancing stakeholders' involvement at all levels. Capacity-building, particularly in the adaptation context, is the key to achieving CCMP's goals in all three phases: short, middle, and long terms. Thailand also strives to enhance its national capacity to cope with climate change relating to *SDG 13—Take Urgent Action to Combat Climate Change and its*

*Impacts.* In terms of the prevention and mitigation of adverse effects of climate-related disasters, various capacity-building programs have been conducted for personnel of district centers, provincial offices, and other local agencies to enhance their knowledge and capacities regarding the formulation of local disaster prevention and mitigation plans and the alignment of such plans with the National Disaster Prevention and Mitigation Plan 2015.

Source: 1) Thailand's Intended Nationally Determined Contribution 2) Thailand's Climate Change Master Plan (TCCMP) 2015-2050 3) Thailand's Voluntary National Review on the Implementation of the 2030 Agenda for Sustainable Development 2021, Ministry of Foreign Affairs

### 5.4.2 Capacity Building Initiatives and Activities

Core government agencies are working on scaling-up capacity-building programs to strengthen the institutional, systematic, and individual capacities enabling the preparation, coordination, and implementation of climate actions. Key initiatives, programs, and activities are described in Table 5-10.

Table 5-10: Examples of capacity-building activities

Agency	Project	Timing	Brief Description
BMA	Bangkok Master Plan on Climate Change	2021-2030	According to Bangkok Master Plan on Climate Change 2021-2030, BMA initiates capacity-building plans and activities for BMA officials, relevant stakeholders, and citizens. For the officials, BMA, in collaboration with JICA, organizes training for the working group in each sector and the Climate Change Strategy (CCS) sub-division staff. BMA also conducts and promotes capacity-building and outreach for relevant stakeholders, such as government agencies, civil society, state enterprises, and the private sector, including academic institutions, NGOs, and international organizations. The collaboration can be created through the exchange of knowledge from training, seminars, and publications as well as cascade Bangkok's execution through the communication channels such as the official website of the Department of Environment ( <a href="http://www.bangkok.go.th/environmentbma">http://www.bangkok.go.th/environmentbma</a> ), the official website of the Bangkok Master Plan on Climate Change and the website of the other internal departments within BMA.
DEQP	Capacity building programs for environmental management	2018	<ul style="list-style-type: none"> <li>• Environmental management training programs for local governmental organizations, local communities, and private sectors</li> <li>• Online courses on climate change issues for DEQP officials, private sectors, students, and all citizens</li> <li>• Courses on mitigation measures (GHG reduction) focus on decarbonizing the production and process methods, sustainable consumption and service, and green innovation for eco-tourism.</li> </ul>
DEQP	<ul style="list-style-type: none"> <li>• Young Thai Environmentalists 2018: YTEn</li> <li>• ASEAN Youth Camp</li> </ul>	2018	<ul style="list-style-type: none"> <li>• Young Thai Environmentalists project is initiated to develop a learning process on climate change issues for young students. This project aims to build the capacity and network of young students. Thus, they will be motivated to be proactive and drive the social movement toward a sustainable future.</li> <li>• ASEAN Youth Camp was held in 2018 under ASEAN Youth Stepping Toward Environmental Sustainability. The project aims to provide opportunities for young generations from ASEAN member states to share their experiences working on different environmental problems in their countries. Many environmental problems are related to climate change (e.g., Vietnam's project on CO<sub>2</sub> reduction using seaweed filters, Thailand's project on crop burning reduction, and Indonesia's project on peatlands/mangroves conservation).</li> </ul>

Table 5-10: Examples of capacity-building activities (cont'd)

Agency	Project	Timing	Brief Description
TGO	Climate Change International Technical and Training Center (CITC) and Climate Action Academy (CAA)	2014 -present	TGO via CITC and CAA holds a sequence of training sessions on climate change measures in various contexts, such as climate finance, climate negotiation, carbon tax, climate mitigation policies, and climate adaptation for cities and communities. Training sessions aim to enhance the capacity of government officials and public sectors.

Source: 1) Department of Environmental Quality Promotion (DEQP) 2) Environmental Department Bangkok Metropolitan Administration 3) Thailand Greenhouse Gas Management Organization

### 5.4.3 Regional and International Cooperation to Promote Capacity Building

Regional and international cooperation are necessary for enhancing Thailand and the global community's capacity to respond to the challenge of climate change. The United Nations Framework Convention for Climate Change (UNFCCC) secretariat and the Institute for Global Environmental Strategies (IGES) established the Regional Collaboration Centre (RCC) Bangkok in September of 2015 to provide hands-on support to governments, NGOs, and the private sector in Asia and the Pacific region to develop their mitigation efforts through capacity building, direct technical assistance, and strategic networking.

At the regional level, the Thailand Greenhouse Gas Management Organization (TGO) launched **the Climate Change International Technical and Training Center (CITC)** with support from Japan International Cooperation Agency (JICA) in 2014 to serve as a knowledge hub and training platform to help meet the needs of ASEAN stakeholders to develop their capacity. The center's objectives include promoting collaborative initiatives and addressing common and specific challenges among the ASEAN Member States and stakeholders. This is accomplished by sharing experience and knowledge at the intra-regional, sub-regional, and bilateral levels. In 2021, the United Nations Office for South-South Cooperation (UNOSSC), TGO, and JICA jointly published "South-South in Action: Capacity Building for Climate Actions in Southeast Asia," which elaborates TGO/CITC's climate change capacity-building activities and programs. It highlighted five primary cases: Regional Training on Climate Change (Mitigation, Adaptation, and Climate Finance), engagement with the ASEAN Working Group on Climate Change (AWGCC) and ASEAN Climate Change Partnership Conferences, Bilateral South-South Cooperation between TGO/CITC and Viet Nam, TGO/CITC Regional Conferences, and Strategic Engagement in United Nations Climate Change Conferences.

As a result of the successful execution of the CITC, TGO decided to expand the capacity building activities and collaboration by integrating the CITC and other training and outreach programs into a newly established **TGO Climate Action Academy (CAA)** which focuses on enhancing competence in climate change issues both in Thailand and the

Southeast Asia region. CAA aims to develop the capacity for personnel in climate change management in Thailand, especially senior executives and leaders from all sectors, to have knowledge and understanding of their roles in promoting the circular economy to achieve maximum productivity, energy efficiency, minimum waste, and greenhouse gas emissions reduction and to promote the consumption of products with low carbon emissions and create a low carbon society. Recently, TGO by CAA, in collaboration with JICA and ONEP, organized the "ASEAN Workshop on preparing for the Enhanced Transparency Framework under the UNFCCC" through the Zoom program for 52 trainees from 6 ASEAN countries to build an understanding of the MRV Report and the Enhanced Transparency Framework (ETF).

Furthermore, Thailand is also a member of **the Asia-Pacific Network for Global Change Network (APN)**, an intergovernmental network addressing global change and sustainability through innovative and transdisciplinary research and capacity development activities that support policy development and implementation. The APN supports research and science-based response strategies, including climate change. It also focuses on linking scientific outcomes with policy mechanisms applicable to all levels of governance and societal sectors in each country. The APN, through its scientific capacity development program (CAPaBLE) supports activities that enhance capacity at individual, organizational and systemic levels. Examples of latest activities include the capacity building programme on developing project proposals for climate change adaptation for Northeast Thailand; capacity building for measuring multi-hazard livelihood security and resilience in the Lower Mekong Basin; and scientific capacity building in assessing the coastal dynamics (land-use, biodiversity & ecosystem services) including the influence of climate change in the coastal zone – toward a locally adapted Marine Spatial Planning (MPS) Framework.

*Source: 1) Regional Collaboration Centre (RCC) 2) Thailand Greenhouse Gas Management Organization (TGO) 3) Asia-Pacific Network for Global Change Network (APN)*

## **5.5 Information Sharing and Networking**

### **5.5.1 Information Sharing**

The Office of Natural Resources and Environmental Policy and Planning (ONEP) was assigned to be a national focal point of the UNFCCC in 2004. The Climate Change Management and Coordination Division (CCMC) within ONEP is responsible for three main tasks: 1) advising and proposing policy, plan, and measures for climate change mitigation and adaptation; 2) tracking and coordinating public sectors and private sectors' works on climate change; 3) disseminating information relating to climate change policies, plans, initiatives, and activities. ONEP acts as a coordinator and information-sharing hub for climate change networking at national, regional, and international levels.

ONEP is developing an information system, a database of the International Collaboration Program on Climate Change. It is designed to categorize data aligning with the Climate Change Master Plan 2015-2050. It is also open to government agencies, the private sector, and international organizations to search for project information in the system to reduce redundancy in operation, serve as a building block for future climate projects, and to be used in negotiations on international cooperation on climate change. The objectives of this database are:

- *To gather information on international cooperation projects under the climate change framework.*
- *To create a database information system for the implementation of international cooperation projects on climate change in Thailand for gap and needs analysis and support policy and decision-making for international cooperation on climate change.*
- *To acquire recommendations and guidelines for the implementation of international cooperation projects on climate change in the future to be used for determining Thailand's negotiation strategies in the framework of bilateral and multilateral cooperation on climate change.*

*Source: Office of Natural Resources and Environmental Policy and Planning (ONEP)*

### 5.5.2 Networking

Thailand has cooperated and collaborated with bilateral, regional, and multilateral partners to strengthen climate technology development, research and observation, education and awareness raising, capacity building, and other climate actions. These collaborations can also be observed in mitigation and adaptation measures in Chapter 3 and 4. Many national climate initiatives and activities received support from international communities, both bilateral and multilateral levels, which will be further discussed in the next chapter. Through networking at all levels, Thailand advances national climate implementation, fulfilling its commitments to the Convention, contributing to global climate mitigation, and strengthening its capacity to cope with climate impacts.

At regional level, as part of the Association of Southeast Asian Nations (ASEAN), Thailand has cooperated to address climate change in a regional collaboration platform through the ASEAN Working Group on Climate Change (AWGCC). In 2019, on behalf of the ASEAN Chairmanship, Thailand took the lead in ASEAN's initiatives and activities on climate actions as follows:

- *Developing ASEAN Joint Statements on Climate Change and communicating to United Nations multilateral mechanisms aiming to reaffirm the ASEAN's commitments and priorities toward achieving the goals of UNFCCC and the Paris Agreement. First, the ASEAN Joint Statement on Climate Change to UNFCCC COP25 was communicated by HE Mr. Varawut Silpa-archa, Thailand's Minister on Natural Resources and Environment, at COP25 held in Madrid. Besides the annual statement to COP, the ASEAN Joint Statement on Climate Change to the UN Climate Action Summit 2019 was delivered by Thailand's Prime Minister General Prayut Chan-o-cha during UN General Assembly held in New York.*

- *Organizing the regional workshop on Strengthening Climate Resilience of AMS through Experience Sharing and Lesson Learned on Progress of Climate Change Adaptation Activities in May 2019 at Chiang Rai Province, Thailand. The workshop is a platform for sharing knowledge and experience on climate change adaptation and resilience among the ASEAN Member States, including showcases and best practices of Thailand in related areas. Constructive discussions included challenges and opportunities in climate policy development and implementation at sectoral and sub-national levels.*

In addition, in 2021, Thailand was involved in several ASEAN activities, including developing the first ASEAN State of Climate Change Report, which outlined the ASEAN vision on climate action toward 2050 in line with the Paris Agreement's goals taking into account national circumstances.

*Source: Office of Natural Resources and Environmental Policy and Planning (ONEP)*



# CHAPTER 6

CONSTRAINTS,  
GAPS, NEEDS, AND  
SUPPORT RECEIVED

# CHAPTER 6: CONSTRAINTS, GAPS, NEEDS, AND SUPPORT RECEIVED

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*Thailand has received support from various international partners to facilitate climate actions in mitigation, adaptation, and enabling environment, including the preparation of Thailand's Fourth National Communication (NC4) and Third Biennial Update Report (BUR3) to the UNFCCC. From 2020-2022, Thailand has received support from multilateral and bilateral partners for a total of 34 projects, entailing 18 mitigation projects with a total amount of 31,438,771 USD, 10 adaptation projects with a total amount of 48,667,056 USD, and 6 enabling environment projects with a total amount of 3,419,548 USD. Most support was a combination of technical support and capacity building.*

*The international support enables Thailand to overcome its constraints, gaps, and barriers to climate action. We take this opportunity to express our gratitude and appreciation for all the support.*

*However, considering remaining constraints and gaps, Thailand still needs international support in terms of finance, technical expertise, technology transfer, and capacity building to ensure the achievement of LT-LEDS in a short-term period (2025-2035), a mid-term period (2040-2050), and a long-term period (2050-2065). More support is needed, particularly for technology development and transfer, which is essential for mitigation and adaptation implementation. For mitigation, Thailand needs support for the energy transition toward renewable sources focusing on renewable energy technologies (such as solar and wind), enhancing the potential use of Carbon Capture Storage (CCS) & Carbon Capture, Utilization, and Storage (CCUS) technologies, and developing other technologies to achieve GHG emission reduction and a net-zero emission. For adaptation, support is needed for developing a data map showing areas at risk of climate change impacts and accessible viable adaptive technology. To enhance the enabling environment, Thailand requires support for developing and strengthening mechanisms, instruments, and policy implementation, such as financial instruments and incentives to engage private sectors in green investment and capacity building for all stakeholders to integrate climate actions into their respective practice and plans.*

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## 6.1 Constraints, Gaps, and Needs

Abiding by its commitments under the Convention, Thailand has unceasingly undertaken climate actions in mitigation, adaptation, and enabling environment. Still, constraints and gaps remain primarily regarding access to finance, technical expertise, technology development and transfer, and capacity building. Support from international communities will help Thailand overcome these impasses and expose its full capacity to implement climate actions.

This section reports constraints, gaps, and the international support needed for the climate implementation of three areas: mitigation, adaptation, and enabling environment. This information was obtained from the priorities stipulated in the LT-LEDS for Thailand's

transition to carbon neutrality and net-zero GHG emissions and the result of stakeholders' consultation via focus group meeting. The stakeholders include all relevant government agencies overseeing climate change measures in respective sectors.

Under each area, a conclusion of constraints and gaps is accentuated, and a description of support needed is briefly summarized in the Tables and categorized into four groups as follows:

a. *Technology Development and Transfer (TT)*: support needed to develop and transfer innovative and practical technologies to support Thailand's actions on climate change, particularly the development of infrastructure and climate-related technology such as EV infrastructure, clean and renewable energy, and GHG reduction technology

b. *Technical Support/Assistance (TS)*: non-financial assistance needed from international specialists, can take the form of sharing information and expertise, the transmission of working knowledge, and consulting services and may also involve the transfer of technical data, know-how and knowledge. This may include but not be limited to the support in policy development and implementation, development of mechanisms and instruments, climate information, and M&E systems.

c. *Capacity Building (CB)*: support needed for developing and strengthening the skills, abilities, processes, and resources of organizations and stakeholders for planning and taking climate actions. This includes support for preparing the forthcoming National Communications and Biennial Update Reports.

d. *Financial Support (FS)*: support needed in the form of money or financial instruments such as a grant, soft loan, equity, or guarantee to support and leverage government and private sector investment in climate actions, particularly for incremental cost or risk premium required to make the investment of climate action viable, or to cover specific activities such as technical assistance or capacity building

### 6.1.1 Mitigation

As Thailand intends to become carbon neutral by 2050 and achieve net-zero GHG emissions by 2065, the priority is given to research development and deployment on mitigation measures reducing GHG emissions, particularly in the energy and transport sector. The energy sector, the most significant contributor to Thailand's GHG emission, has a vital role in implementing climate mitigation measures. The latest adoption of the National Energy Plan 2022 articulates elevated targets to enhance energy efficiency, increase renewable energy production, transition toward green energy for transportation, and transform the energy business structure to embrace energy transition. The industrial development strategy also reflects the urge to stimulate the green growth engine focusing on environmentally friendly technology development and renewable energy transition. Despite being a modest contributor to GHG emissions, the waste sector aims to eliminate the waste from its production sources for sustainable waste management by employing three principles: Reduce, Reuse, and Recycle. The National Solid Waste Management Master Plan also seeks to enhance energy production and organic fertilizer from waste.

### Constraints and gaps

The core constraint of realizing the mitigation targets and measures is to balance between securing energy production and reducing GHG emissions. The energy transition requires high technical capacity, technology advancement, and sufficient investment funds, particularly for technology and infrastructure development costs. While attempting to reduce GHG emissions, the Energy sector must secure energy supply bearing the cost of energy types, prices, and governmental policy on fossil fuels, which affect overall national economic growth. Thus, it is vastly challenging to maintain the equilibrium between energy security, economy, and environment. For the transport sector, the main barrier is limited resources and funding to develop and implement climate mitigation initiatives such as investment in electrification of transport and battery charging technologies, road-to-rail model shift for both freight and passenger transport, or awareness-raising for increased use of public transportation. For the waste management, limited financial resources, capacity, and technology development at subnational and local levels for waste management systems remain key obstacles, such as insufficient knowledge and development of GHG reduction technology for wastewater treatment and inadequate financial resources, technical capacity, and technology for producing energy from waste.

### Support Needed

Thailand's mitigation measures focus on the Energy, IPPU, Agriculture, and Waste sectors accountable for overall national GHG emissions. In addition, with growing attention on the nature-based solutions for climate mitigation, forests and their carbon sequestration capacity have become subjects of research and technology development. Support in various types is still needed to ensure the achievement of LT-LEDS in a short-term period (2025-2035), a mid-term period (2040-2050), and a long-term period (2050-2065), particularly for the followings:

#### Energy, IPPU, and transport:

- In a **short-term** period, Thailand urgently needs support for the energy transition toward renewable sources focusing on renewable energy technologies (such as solar and wind); approaches in advanced energy storage system (EES) and demand-side management; and development of electric vehicle (xEV), battery, and infrastructures; and increasing grid modernization, smart energy management, and Independent Power Supply (IPS).
- In a **mid-term** period, Thailand needs support to enhance the potential use of Carbon Capture Storage (CCS) & Carbon Capture, Utilization, and Storage (CCUS) technologies in industries and power plants, and Bioenergy with CCS.
- In a **long-term** period, Thailand needs support to develop other technologies to achieve GHG emission reduction and a net-zero economy (e.g., Hydrogen or Bio-hydrogenated diesel)

#### Agriculture and waste

- In a **short-term** period, support is needed for enhancing the GHG reduction technologies in the agriculture and waste sectors such as Methane reduction in rice cultivation, waste and wastewater treatment, and waste-to-energy technology.

• In a **mid-term** period, Thailand needs support in developing technologies for soil and manure management and water usage reduction and circulation.

The overall support needed for mitigation actions is presented in in Table 6-1:

**Table 6-1:** Summary of financial, technology, technical and capacity-building support needed for mitigation actions

Sector	Support Needed (Policy, Plan, Measure, Program, Project)	Key Stakeholder	Support Type			
			CB	TS	TT	FS
Energy IPPU	Enhancement of Carbon Capture Storage & Utilization (CCS-CCU) Technology and development of concept and case study of Hydrogen Fuel Cell	EGAT, DIW	x	x	x	x
Energy	Development of Carbon Neutrality planning and forecasting model of GHG emission	EGAT	x			x
Renewable Energy	Development of technology for solar cooling, heating, and energy for public transport	DEDE	x	x	x	x
Renewable Energy	Research and technology transfer for reducing the production cost of biofuel and enabling biofuel use in the various transport sector such as aviation	DEDE	x	x	x	
Energy	Technology & Innovation of renewable energy (RE) and Industrial energy efficiency (EE) & Conservation	DEDE	x	x	x	x
Energy	Implementation of the area-based emission trading system in area base, especially in the Eastern Economic Corridor	TGO	x	x		x
Energy	Intensive capacity building and technical support for the implementation of Internal Carbon Pricing	TGO	x	x		x
Wastewater	Development of knowledge and technology for water usage reduction, water circulation, and wastewater treatment appropriated for local context for GHG reduction	ONWR	x	x	x	x
Transport	Electrification for transport and battery charging technologies, a transition of public transport into EV, improving Non-Motorized Transport, and formulating policies and measures enabling the utilization of EV	OTP	x	x	x	x
Transport	Development of a central database for climate change and GHG data for transport sector	OTP	x	x	x	x
Agriculture	Development of GHG reduction technology for agriculture and preparation of policy recommendations for mitigation measures	OAE	x	x	x	
Agriculture	Development of tools for tracking carbon emissions in agricultural areas, training sessions, and research on climate change impacts in the agriculture sector	LDD	x	x	x	x
Forestry	Enhancement of knowledge and technology to track the change of carbon stock in mangrove forests	DMCR		x		x
Forestry	Development of tools for tracking and reporting carbon stock in forest areas	RFD		x	x	x

**Remark:**

TT: Technology Development & Transfer / TS: Technical Support & Assistance / CB: Capacity Building / FS: Financial Support

### 6.1.2 Adaptation

Thailand is highly vulnerable to climate change impacts. According to the Global Climate Risk Index 2021, Thailand was ranked the 9<sup>th</sup> most affected country in terms of human impacts and direct economic losses from weather-related loss events during 2000-2019.

Aiming to increase adaptive capacity and climate resilience, Thailand has formulated the National Adaptation Plan (NAP) to be an implementation framework to integrate climate change adaptation into the sectoral and local strategic plans, covering six priority sectors, including water resources management, agriculture and food security, tourism, public health, natural resources management, and human settlements and security. The objectives are 1) to increase water security and decrease losses and damage from water-related disasters, 2) to maintain productivity and food security amidst climate change risks and impacts, 3) to strengthen the capacity of the tourism sector toward climate resilience and sustainable development, 4) to establish effective public health systems to manage risks and reduce impacts from climate change, 5) to sustainably manage biodiversity resources to respond to climate change impacts, and 6) to enhanced capacity of individuals, communities, and cities, to adapt to climate change impacts appropriately according to the local context.

#### Constraints and gaps

The fundamental barriers to the implementation of adaptation measures are 1) unfinished development of a central database and insufficient data integration and coordination on climate change projection and impacts, 2) lack of a national climate information center compiling climate-related information, 3) insufficient knowledge and research on climate-related risks for key stakeholders to comprehend and implement appropriate adaptation measures, 4) limited access to adaptive technology, and 5) inconsistent financial supports and distribution. For instance, the health sector still requires research on climate-related risks, a central database identifying climate impacts on human health at local and national levels, and uniform distribution of resources in terms of healthcare budget and technical experts. Similarly, the water management sector requires knowledge development for forecasting models, a central water resource and climate change database, and institutional arrangement for uniform budget distribution and climate measures implementation.

#### Support Needed

According to the ONEP database, support is needed primarily for:

- *Developing a data map showing areas at risk of climate change impacts. The map should show an overview and data on a specific sector (e.g., showing drought and floods for water management and agriculture sectors or showing ecological risks or disasters for the tourism sector)*
- *Developing assessment data on climate change impacts, using both models and observation data. The data includes loss or damage from impacts and effects on ecosystems, watershed cycle, life cycle of insects, various pathogens, and outbreaks of pathogens, including their impacts on food security, tourist attractions, and communities that settle near or rely on such natural resources*

- *Creating a central data center that manages and links information related to adaptation, research data, weather research, forecasting information (WRF-ARW model), and relevant information between fields, such as information on agriculture and water for effective management*

The overall support needed for adaptation actions identified by relevant agencies is presented in Table 6-2:

**Table 6-2:** Summary of financial, technology, technical, and capacity-building support needed for adaptation actions

Sector	Support Needed (Policy, Plan, Measure, Program, Project)	Key Stakeholder	Support Type			
			CB	TS	TT	FS
Resources	Knowledge and technology for tracking and managing sea temperature change, coral bleaching, coral diseases, coral reef immunity, and ocean acidification	DMCR	x	x		x
Natural Resources	Database development for forecasting climate change impacts on the ecosystem and natural resources	DMCR		x		x
Natural Resources	Development of forest map indicating climate change vulnerabilities	RFD		x	x	x
Tourism	Development of sustainable tourism destination, tourist route plans, and smart tourism village design guidelines.	DOT	x	x		x
Multi-Sectoral	Development of a civil society network for climate mitigation and adaption actions	DEQP	x			x
Agriculture	Development of criteria and co-benefit assessment on mitigation and adaptation for the agricultural sector	TGO	x	x		x
Water Management	Development of the study and planning of Integrated Water Resources Management to align with Water Master Plans	ONWR	x	x	x	
Water Management	Enhancement of Integrated Water Resources Management database and assessment system: water management database center, Thai Water Plan (TWP), water management budget planning, and Thai Water Assessment (TWA)	ONWR	x	x	x	
Natural Resources	Technical support for community participation in the preservation and conservation of natural resources	DNP, DMCR		x		x
Public Health	Strengthening the health system in case of emerging diseases	DOH	x	x		x
Natural Resources	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 sea-level rise.	DMCR		x		

**Remark:**

TT: Technology Development & Transfer / TS: Technical Support & Assistance / CB: Capacity Building / FS: Financial Support

### 6.1.3 Enabling Environment

A proper enabling environment is a core foundation for efficient and effective climate actions. Climate Change Master Plan 2015-2050 seeks to strengthen enabling environment in 4 main areas, comprising 1) research and development in data and technology for climate, 2) development of legislations, economic instruments, financial mechanisms, and technical tools to support climate actions, 3) capacity building for relevant stakeholders and raising climate ethic and awareness for all, 4) development of Measurement, Reporting and Verification (MRV) and Monitoring and Evaluation (M&E) systems to enhance the transparency of climate action implementation in all levels.

#### **Constraints and gaps**

For building a suitable enabling environment for climate actions, Thailand still requires the followings: establishing financial mechanisms to support climate actions and technology development, strengthening mechanisms for sectoral and subnational agencies to integrate adaptation and mitigation measures into their respective planning processes, setting national monitoring and evaluation system of climate-related policies, enhancing formal and non-formal education and training programs to improve knowledge and awareness of teachers, educators, students, stakeholders, and the general public on climate change at all levels, and developing networking for climate research and information.

#### **Support Needed**

Aligning with the LT-LEDS, Thailand primarily needs the support for:

##### 1. Policy Implementation:

- Building capacity in the public and private sectors to integrate climate actions into their respective plans or enterprises
- Raising awareness of climate change, Thailand's LT-LEDS and NDCs among relevant stakeholders and the general public

##### 2. Mechanism and instruments:

- Financial instruments, incentives, mechanisms, and approaches to engage the private sector in the shift to green investment
- Sharing knowledge and best practices on legal frameworks and modalities to support Thailand's LT-LEDS and NDC implementation

The overall support needed for enabling the environment is presented in Table 6-3:

Table 6-3: Summary of financial, technology, technical, and capacity-building support needed for enabling environment

Area	Support Needed (Policy, Plan, Measure, Program, Project)	Key Stakeholder	Support Type			
			CB	TS	TT	FS
Mechanism and Instruments	Expertise in climate change finance area to assist the development of financial instruments	FPO	x	x		x
Awareness Raising	Awareness-raising for relevant stakeholders and the general public on climate change measures	DEQP	x	x		x
Awareness Raising	Integration of climate change study and activity in the educational system at all levels	DEQP	x			x
Capacity Building	Enhance the capacity of teachers, instructors, trainers, and students in environmental science and climate change	IPST	x			x
Capacity Building	Development of capacity-building or intensive training courses for stakeholders in the transport sector	OTP	x			x
Mechanism and Instruments	Mechanism promoting community roles in natural resource conservation	DMCR	x			x
Mechanism and Instruments	Establishment of a market mechanism to incentivize the implementation of community enterprises based on sustainable forest resources	RFD	x	x		x
Mechanism and Instruments	Development of matching grants financial mechanism for IPPU sector in CCUS research, development, and technology transfer	NXPO			x	x
Mechanism and Instruments	Establishment of funding mechanism for climate change technology innovator startup	NXPO	x	x	x	x
Mechanism and Instruments	Development of financial mechanism to subsidize renewable energy technology	NXPO			x	x
MRV	Capacity Building programs for preparing MRV under EU Carbon Border Adjustment (CBAM)	TGO	x			x
Networking	Develop academic networking for climate change information sharing and research	ONEP	x	x		x

**Remark:**

TT: Technology Development & Transfer / TS: Technical Support & Assistance /  
CB: Capacity Building / FS: Financial Support

### 6.2 International Support Received

Thailand has received support from various international partners, which enables the country to overcome some constraints, gaps, and barriers to climate action. We take this opportunity to express our gratitude and appreciation for all support. To further enhance Thailand's effective implementation of mitigation, adaptation, and climate-resilient actions toward the goal of the Paris Agreement, adequate means of support in terms of finance, technology transfer, and capacity building are still needed, as described in the previous section.

This section summarizes key messages and provides an overview of the support received by Thailand, excluding global and regional supporting projects, during the years 2018 and 2021. The formal support received prior to 2018 can be found in the Third National Communication (NC3) and Third Biennial Update Report (BUR3). The support received was categorized into three main areas: mitigation, adaptation, and enabling environment.

#### 6.2.1 Support Received for Preparing National Communication (NC) and Biennial Update Report (BUR)

Thailand, as a signatory to the UNFCCC, received financial support from the Global Environment Facility (GEF) to compile and publish Thailand's Fourth National Communication (NC4) and Third Biennial Update Report (BUR3) to the UNFCCC. The preparation was supported by GEF funding of 852,000 USD and in-kind support from the Thai Government of 700,000 USD. The United Nations Development Programme (UNDP) has been an implementing entity responsible for managing these funds for the GEF.

#### 6.2.2 Support Received from International Donors

Thailand has received support from various multilateral and bilateral partners to facilitate climate actions in mitigation, adaptation, and enabling environment.

##### **Global Environment Facility (GEF)**

The Global Environment Facility (GEF) has provided Thailand with financial, technical, and capacity-building supports through various programs. From GEF-6 and GEF-7, Thailand received support for climate change activities in 6 key projects with a GEF project grant of around 24 million USD and Thailand's co-financing of around 250 million USD, excluding the support on the NC and BUR preparation. Key programs supported by GEF include the Sixth Operational Phase of the GEF Small Grants Programme in Thailand, Inclusive Sustainable Rice Landscapes in Thailand, accelerating the adoption and life-cycle solutions to electric mobility in Thailand, accelerating construction of energy-efficient green housing units in Thailand, and strengthening Thailand's institutional and technical capacities. Furthermore, GEF has provided grant funding through UNDP to assist Thailand in the preparation of its NC and BUR, as described previously.

### **Green Climate Fund (GCF)**

Thailand has received several readiness activities supported through GCF's Readiness and Preparatory Support Programme (GCF's Readiness Programme). Key activities include 1) increasing resilience to climate change impacts in marine and coastal areas along the Gulf of Thailand and 2) strengthening the capacities of the Environmental Fund Division to act as a national climate funding mechanism. Beyond the readiness support, Thailand received support for the project "Enhancing Climate Resilience in Thailand through Effective Water Management and Sustainable Agriculture." The project aims to mitigate climate change's social and economic impacts in the Yom and Nan River basins.

### **Multilateral Partners**

Major multilateral partners include United Nations entities such as United Nations Development Programme (UNDP), the United Nations Environment Programme (UNEP), United Nations Industrial Development Organization (UNIDO), and the United Nations Educational, Scientific, and Cultural Organization (UNESCO). United Nations partners play a crucial role in assisting Thailand to access the UNFCCC climate funds mentioned above. Multilateral partners also include financial institutions and organizations, such as the World Bank and World Meteorological Organization.

#### *United Nations*

United Nations entities have focused on assisting Thailand in implementing the mitigation and adaptation measures as well as strengthening its institutional and policy frameworks, both of which are crucial to facilitating the country's efforts to achieve national climate targets. As reported in the TBUR, Thailand's Office of Natural Resources and Environmental Policy and Planning (ONEP), together with UNDP, has implemented a project, "NDC Support Delivering Sustainability through Climate Finance Actions in Thailand," to support Thailand in making progress on its NDCs through the development of financing frameworks for climate action.

Since 2019, more UNDP-led projects have been implemented: programme framework of support in response to Thailand's development challenges and in supporting the achievement of the SDGs, increasing resilience to climate change impacts in marine and coastal areas along the Gulf of Thailand, sixth operational phase of the GEF small grants programme in Thailand, sustainable mangrove management and coastal ecosystem development in Phetchaburi province, achieving low carbon growth in cities through sustainable urban systems management in Thailand, tillage and organic fertilizer production to prevent GHGs in the northern agricultural areas, and enhancing climate resilience in Thailand through effective water management and sustainable agriculture.

In addition, UNEP has provided support for the following projects: accelerating construction of energy-efficient green housing units in Thailand, assessing carbon stock change in a stratum (Carbon Fluxes) in Thailand, Mekong EbA South: enhancing climate resilience in the Greater Mekong Sub-region through ecosystem-based adaptation in the Context of South-South cooperation, inclusive sustainable rice landscapes in Thailand, and the Capacity Building Initiative for Transparency (CBIT). UNIDO has supported Thailand in implementing the programs of accelerating the adoption and life-cycle solutions to electric mobility development in Thailand and the establishment of Learning Center and

Extension of Complete Green Energy Station, Kanchanaburi. Likewise, UNESCO has led the project on groundwater resources in the Greater Mekong Subregion, which is the collaborative management to increase resilience to climate change.

### *The World Bank*

The World Bank has been a notable partner to Thailand for decades, and it has supported Thailand in two significant projects. The first project is the HCFC phase-out management plan: stage II. The project development objective is to reduce HCFC consumption in Thailand. By phasing out HCFC, Thailand will contribute to GHG reduction under the UNFCCC and fulfill the 2020 HCFC consumption phase-out obligations of the Montreal Protocol, its Multilateral Fund, and the initial requirements of the Kigali Amendment. The second project is Thailand Readiness Preparation Proposal (R-PP), which has established the compulsory components for future implementation of REDD+ mechanism in the country. REDD+ is an international mechanism to support mitigation measures to reduce GHG emissions from deforestation and forest degradation and enhance carbon stock from forest conservation, sustainable forest management, and reforestation. Thailand has actively participated in the REDD+ readiness preparation program supported by the Forest Carbon Partnership Facility (FCPF). Policy related to REDD+ implementation was also acknowledged in the draft 13<sup>th</sup> National Economic and Social Development Plan (2022-2026). In addition, National strategies and action plans for REDD+ were developed in 2021 to increase carbon sequestration and ecosystem services in natural forests with social and environmental stability and equitable benefit sharing. The Department of National Parks, Wildlife, and Plant Conservation is the key organization implementing REDD+. The latest six-year action plan (2016-2021) focused on conserving and restoring degraded forests in watershed areas and preserving biodiversity using community participation processes based on ecological restoration that support REDD+ measures and the national REDD+ strategy plan.

### **Bilateral Partners**

#### *Germany*

The German Federal Ministry for the Environment, Nature Conservation, and Nuclear Safety (BMU), through its funding instrument, the International Climate Initiative (IKI), has provided support to Thailand for many climate-related projects. The key projects include the Sustainable and Climate-Friendly Palm Oil Production and Procurement Project, climate and environmentally friendly agricultural waste management, Low Carbon Cities Programme (LCCP) through the cancellation of TVERs, Integrated Waste Management for GHG Reduction, and Climate Action Programme for the Chemical Industry (CAPCI). In addition, BMU established Nitric Acid Climate Action Group (NACAG) to support the reduction of nitrous oxide (N<sub>2</sub>O) in developing countries' production processes by providing technical and financial support to improve production technology, as well as training relevant officials. In 2021, Thailand signed the Statement of Undertaking (SOU) to formally join the NACAG group. Under NACAG, BMU by the GIZ will provide support for Thailand in the following areas: 1) policy and strategic consultation on nitrous oxide emission requirements, 2) technical support for reducing nitrous oxide, 3) financial support for Thailand's nitric acid industry, 4) capacity building to monitor and report nitrous oxide emissions and 5) support for reporting greenhouse gas emissions under the NDC.

### *Sweden*

The government of Sweden, through the Swedish International Development Cooperation Agency and its Challenge Funds, has provided support to Thailand for two key projects: 1) Investment and Financial Flows Assessment (I&FF) Transport Sector under NDC Support Project: Delivering Sustainability through Climate Finance Actions in Thailand, and 2) Climate Change Financing Framework: CCFF under the NDC Support Project: Delivering Sustainability through Climate Finance Actions in Thailand.

### *Australia*

The government of Australia, by the Australian Water Partnership, supports a new initiative as part of its Australia-Mekong Water Facility to identify, evaluate and realize the benefits associated with Nature-based Solutions (NbS) for integrated urban flood management in the Mekong region. This "Project on Valuing the Benefits of Nature-based Solutions for Integrated Urban Flood Management" is implemented in Thailand with the objectives of supporting economic analysis for selecting suitable Nature-based solutions for solving urban flooding caused by climate change and strengthening the capacity of using economic assessment tools through case studies in 2 places in Thailand, namely Bangkok and Rayong Municipality.

### *The European Union*

The European Union has supported Thailand to become more resilient to climate change and enhance its sustainable development goals. The key projects are 1) Strengthening urban climate governance for inclusive, resilient, and sustainable societies in Thailand (SUCCESS) aims to enhance the adaptive capacity of local urban communities through improved urban climate governance, state-of-the-art knowledge, and shared learning and strengthen local institutional mechanisms and practices for inclusive, climate-resilient and sustainable urban development, 2) Climate-resilient Agriculture for Disaster Risk Reduction (CRADR), a collaborated project between Disaster Mitigation Working Group (DMWG) and Agriculture Working Group (AgWG), under the Asia-Pacific Advanced or APAN network which linked between members of research agencies and educational institutions from all over the world.

The project aims to study climate change's effects on agriculture in a small-scale case study (Phrae Province). It also seeks to have modern technologies transferred by "Partners" from various countries such as Japan, Taiwan, and India to solve the climate-resilient problems and develop this project into "Smart Agriculture." Moreover, the project will be participated by and shared among ASEAN members so that each country can study and adopt the outcome of this project to deploy in their own country.

### *Japan*

After establishing the Asia-Pacific Adaptation Information Platform (AP-PLAT) to share regional climate change risk information via an online network, the Ministry of Environment of Japan (MOEJ) signed the Memorandum of Cooperation (MOC) with Thailand on 17 May 2018 to support the "Cooperation for Development of Information Infrastructure

for Climate Change Adaptation in Thailand." The Thailand Climate Change Adaptation Information Platform (T-PLAT) aims to 1) create a platform providing information on climate risks and adaptation in Thailand and 2) link data on climate change adaptation with regional platforms (AP-PLAT projects) and support the data dissemination in Southeast Asia. MOEJ assigned the Overseas Environmental Cooperation Center, Japan (OECC), in partnership with Green Pacific Co., Ltd., as a project consultant working with ONEP and DEQP to implement the project. With technical support from Japan, Thailand has successfully installed the T-PLAT website and presented information in a comprehensive infographic format.

### 6.2.3 Support Received by Sector

Categorizing by sector, Thailand has received support for 18 mitigation projects with a total amount of 31,438,771 USD, 10 adaptation projects with a total amount of 48,667,056 USD, and 6 enabling environment projects with a total amount of 3,419,548 USD. Thailand has received the most support in climate change mitigation by the number of projects and climate change adaptation by the amount of support received. The number of enabling environment projects is slightly less than adaptation, but the amount of support received is much lower. Considering the small amount of supports received for climate adaptation reported in the BUR3, more support has been provided to Thailand for this sector. However, more financial support is needed to strengthen the enabling environment for climate actions.

The breakdown of information for each sector is detailed in Figure 6-1, providing a bigger picture of the international support Thailand received.

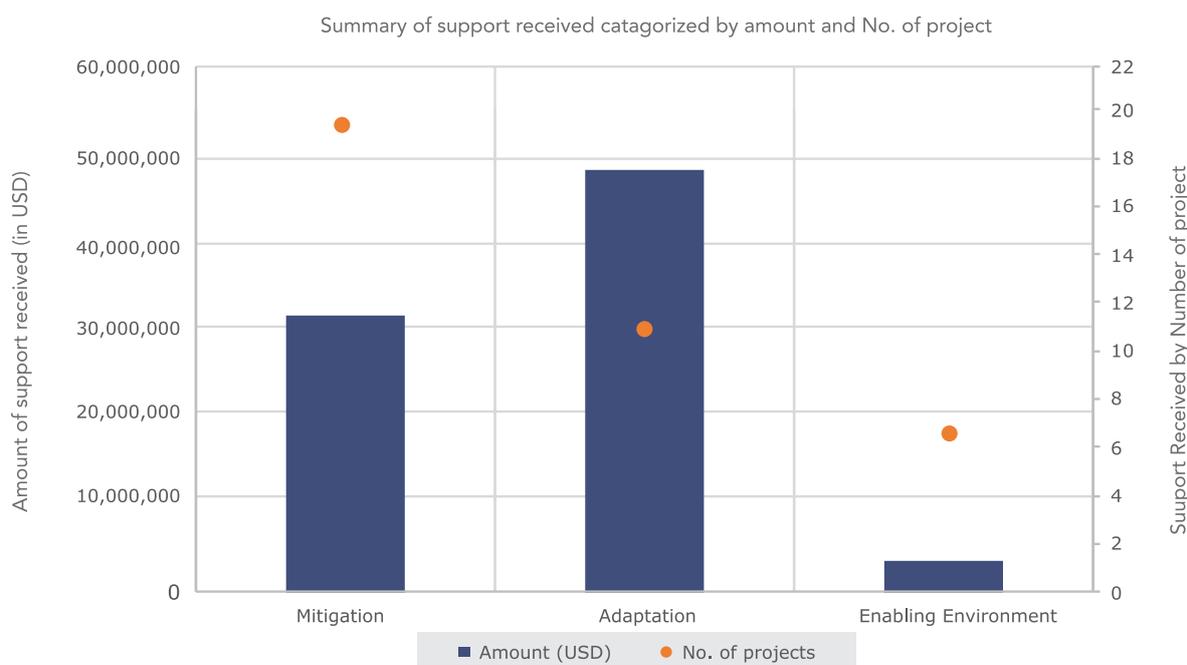


Figure 6-1: Summary of all support received

**Remark:**

The chart presents only the amount of support received specifically distributed to Thailand

## Mitigation

From the support received for mitigation actions, the IPPU sector received the most support by the number of projects and amount of funding received. The energy, transport, and waste sectors received approximately comparable numbers of projects and amounts of funding. Though the IPPU sector notably contributes to national GHG emissions, the national priority focuses on the energy and transport sectors as they are the most significant GHG contributors and the cornerstone for climate mitigation actions.

To align with the energy transition's priority previously described, Thailand still requires more support for mitigation projects in the energy, transport, waste, agriculture, and LULUCF sectors to achieve NDC and LT-LEDS targets.

The support received by sector for mitigation actions is summarized in Figure 6-2.

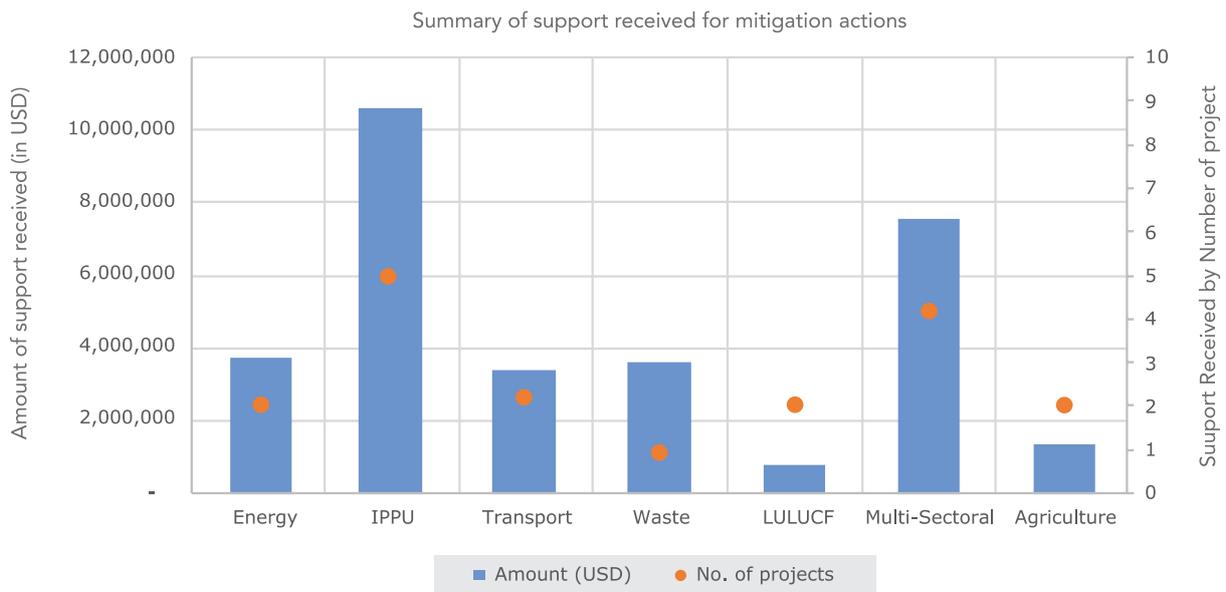


Figure 6-2: Support received for mitigation actions

### Adaptation

Thailand's support received for adaptation actions concentrates on water management, human settlement, agriculture, and multi-sector. Water management received the most support in terms of projects, while human settlement received the most support for financing amount. However, it is essential to note that the amount of support received was far lower than support needed by Thailand to minimize risks and vulnerability and improve the country's resilience.

As a highly vulnerable country to the impacts of climate change, Thailand needs more support in climate change adaptation, especially in tourism, public health, natural resources, and agriculture as listed in the support needed section.

The support received by sector for adaptation actions is summarized in Figure 6-3.

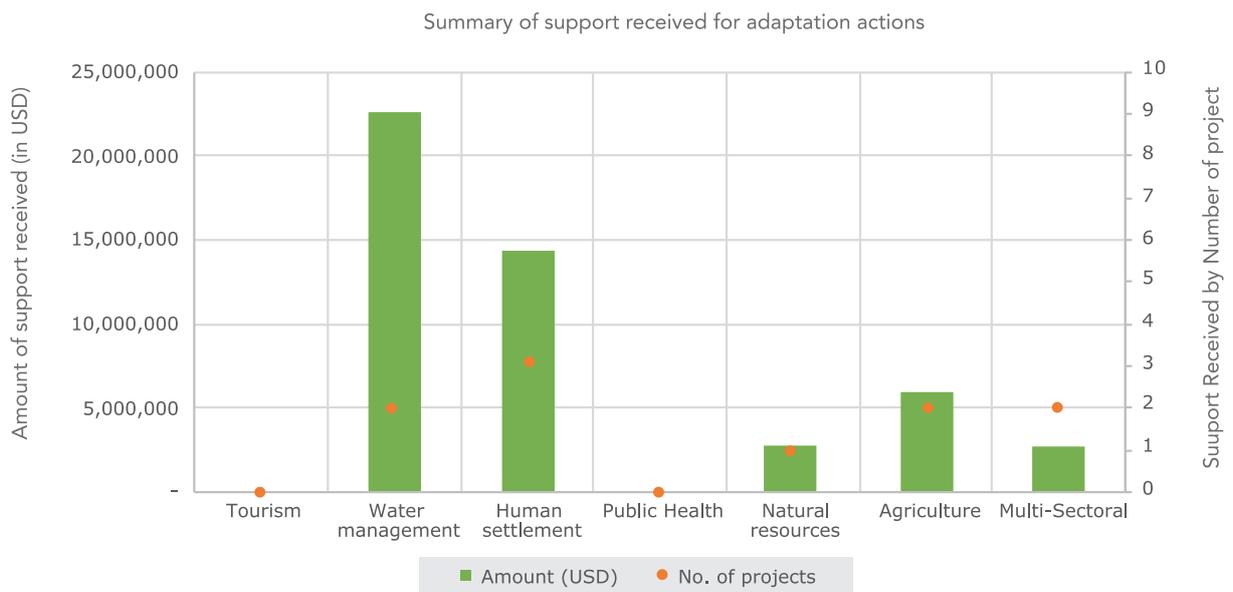


Figure 6-3: Support received for adaptation actions

### Enabling Environment

Most support for enhancing the enabling environment of climate actions in Thailand targets institutional strengthening and mechanisms and instruments. Both received a comparable amount of funding, but institutional strengthening received more numbers of projects.

Based on the support needed section, Thailand still requires more support for policy implementation, mechanism and instruments, networking, awareness-raising, and capacity building to enable climate actions effectively.

The support received by sector for enhancing the enabling environment is summarized in Figure 6-4.

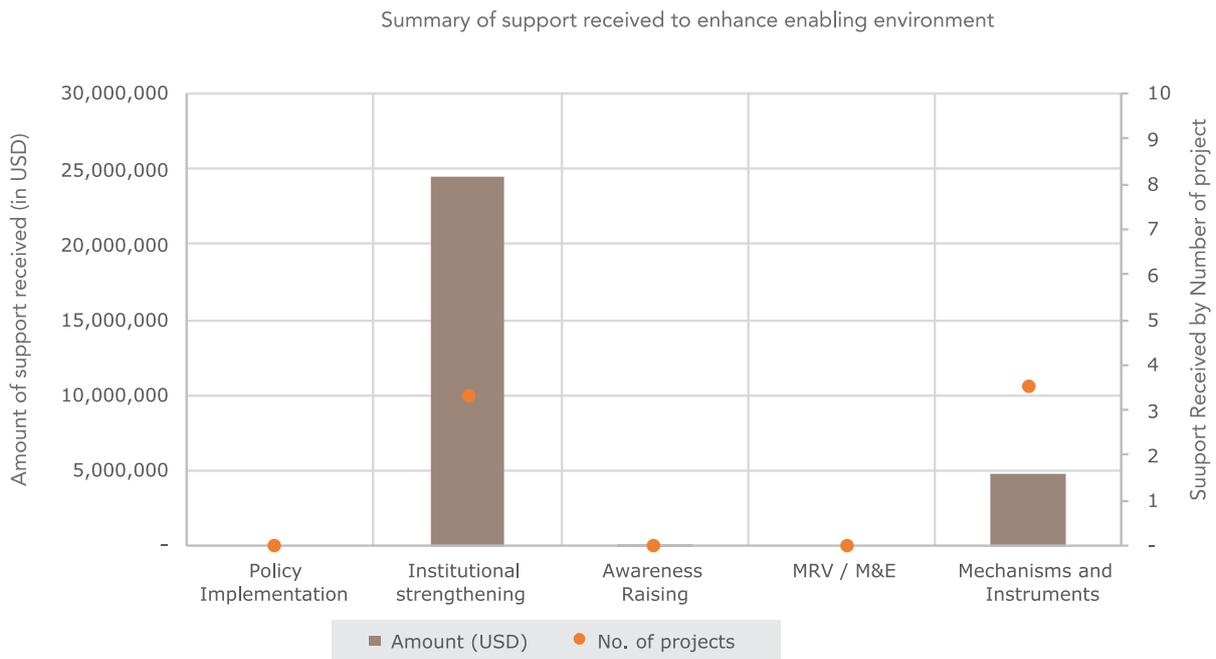


Figure 6-4: Support received for enhancing enabling environment

### 6.2.4 Support Received by Type

The support received in climate actions can also be categorized into 4 supporting types: technology transfer, technical support, capacity building, and financial support (see Figure 6-5).

It is important to note that most projects detailed in this report involve more than one type of support. A combination of technical support and capacity building is the most common type of support that Thailand has received. In addition, Thailand only received a few projects that provided support in technology development and transfer, which play important roles in mitigation and adaptation implementation.

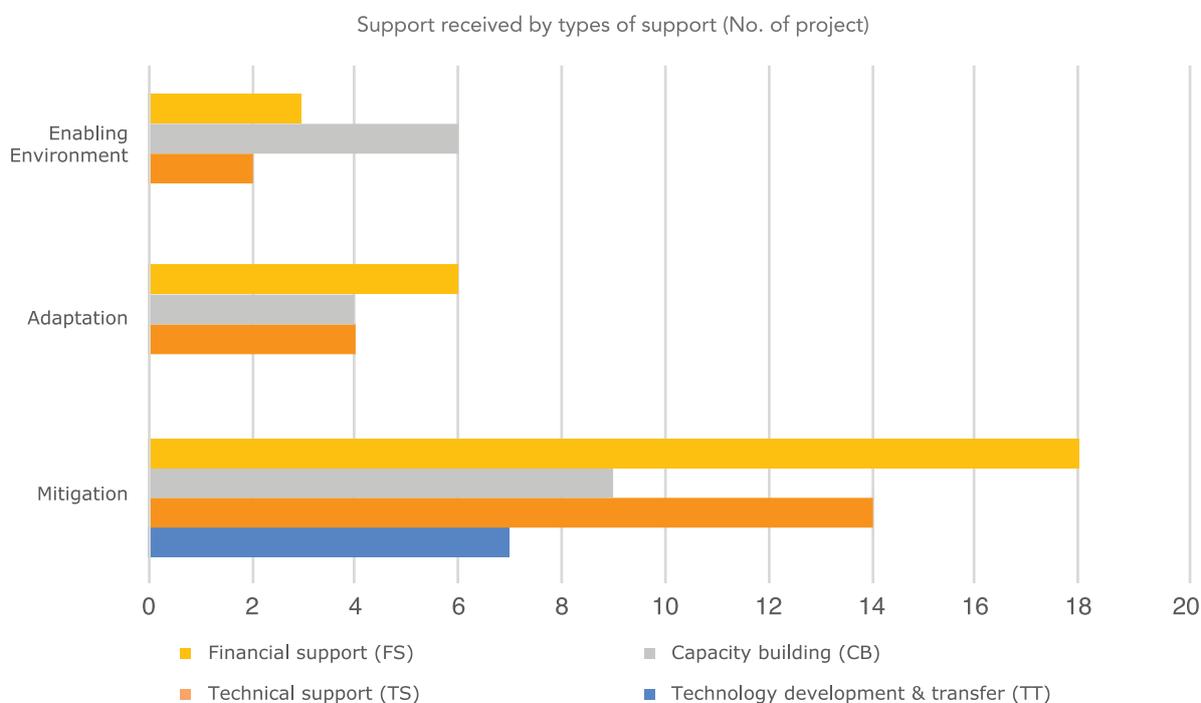


Figure 6-5: Support received by support type

### 6.2.5 Summary of Support Received

While contributing to less than 1% of global emissions, Thailand bears increasingly significant climate risks of natural disasters and catastrophes. Thus, Thailand has made substantial efforts to mitigate climate change by implementing GHG emission reduction measures, enhancing national adaptive capacity to achieve climate resilience, and strengthening the enabling environment for climate measures implementation. Nevertheless, these efforts require extensive investment, innovative technology, institutional integration, and capacity and expertise.

At present, support is needed for Thailand to increase the capacities, resources, and technology development of governmental agencies, private sectors, and the public to take climate actions. To enhance Thailand's effective implementation of mitigation, adaptation, and climate-resilient actions toward the goal of the UNFCCC and Paris Agreement, the support needed by Thailand and the support provided should be aligned. From the support received during 2019-2022, there are still some gaps between support needed and support received. Fulfilling these gaps will ensure that Thailand can expose its full potential to implement climate actions effectively and efficiently.

Table 6-4: Project list of support received for mitigation actions in Thailand (Projects reported in the NC3 and BUR3, though remaining active in the NC4 reporting period, are not listed in the Table below.)

Mitigation Project	Objectives/ Description	Sub-Sector	Project Period	Donor/Partner Agency	Amount	Support Type		
						CB	TS	FS
Accelerating the adoption and life-cycle solutions to electric mobility development in Thailand	The project focuses on GHG reduction in the Transport sector by addressing the problems concerning the scaling up of EV utilization in Thailand. It seeks to set out the institutional framework and EV usage demonstration in the EEC zone.	Transport	2020-2025	UNIDO	3,299,744 USD	X	X	
Investment and Financial Flows Assessment (I&FF) Transport Sector under NDC Support Project: Delivering Sustainability through Climate Finance Actions in Thailand	The I&FF study will draw on historical and current public and private investment data to create a projection. It is a tool to support the country's policy planning.  Objective: 1) To estimate the amount of investment and funding for climate change adaptation of the transport sector, 2) To promote awareness of the impact of climate change on the transport sector, and 3) To create an adaptation guideline to support investment prioritization and coordination at the policy level, 4) To assess the financial need and investment volume for climate change adaptation of the transport sector	Transport	2019-2021	SIDA	55,417 USD		X	X
Climate and environmentally friendly agricultural waste management in Thailand	To transform traditional waste management into climate-friendly waste management, reduce the burning of agricultural waste, and add organic matter to the soil to benefit plant growth	Multi-Sector	2022-2026	BMU, GIZ	2,500,000 EUR		X	X
Learning Center and Extension of Complete Green Energy Station, Kanchanaburi	To be a center for learning and developing the production and use of integrated biomass energy (Both upstream, midstream, and downstream levels) and a model for the production and use of electricity from small biomass plants in the community / setting up a learning center and transfer knowledge to interested parties	Energy	2019-2020	UNIDO, GEF	40,000 USD	X		X

Table 6-4: Project list of support received for mitigation actions in Thailand (cont'd)

Mitigation Project	Objectives/ Description	Sub-Sector	Project Period	Donor/Partner Agency	Amount	Support Type			
						CB	TS	TT	F5
Accelerating construction of energy-efficient green housing units in Thailand	The project aims to implement greenhouse gas reduction activities in the Housing Authority's housing project. The objective is to develop energy-efficient and environmentally friendly housing to reduce greenhouse gas emissions. The activities consist of three elements: 1) energy-efficient housing design and labeling for energy-efficient housing, 2) financial mechanisms for promoting energy-efficient housing, and 3) raising awareness and capacity for promoting energy-efficient housing.	Energy	2021-2026	UNEP	3,560,000 USD	X	X		
Integrated Waste Management for GHG Reduction	The project intends to enhance the capacity of the waste (wastewater) sector to implement Thailand's GHG reduction goal and climate change action after 2020 and the country's greenhouse gas reduction navigation map after 2020.	Wastewater	2018-2022	GIZ	120,000,000 THB	X	X		X
HFC Phase-out management plan: stage II	The objectives: 1. Reduce the use of HCFCs in the spray foam industry and the commercial refrigerator and freezer sector, enabling Thailand to meet its obligations under the Montreal Protocol 2. Provide basic tools/equipment for air conditioners that use HFC-32 as a refrigerant to the Department of Skill Development and the Office of Vocational Education Commission 3. Organize training on installation and maintenance of air conditioners that use HFC-32 for technicians working under the Department of Skill Development and the Office of Vocational Education Commission 4. Provide refrigerant identifier for the Customs Department	IPPU	2020-2023	World Bank	152,520,000 THB	X	X		X
Enabling Activities for Kigali Amendment Ratification and supporting the preparation of Thailand HFCs Phase down strategy	The project aims to explore the consumption of HFCs in all industries in Thailand and analyze and plan to reduce the country's use of HFCs to ratify the Montreal Protocol revised in Kigali.	IPPU	2018-2021	World Bank	7,500,000 THB		X		X

Table 6-4: Project list of support received for mitigation actions in Thailand (cont'd)

Mitigation Project	Objectives/ Description	Sub-Sector	Project Period	Donor/Partner Agency	Amount	Support Type			
						CB	TS	TT	F5
Technical assistance to support Market Transformation to Higher Energy Efficient Room Air Conditioning through Manufacturing Readiness	The project aims to 1) transfer inverter technology in air conditioning to Thai air conditioning manufacturers, which will enable the industry in Thailand to produce clean and environmentally friendly products and change the domestic air conditioning market, and 2) compare energy-saving performance between inverter air conditioners and fixed-speed air conditioners., and 3) develop energy efficiency plan for cooling systems in the air conditioning industry, refrigerator, and commercial freezer in the country.	IPPU	2018-2021	K-CEP, World Bank	48,000,000 THB		X	X	
Tillage and Organic Fertilizer Production to Prevent Greenhouse Gas in the northern agricultural areas	To transform into climate-friendly agricultural waste management which can reduce the burning of agricultural waste, reduce GHG emissions, and add organic matter to the soil to benefit plant growth.	Agriculture	2021-2023	GEF, UNDP	200,000 USD		X		X
Sustainable and Climate-friendly Palm Oil Production and Procurement Project in Thailand	The goal is to enhance the sustainable production of palm oil, aligning with the international standards and improving the palm farmers' quality of life. The targets are: 1) to create sustainable palm oil production throughout the supply chain, 2) to promote greenhouse gas reduction measures and appropriate supporting tools, and 3) to scale up the sustainable palm oil production.	Agriculture	2018-2022	GIZ	1,000,000 EUR	X	X	X	X
EGAT Cooling Innovation Fund: CIF	To foster the development of innovations in energy-efficient refrigeration technology and drive Thai industry toward the use of green refrigeration technology that uses natural refrigerants or alternative cooling technology	IPPU	2021-2024	Germany, UK, NAMA Facility, GIZ	180,000,000 THB			X	X

Table 6-4: Project list of support received for mitigation actions in Thailand (cont'd)

Mitigation Project	Objectives/ Description	Sub-Sector	Project Period	Donor/Partner Agency	Amount	Support Type				
						CB	TS	TT	F5	
Support of the Thailand Low Carbon Cities Programme (LCCP) through cancellation of TVERs	Inducing greenhouse gas reduction measures in associated cities and municipalities across Thailand through Results-Based Payment Mechanism (RBP Mechanism) for cancellation of verified emission reductions from Thailand Voluntary Emission Reduction (T-VER) Projects	Multi-Sector	2019-2022	Germany/IKI	1,800,000 EUR					X
Achieving Low Carbon Growth in Cities through Sustainable Urban Systems Management in Thailand	Strengthening capacity development for cities/municipalities on low carbon emission urban systems management, low carbon development policy and targets, and preparedness of the innovative domestic voluntary city offsetting mechanism to reduce carbon emission and demonstrate low carbon-emitting urban system projects in cities including Khon Kaen, Chiang Mai, Nakhon Ratchasima, and Samui in a measurable, reportable and verifiable (MRV) manner, and develop city models for Low Carbon Cities Initiatives, and networking in Thailand.	Multi-Sector	2017-2021	UNDP, GEF	3,150,000 USD					X
Thailand REDD+ Readiness Preparation Proposal Project	To study and analyze the underlying causes of deforestation and forest degradation and formulate the National Redd Plus Strategy; to establish a mechanism to resolve complaints and formulate a benefit-sharing framework under the Redd Plus mechanism, as well as a strategic social and environmental impact assessment for the Redd Plus Mechanism for Thailand	LULUCF	2020-2021	World Bank	13,000,000 THB					X
Assessing Carbon Stock Change in a Stratum (Carbon Fluxes) in Thailand	The objective is to estimate the amount of carbon in soil and develop a carbon map. The result should reveal the assessment of carbon loss caused by soil erosion and the mapping of areas with a high risk of soil erosion in Thailand.	LULUCF	2021-2023	GEF, UNEP	315,000 USD		X	X	X	X

Table 6-4: Project list of support received for adaption actions in Thailand (cont'd)

Mitigation Project	Objectives/Description	Sub-Sector	Project Period	Donor/ Partner Agency	Amount	Support Type			
						CB	TS	TT	FS
Nitric Acid Climate Action Group (NACAG) in Thailand	The objective of the project is to support the reduction of nitrous oxide (N <sub>2</sub> O) from the production processes by providing 1) policy and strategic consultation on nitrous oxide emission requirements, 2) technical support for reducing nitrous oxide, 3) financial support for Thailand's nitric acid industry 4) capacity building to monitor and report nitrous oxide emissions and 5) support for reporting greenhouse gas emissions under the NDC.	IPPU	2021 on-going	BMU/GIZ	Not specified*	X	X	X	X
Climate Action Programme for the Chemical Industry (CAPCI)	The project aims to enable key actors in the chemical industry to identify and tap mitigation potentials in chemicals production and associated value chains. The first phase focuses on information, knowledge, and awareness creation as well as stakeholder dialogue. The second phase focuses on action-oriented capacity building, training, and technical advice.  It is a global project covering 5 countries: Argentina, Ghana, Peru, Thailand, and Vietnam.	Multi-sector	2021-2024	BMU Germany/IKI	2,000,000** EUR	X			X

**Remark:**

TT: Technology Development & Transfer / TS: Technical Support & Assistance / CB: Capacity Building / FS: Financial Support

\* Nitric Acid Climate Action Group (NACAG) in Thailand: The amount of support received for this project is not specified. It depends on the procured technologies: secondary and tertiary abatement technologies. For the secondary abatement technology, the investment and operational costs are approximately 1.5 million EUR and 2 million EUR per tCO<sub>2</sub>eq, respectively. For the tertiary abatement technology, the investment and operational costs are about 7 million EUR and 5 million EUR per tCO<sub>2</sub>eq (for the period of 20 years), respectively

\*\*Climate Action Programme for the Chemical Industry (CAPCI): The amount of support received for this project was distributed among the five countries: Argentina, Ghana, Peru, Thailand, and Vietnam.

Table 6-5: Project list of support received for adaption actions in Thailand (Projects reported in the NC3 and BUR3, though remaining active in the NC4 reporting period, are not listed in the Table below.)

Adaptation Project	Objectives/Description	Sub-Sector	Project Period	Donor/ Partner Agency	Amount	Support Type			
						CB	TS	TT	FS
Mekong EbA South: Enhancing Climate Resilience in the Greater Mekong Sub-region through Ecosystem-based Adaptation in the Context of South-South Cooperation	The project aims to: 1) demonstrate the EbA guidelines in the vulnerable communities in Thailand to address climate change impacts, particularly from drought and flood in the selected areas such as basin areas in Thailand, and 2) elevate the level of knowledge and awareness of climate adaptation measures, particularly the EbA to exchange climate impacts data in a different ecosystem, and 3) enhance regional cooperation leading to the establishment of roadmap and plans for climate adaptation in Mekong Sub-Region.	Multi-Sector	2022-2025	UNEP	2,506,000 USD	X			
Enhancing climate resilience in Thailand through effective water management and sustainable agriculture	The project promotes water management for agriculture and the community in the Chaopraya basin.	Water Management	2021-TBA	UNDP, GCF	17,533,500 USD	X	X		X
Enhancing Climate Resilience of Mekong River Communities through Strengthening Climate Services (ECR-MEKONG)	The project aims to enhance climate resilience in Mekong River communities and reduce vulnerability to climate change effects.	Human Settlement	2021-2026	WMO	13,780,000 USD				X
Inclusive sustainable rice landscapes in Thailand	The project promoted sustainable rice production covering both highland and flood-plain land, and irrigation and rainwater fields. The project was carried out in Suphanburi and Ubon Ratchathani provinces by using new agricultural theory and standards of sustainable rice production and promoting local community participation.	Agriculture	2019	UNEP, GEF	6,125,000 USD	X	X		X

Table 6-5: Project list of support received for adaption actions in Thailand (cont'd)

Adaptation Project	Objectives/Description	Sub-Sector	Project Period	Donor/ Partner Agency	Amount	Support Type			
						CB	TS	TT	FS
Groundwater Resources in the Greater Mekong Subregion: Collaborative Management to Increase Climate Change Resilience	Objectives: Utilize and manage groundwater resources to reduce its vulnerability and ensure climate resilience for water users, especially the low-income farmers. The project is consistent with the approaches/measures under the Climate Change Adaptation Plan to drive implementation under the International Basin Management Cooperation Mechanism and increase the efficiency of groundwater management together with the use of surface water, especially in drought-prone areas. The pilot projects can be used as a case study for future development in other areas.	Water Management	2021-2025	UNESCO	4,898,755 USD				X
Strengthening urban climate governance for inclusive, resilient, and sustainable societies in Thailand (SUCCESS project)	To strengthen mechanisms for sustainable urban development by taking into account how to cope with climate change and urban development for people of all levels	Human Settlement	2020-2024	EU	25,000,000 THB				X
Climate-resilient Agriculture for Disaster Risk Reduction (CRADR)	Study of variables affecting farming in Thailand (Phrae Study Area) and future implementation practices	Agriculture	2020	EU, Trans-Eurasia	3,276,552.86 THB				X
Project on Valuing the Benefits of Nature-based Solutions for Integrated Urban Flood Management	Project Objectives: 1) Support economic analysis for selecting suitable Nature-based solutions for solving urban flooding caused by climate change, and 2) Strengthen the capacity of using economic assessment tools through case studies in 2 places in Thailand, namely Bangkok and Rayong Municipality The expected outcomes of the project focus on the development of human resource capacity in economic analysis to choose the appropriate Nature-based Solutions (NbS), with a case study assessment presented in Thailand and successful performance in China including expanding the scope of operations in the area other Mekong sub-regions in the future.	Human Settlement	2020-2021	Australia	-	X	X		

Table 6-5: Project list of support received for adaptation actions in Thailand (cont'd)

Adaptation Project	Objectives/Description	Sub-Sector	Project Period	Donor/ Partner Agency	Amount	Support Type			
						CB	TS	TT	FS
Increasing resilience to climate change impacts in marine and coastal areas along the Gulf of Thailand	<p>The objective is to integrate planning and budgeting for climate adaptation operations in marine and coastal areas. This project builds on the adaptation plan currently being implemented by the Office of Natural Resources and Environmental Policy and Planning (ONEP). The project will focus on marine and coastal areas and local adaptation planning processes. Resources and assistance from the Green Climate Fund (GCF) will be used to address the barriers, data gathering, knowledge, and coordination for adaptation planning, especially in the private sector. The expected results are</p> <ol style="list-style-type: none"> <li>1. Increasing the capacity and knowledge to apply climate risk data to the planning and development of regional marine and coastal areas</li> <li>2. Increasing the efficiency of the implementation of the National Climate Change Adaptation Plan and integration of adaptation in planning and budgeting in marine and coastal areas</li> <li>3. Developing financial strategies for climate change adaptation in marine and coastal areas</li> </ol>	Natural Resources	2020-2024	GCF, UNDP	3,000,000 USD	X	X		
Thailand Climate Change Adaptation Information Platform (T-PLAT)	The project aims to 1) create a platform providing information on climate risks and adaptation in Thailand and 2) link data on climate change adaptation with regional platforms (AP-PLAT projects) and support the data dissemination in Southeast Asia.	Multi-Sector	2017-2021	Japan	Not disclosed		X		

**Remark:**

TT: Technical Support & Assistance / TS: Technical Support & Assistance / CB: Capacity Building / FS: Financial Support

Table 6-6: Project list of support received for enabling environment in Thailand  
(Projects reported in the NC3 and BUR3, though remaining active in the NC4 reporting period, are not listed in the Table below.)

Enabling Environment Project	Description	Sub-Sector	Project Period	Donor/Partner Agency	Amount	Support Type		
						CB	TS	FS
Building project pipeline capacities: development of GCF concept notes in the transport and health sectors in Thailand	The project seeks to enhance Thai agencies' capacity to approach Green Climate Fund for climate mitigation and adaptation	Institutional Strengthening	2022-2024	GIZ	544,222 USD	X		
Strengthening the capacities of the Environmental Fund Division to serve as a key Thailand's national mechanism for climate finance	The project aims to strengthen the capacity of Thailand's Environmental Fund Division to be recognized and endorsed by the Green Climate Fund.	Institutional Strengthening	2020-2021	GIZ	409,142 USD	X		
Developing GCF pipeline of projects from locally-driven climate actions	To enhance the capacity of local communities to adopt climate mitigation measures	Mechanism and Instrument	2022-2024	GCF	349,999 USD	X		
Inclusive, gender-responsive Climate Change Benefit Analysis: iCCBA) under NDC Support Project: Delivering Sustainability through Climate Finance Actions in Thailand (NDC Support)"	The project is to develop a plan/policy for integrating gender-inclusive factors in budget management and planning of climate change measures. Several activities were initiated, such as target training sessions for agencies, operational meetings, and a handbook on climate finance.	Mechanism and Instrument	2019-2021	Germany and Sweden	71,585 USD	X	X	X

Table 6-6: Project list of support received for enabling environment in Thailand (cont'd)

Enabling Environment Project	Description	Sub-Sector	Project Period	Donor/Partner Agency	Amount	Support Type			
						CB	TS	TT	FS
The Capacity Building Initiative for Transparency (CBIT)	The project aims to strengthen Thailand's institutional and technical capacities to comply with the Enhanced Transparency Framework of the Paris Agreement. The project consists of 4 elements: 1) enhance the capacity to collect data activity for GHG inventory, 2) enhance the capacity of MRV system for NDC implementation, 3) elevate the assessment of received funds for NDC implementation, and 4) enhance the transparency of adaptation and mitigation measures.	Institutional Strengthening	2021-2024	GEF, UNEP	1,991,000 USD	X			X
Climate Change Financing Framework: CFFF under the NDC Support Project: Delivering Sustainability through Climate Finance Actions in Thailand	Objective: 1) To assess the degree of integration of climate change in the public finance system, 2) To identify strategies and guidelines for climate change response planning and budgeting as well as presenting anavigationmapforclimatechangeintegration,3)Todevelop roadmaps and action plans in the short, medium and long term to lead to unified climate change policy implementation. This leads to efficient and effective climate change budget planning and allocation. Currently, the UNDP is in discussions with the Budget Office and the Office of the National Economic and Social Development Council, and other related agencies to develop a climate change financing framework to enhance NDC mobility and achieve the Sustainable Development Goals.	Mechanism and Instrument	2019-2021	SIDA	53,600 USD	X	X		X

**Remark:**

TT: Technology Development & Transfer / TS: Technical Support & Assistance / CB: Capacity Building / FS: Financial Support

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## APPENDIX

This appendix contains the risk maps for the 6 sectors, namely water management, agriculture and food security, tourism, public health, natural resource management, and human settlement. For each sector, two Representative Concentration Pathways (RCPs) are considered, i.e., the RCP4.5 and RCP8.5 scenarios, and risk maps for heat, flooding and drought as well as the overall risk map are presented.

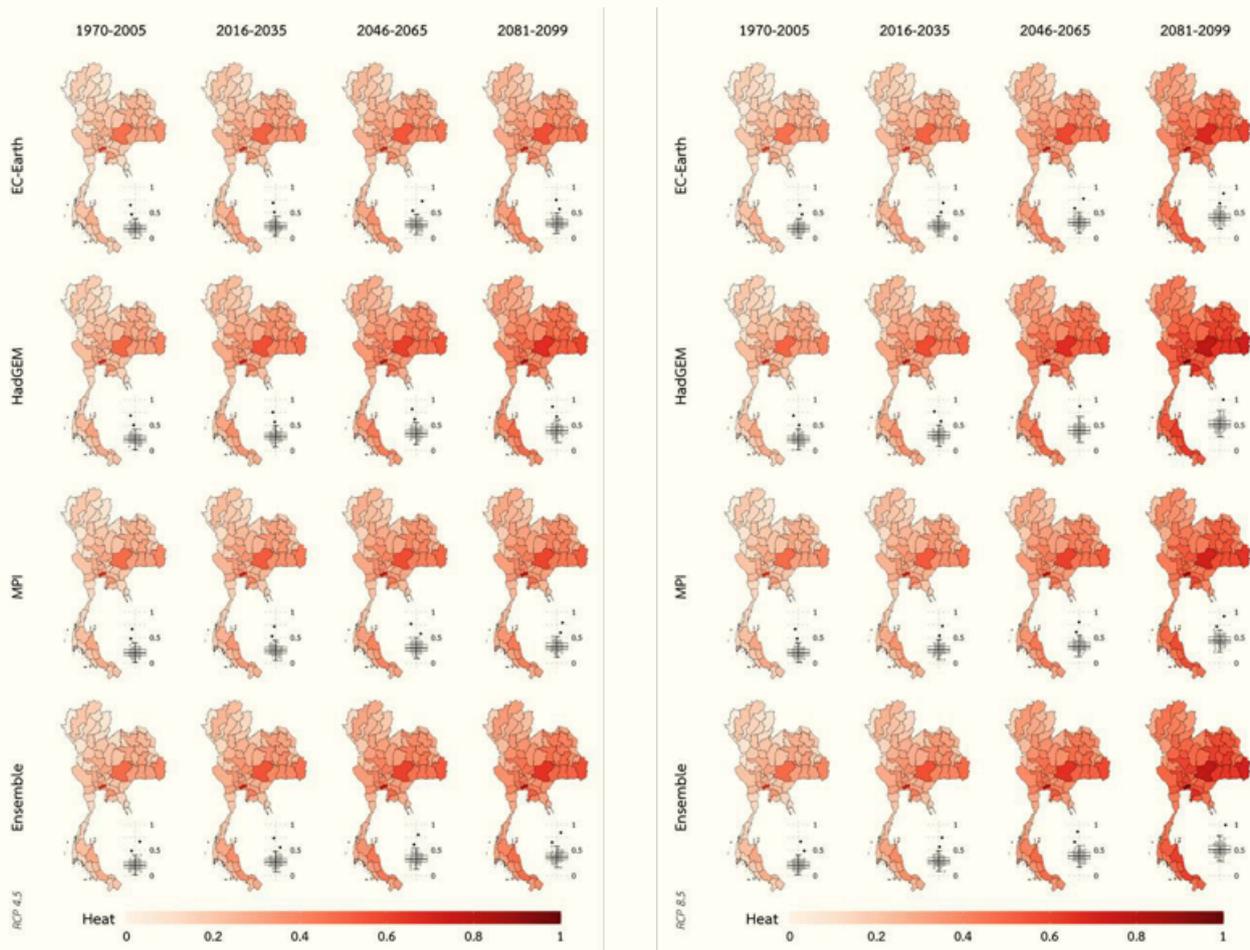


Figure A-1: Heat risk map in water management sector under RCP4.5 (Left) and RCP8.5 (Right)

Source: Office of Natural Resources and Environmental Policy and Planning (ONEP) and Ramkhamhaeng University Center of Regional Climate Change and Renewable Energy (RU-CORE) (2021)

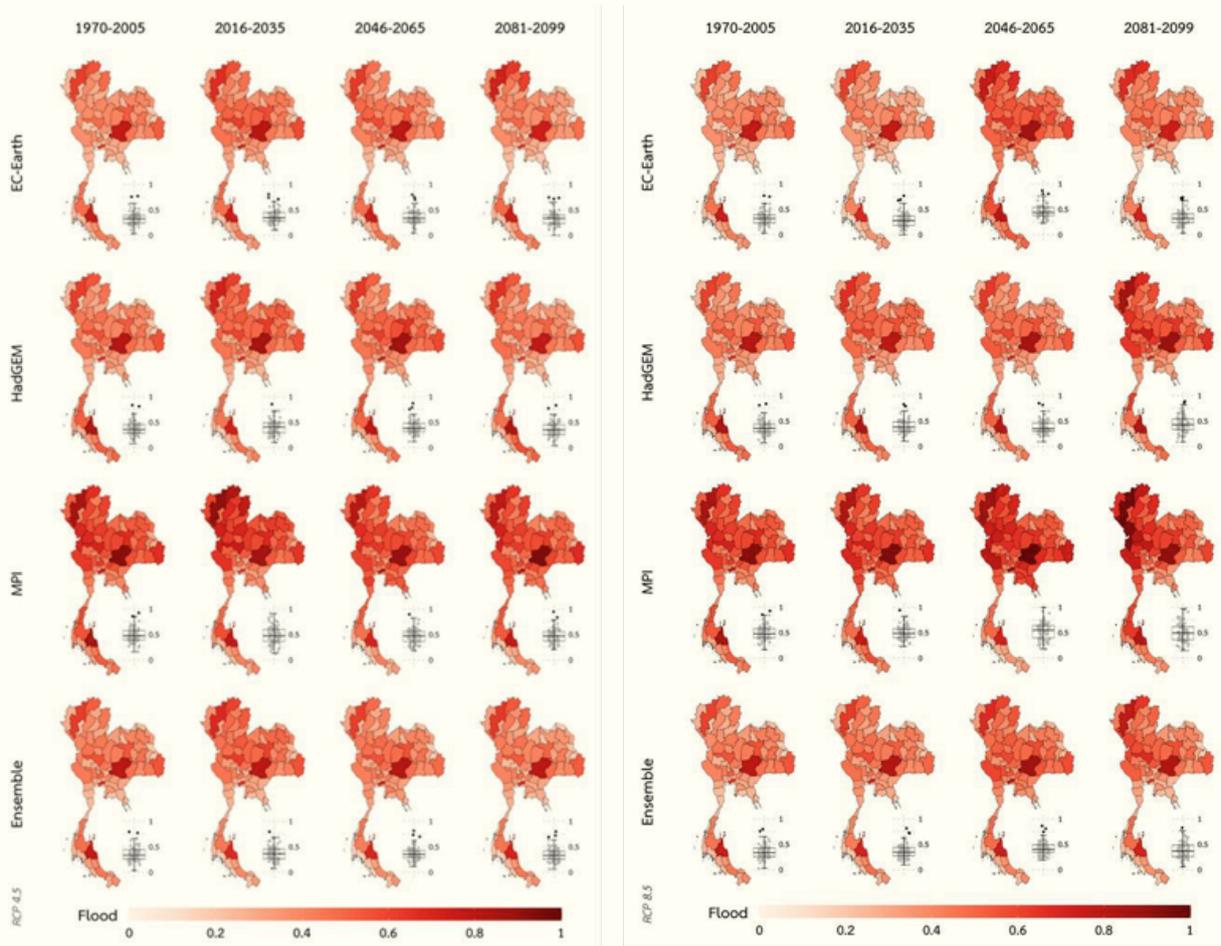


Figure A-2: Flood risk map in water management sector under RCP4.5 (Left) and RCP8.5

Source: Office of Natural Resources and Environmental Policy and Planning (ONEP) and Ramkhamhaeng University Center of Regional Climate Change and Renewable Energy (RU-CORE) (2021)

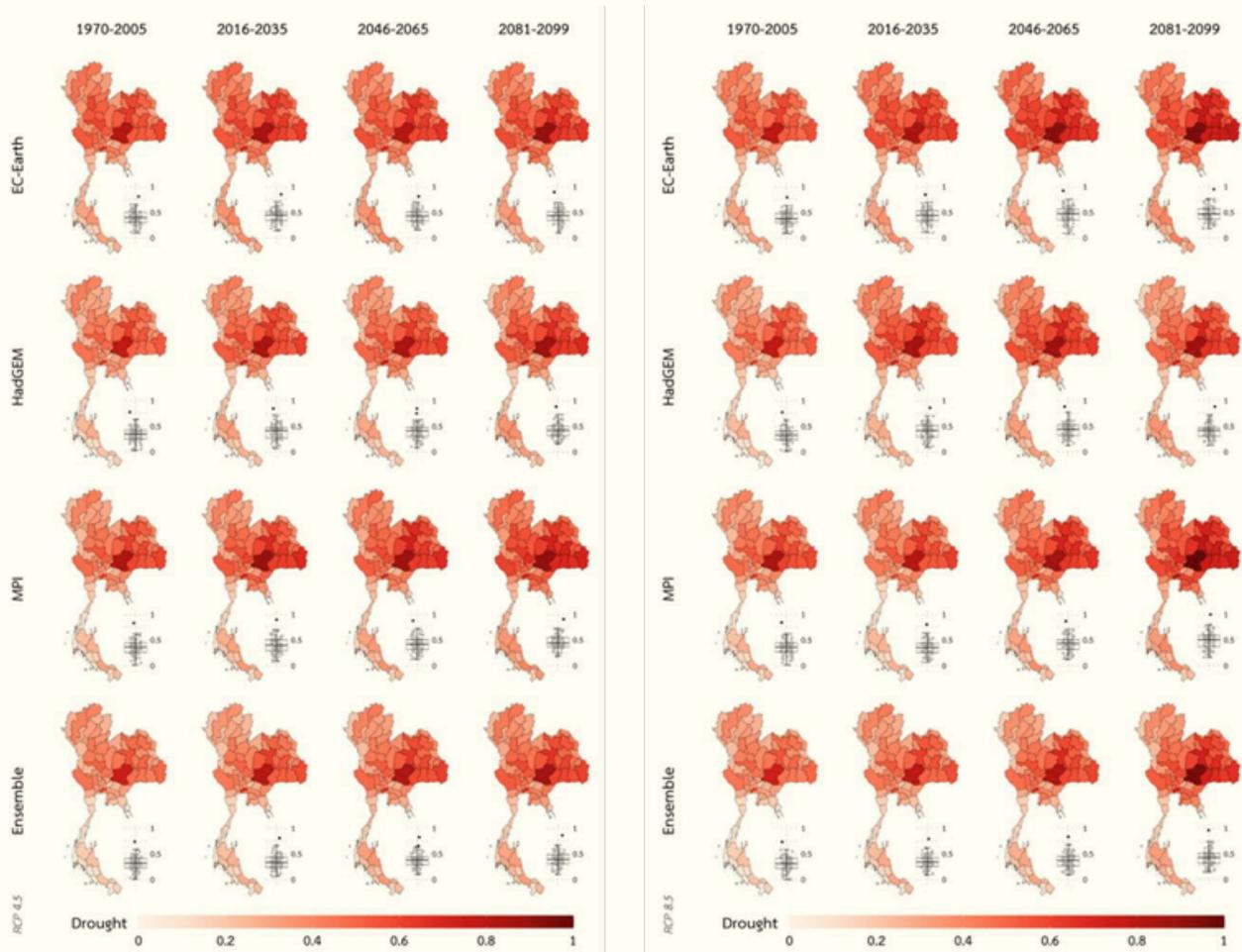


Figure A-3: Drought risk map in water management sector under RCP4.5 (Left) and RCP8.5 (Right)

Source: Office of Natural Resources and Environmental Policy and Planning (ONEP) and Ramkhamhaeng University Center of Regional Climate Change and Renewable Energy (RU-CORE) (2021)

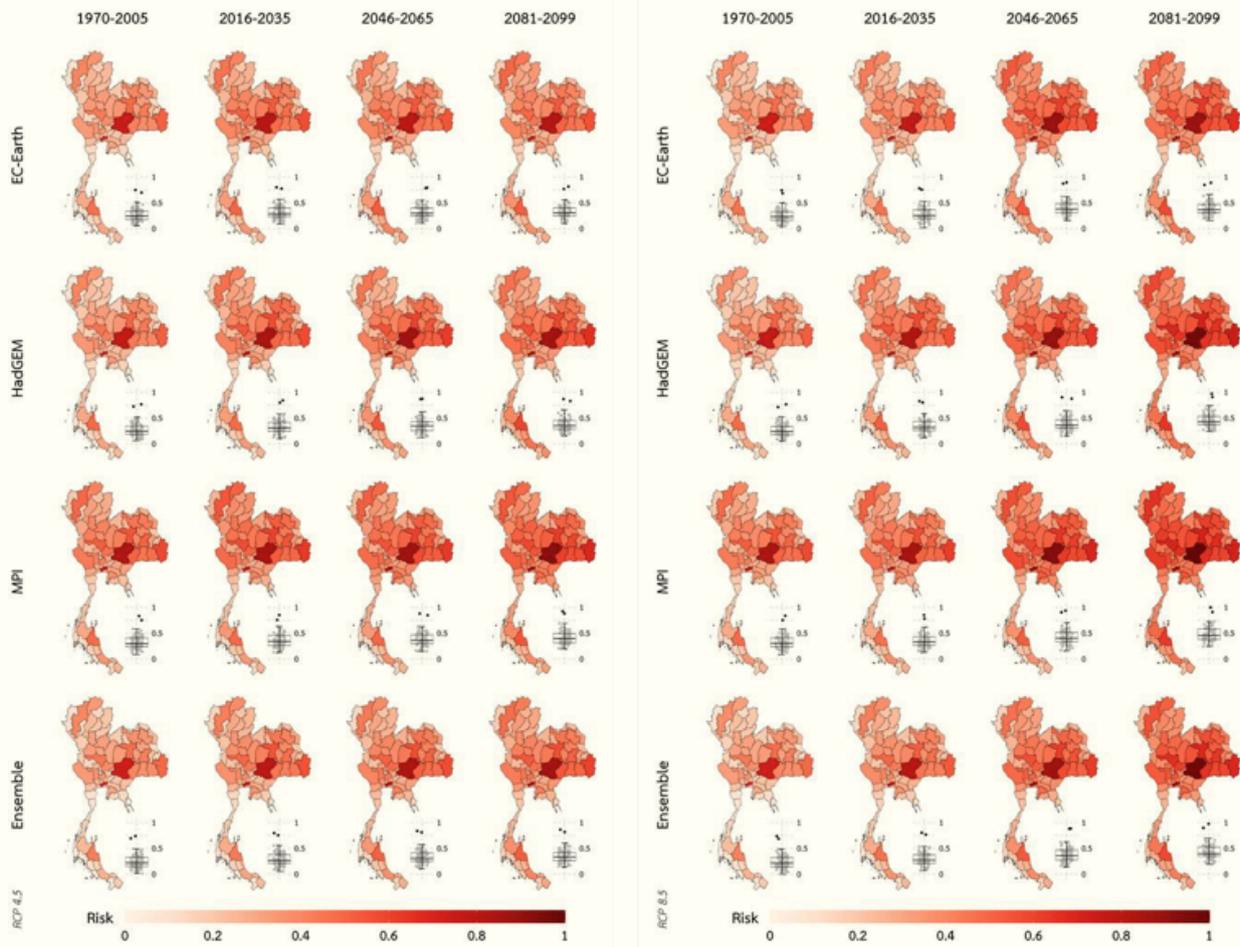


Figure A-4: Overall risk map in water management sector under RCP4.5 (Left) and RCP8.5 (Right)

Source: Office of Natural Resources and Environmental Policy and Planning (ONEP) and Ramkhamhaeng University Center of Regional Climate Change and Renewable Energy (RU-CORE) (2021)

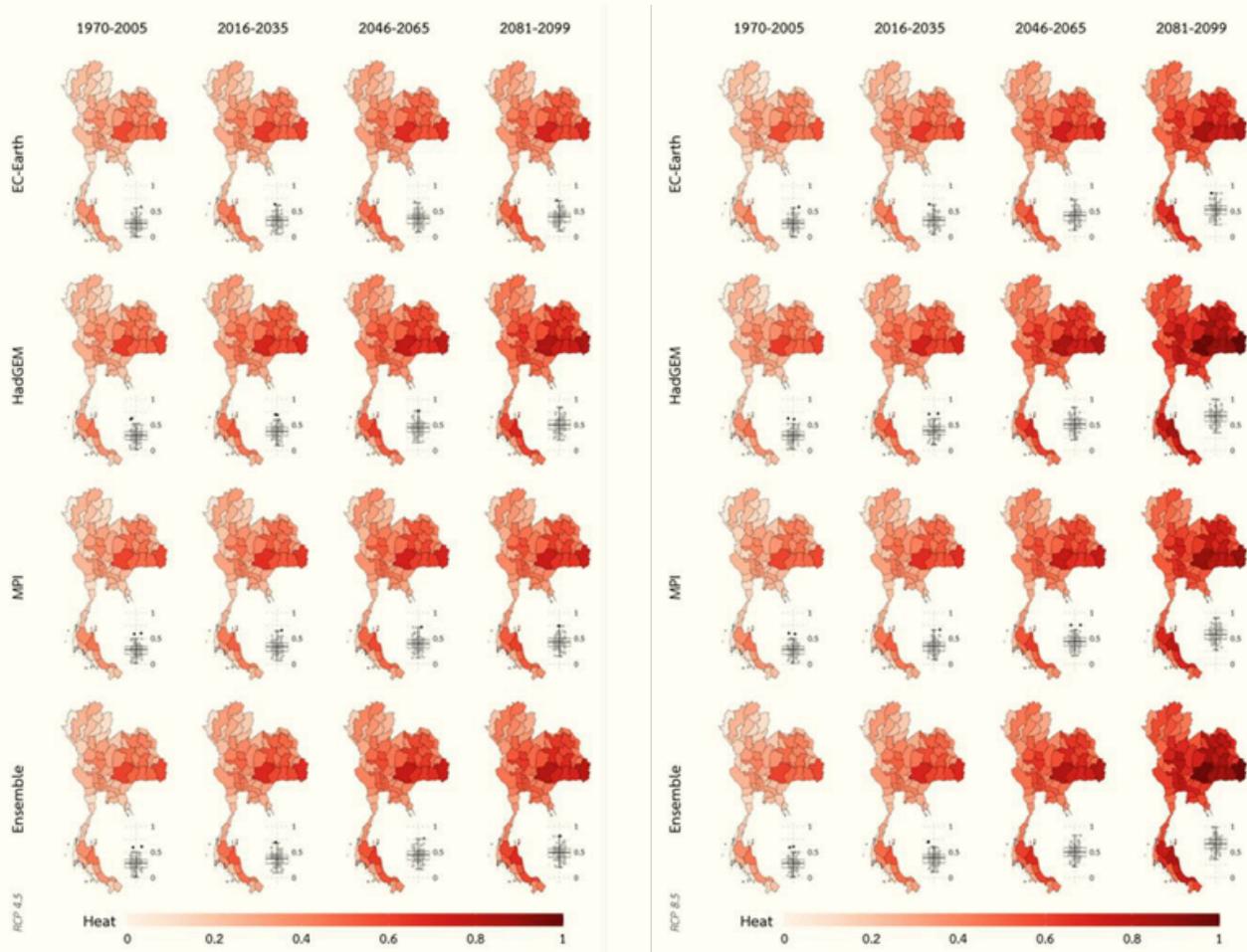


Figure A-5: Heat risk map in agricultural sector under RCP4.5 (Left) and RCP8.5 (Right)

Source: Office of Natural Resources and Environmental Policy and Planning (ONEP) and Ramkhamhaeng University Center of Regional Climate Change and Renewable Energy (RU-CORE) (2021)

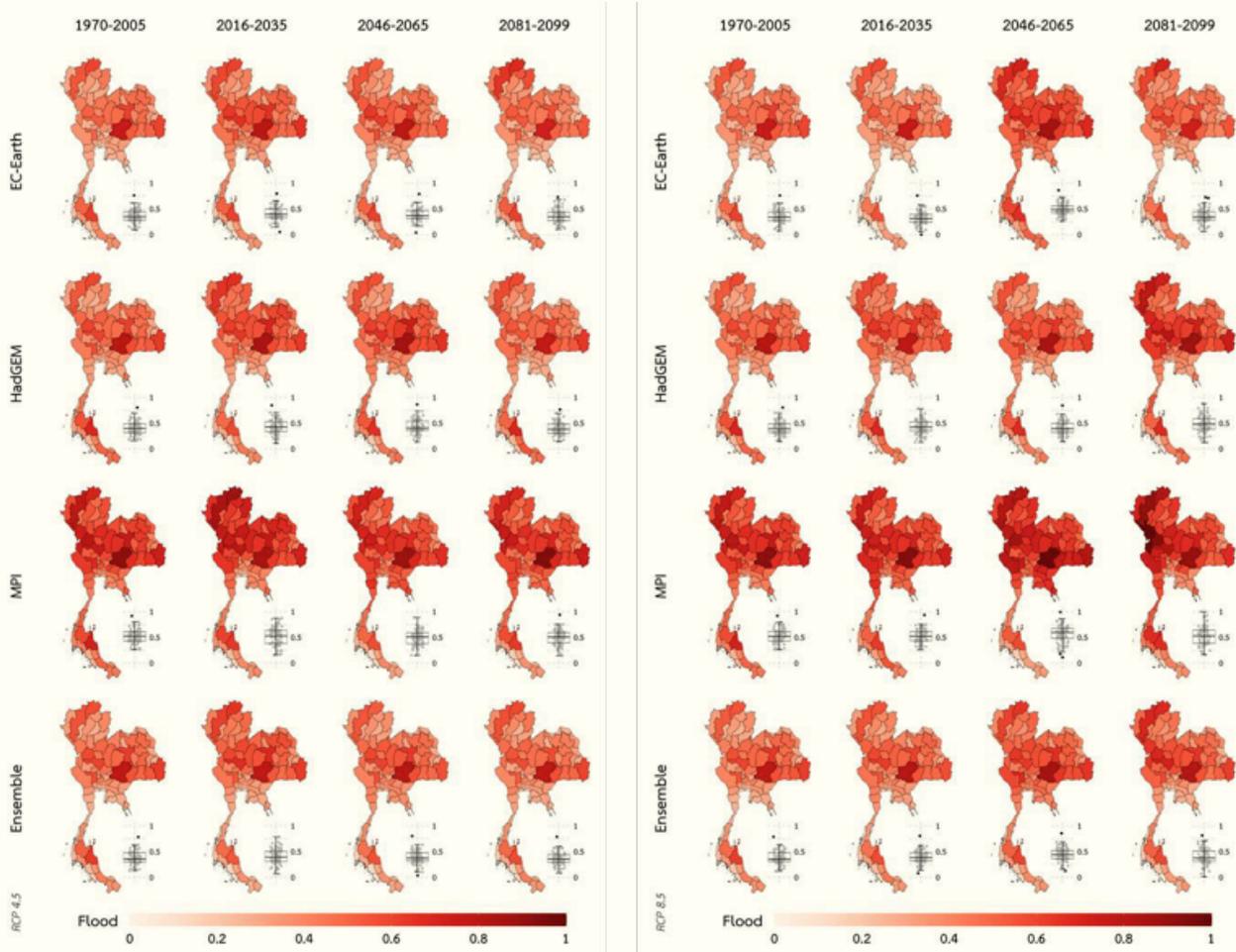


Figure A-6: Flood risk map in agricultural sector under RCP4.5 (Left) and RCP8.5 (Right)

Source: Office of Natural Resources and Environmental Policy and Planning (ONEP) and Ramkhamhaeng University Center of Regional Climate Change and Renewable Energy (RU-CORE) (2021)

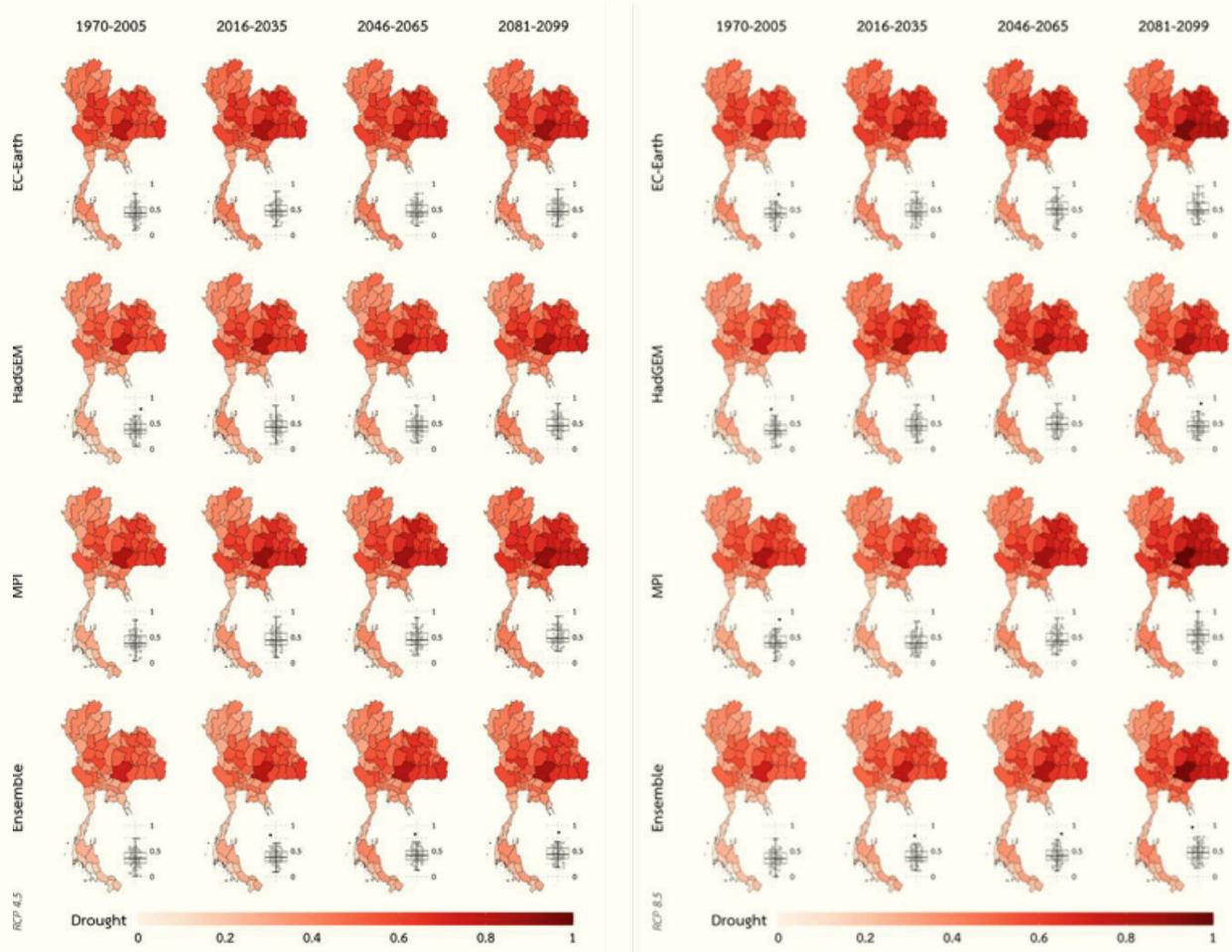


Figure A-7: Drought risk map in agricultural sector under RCP4.5 (Left) and RCP8.5 (Right)

Source: Office of Natural Resources and Environmental Policy and Planning (ONEP) and Ramkhamhaeng University Center of Regional Climate Change and Renewable Energy (RU-CORE) (2021)

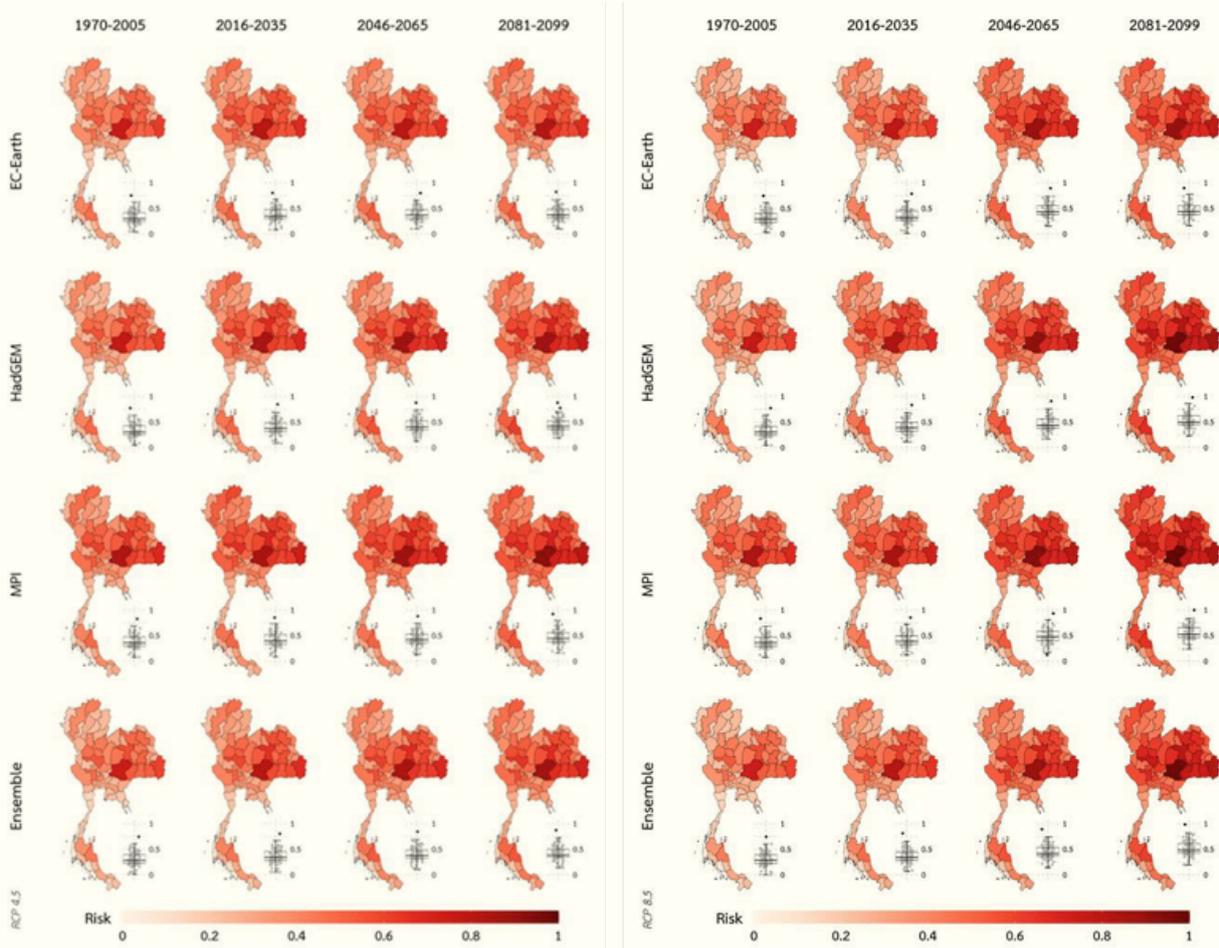


Figure A-8: Overall risk map in agricultural sector under RCP4.5 (Left) and RCP8.5 (Right)

Source: Office of Natural Resources and Environmental Policy and Planning (ONEP) and Ramkhamhaeng University Center of Regional Climate Change and Renewable Energy (RU-CORE) (2021)

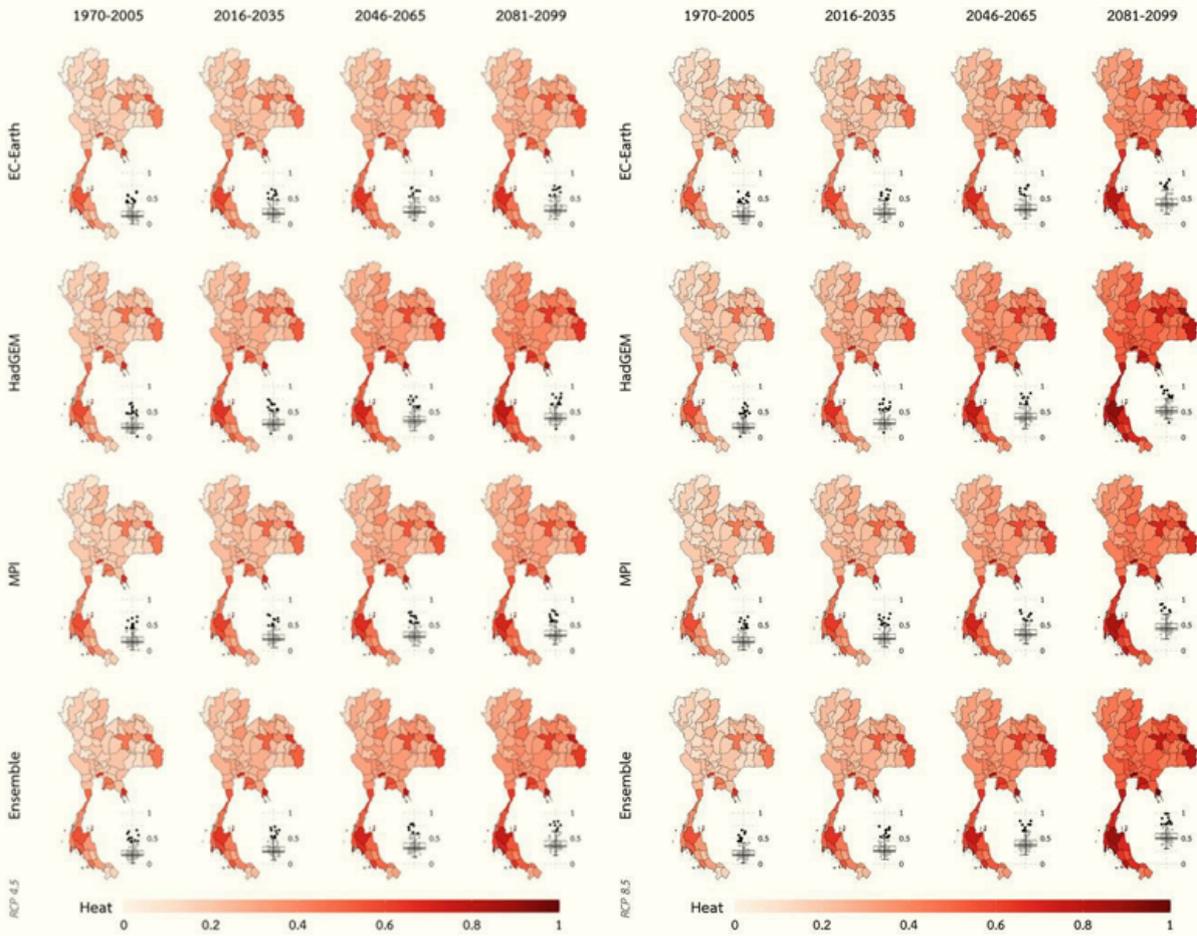


Figure A-9: Heat risk map in tourism sector under RCP4.5 (Left) and RCP8.5 (Right)

Source: Office of Natural Resources and Environmental Policy and Planning (ONEP) and Ramkhamhaeng University Center of Regional Climate Change and Renewable Energy (RU-CORE) (2021)

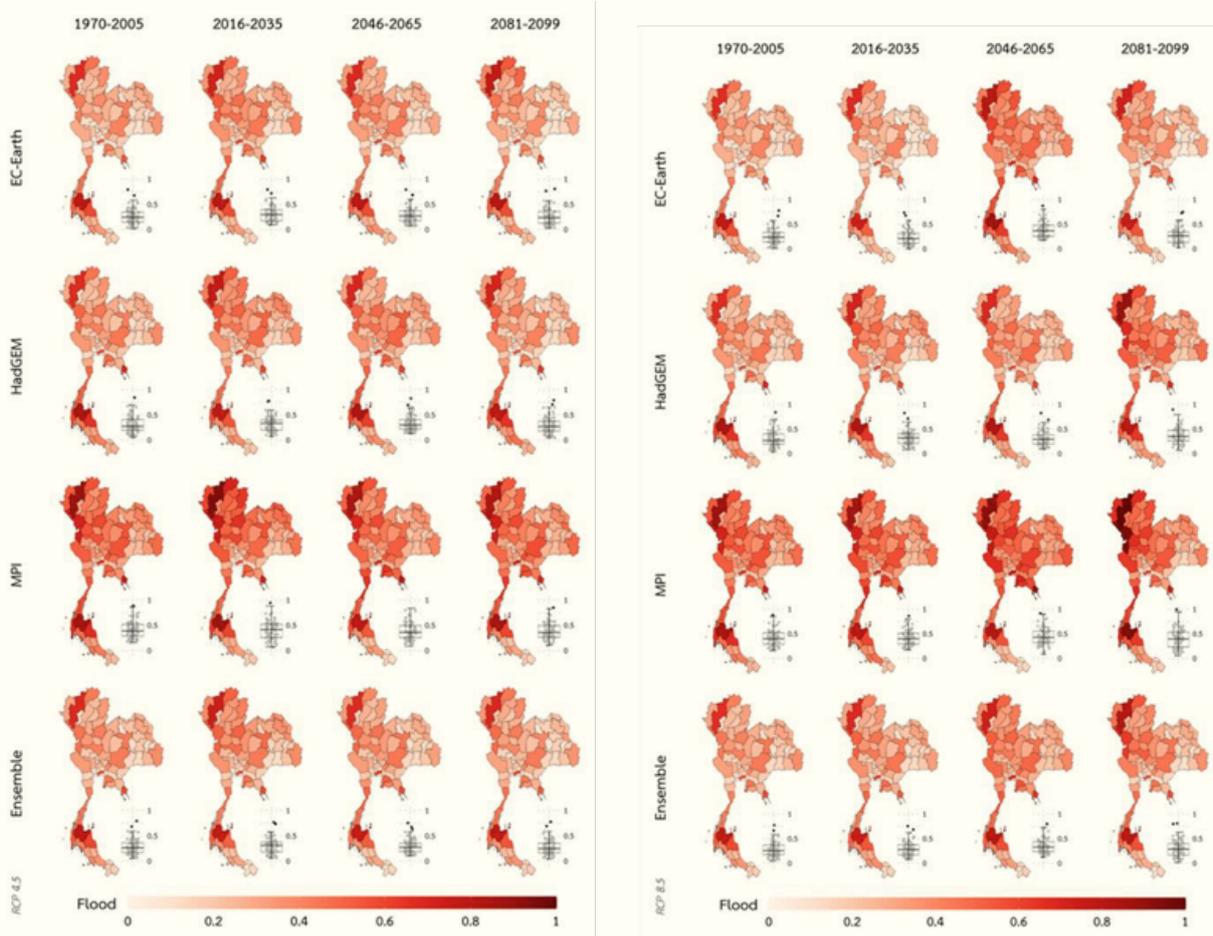


Figure A-10: Flood risk map in tourism sector under RCP4.5 (Left) and RCP8.5 (Right)

Source: Office of Natural Resources and Environmental Policy and Planning (ONEP) and Ramkhamhaeng University Center of Regional Climate Change and Renewable Energy (RU-CORE) (2021)

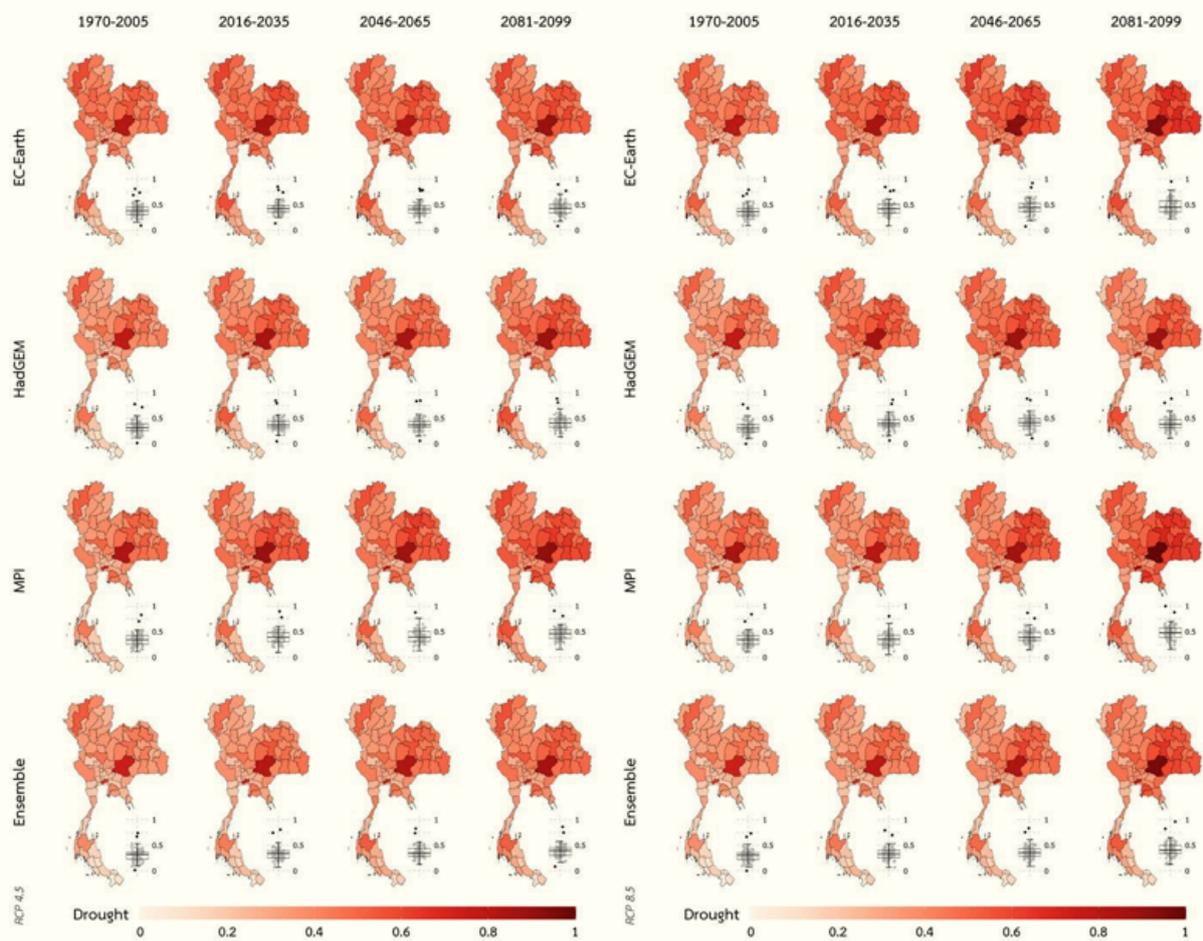


Figure A-11: Drought risk map in tourism sector under RCP4.5 (Left) and RCP8.5 (Right)

Source: Office of Natural Resources and Environmental Policy and Planning (ONEP) and Ramkhamhaeng University Center of Regional Climate Change and Renewable Energy (RU-CORE) (2021)

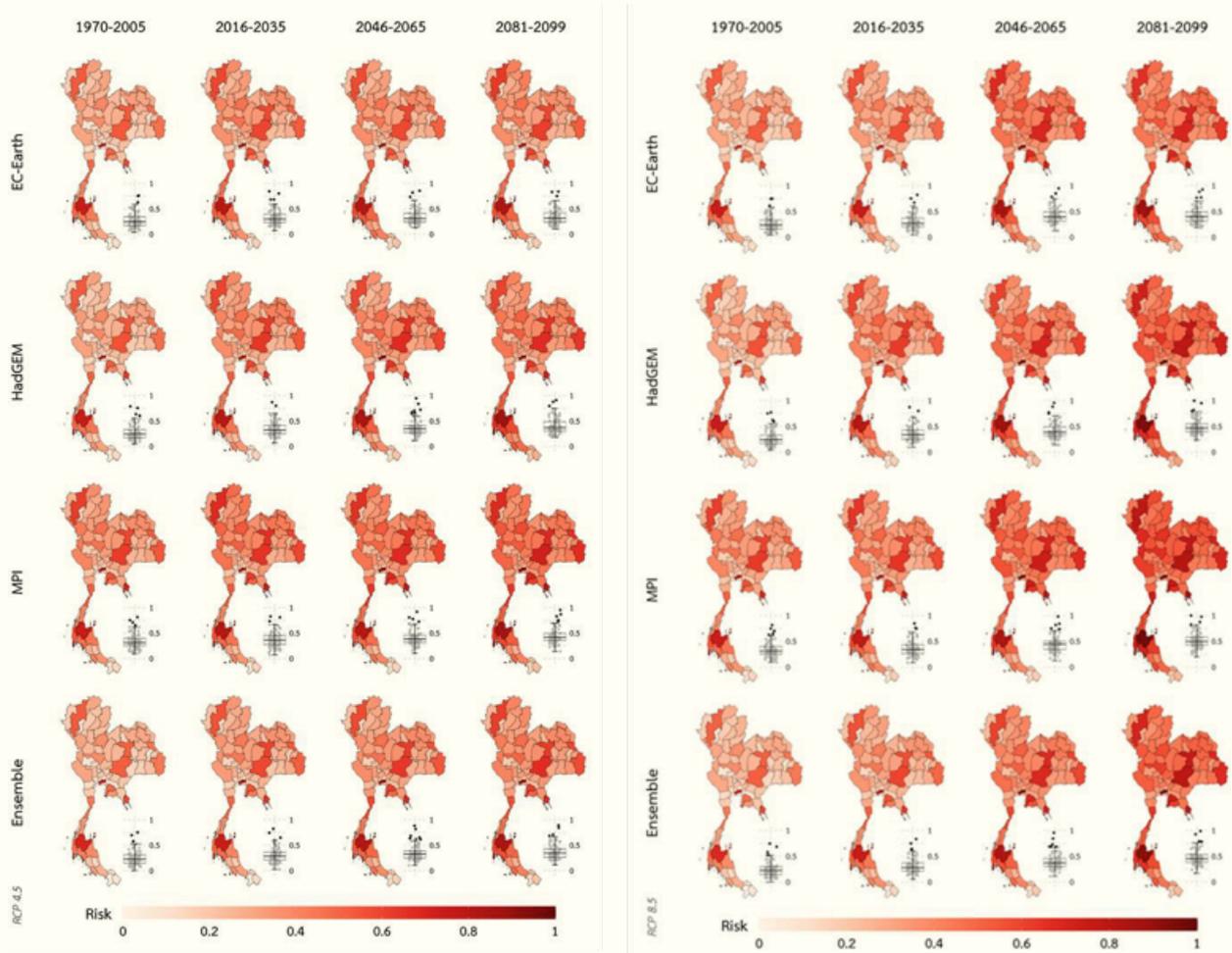


Figure A-12: Overall risk map in tourism sector under RCP4.5 (Left) and RCP8.5 (Right)

Source: Office of Natural Resources and Environmental Policy and Planning (ONEP) and Ramkhamhaeng University Center of Regional Climate Change and Renewable Energy (RU-CORE) (2021)

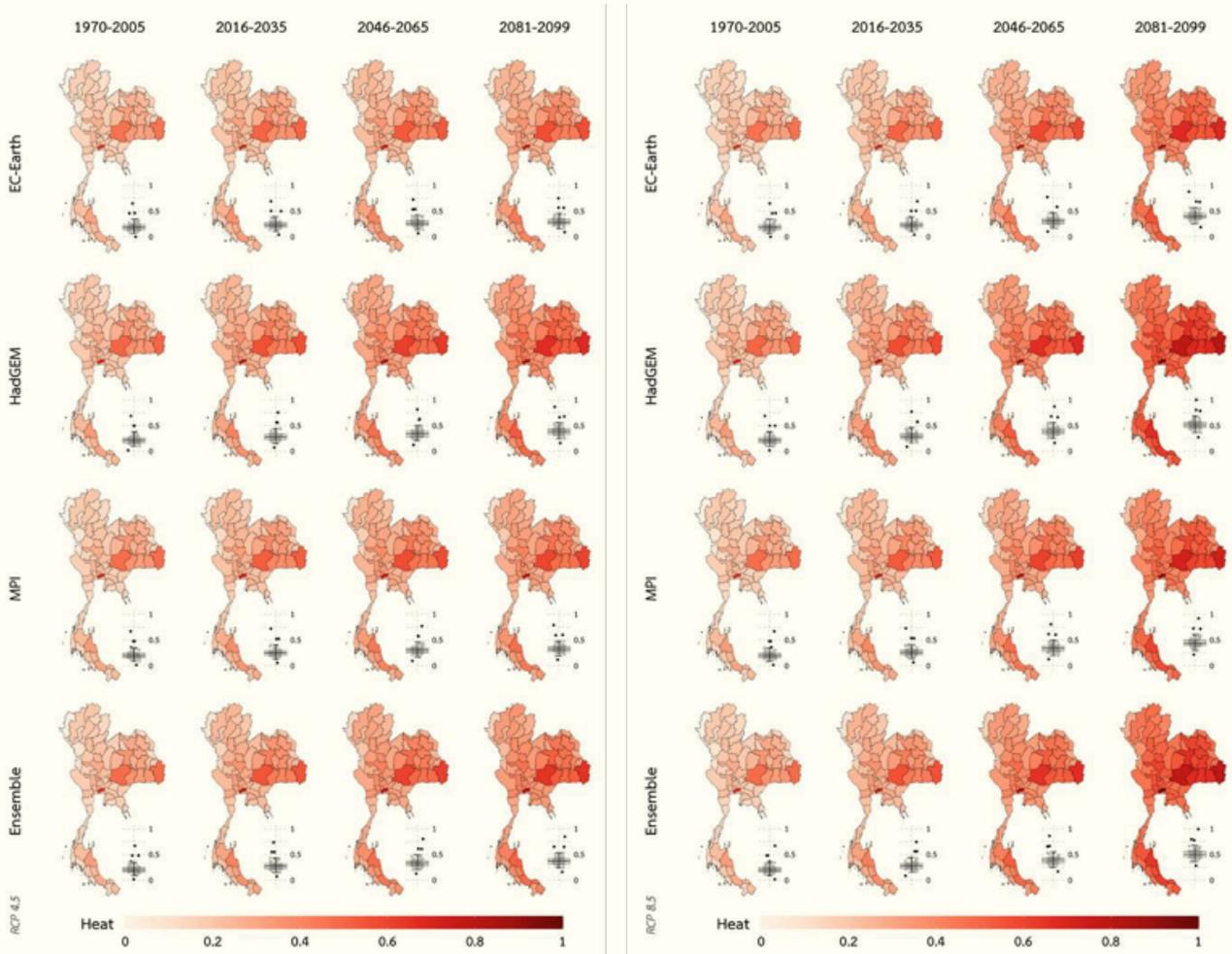


Figure A-13: Heat risk map in public health sector under RCP4.5 (Left) and RCP8.5 (Right)

Source: Office of Natural Resources and Environmental Policy and Planning (ONEP) and Ramkhamhaeng University Center of Regional Climate Change and Renewable Energy (RU-CORE) (2021)

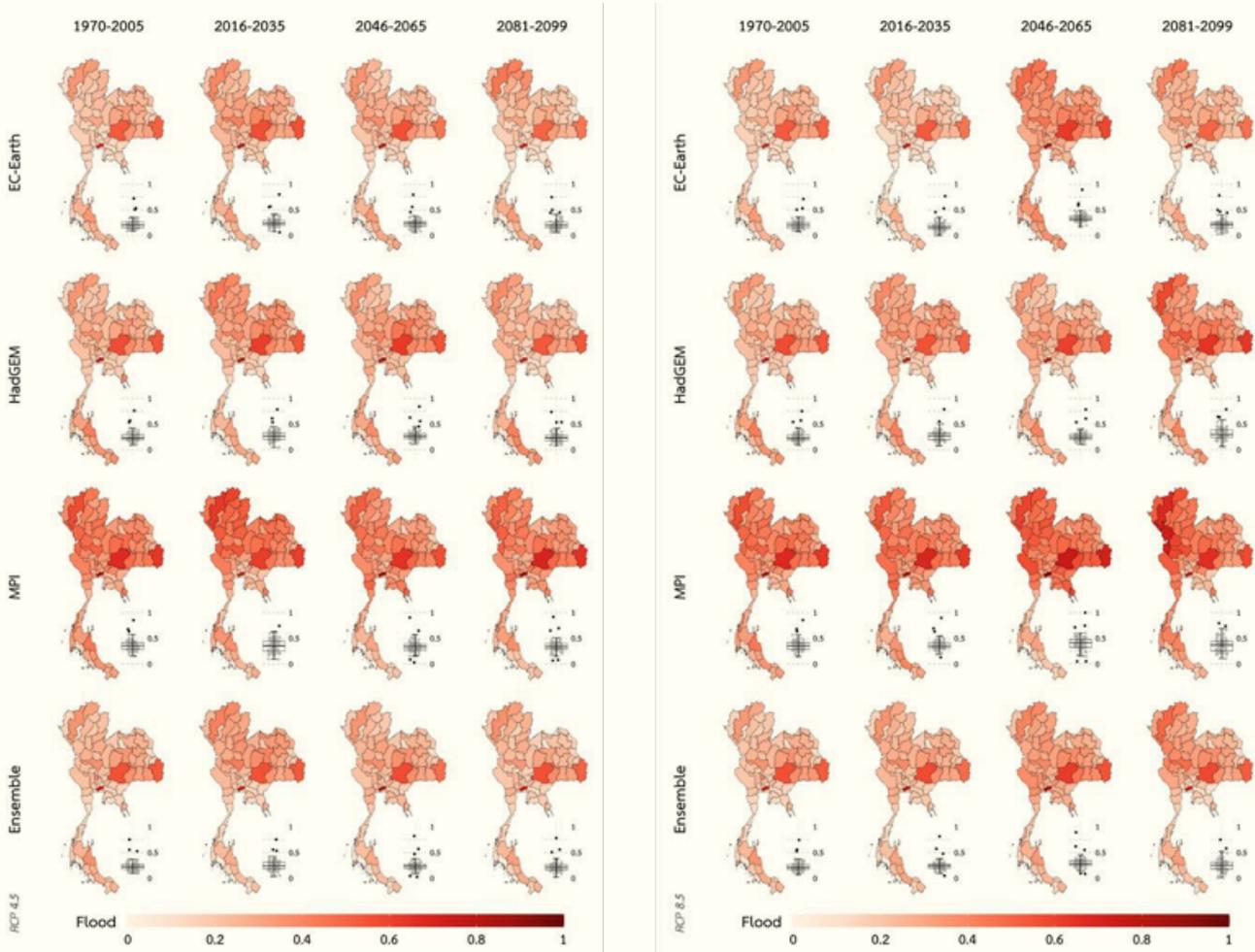


Figure A-14: Flood risk map in public health sector under RCP4.5 (Left) and RCP8.5 (Right)

Source: Office of Natural Resources and Environmental Policy and Planning (ONEP) and Ramkhamhaeng University Center of Regional Climate Change and Renewable Energy (RU-CORE) (2021)

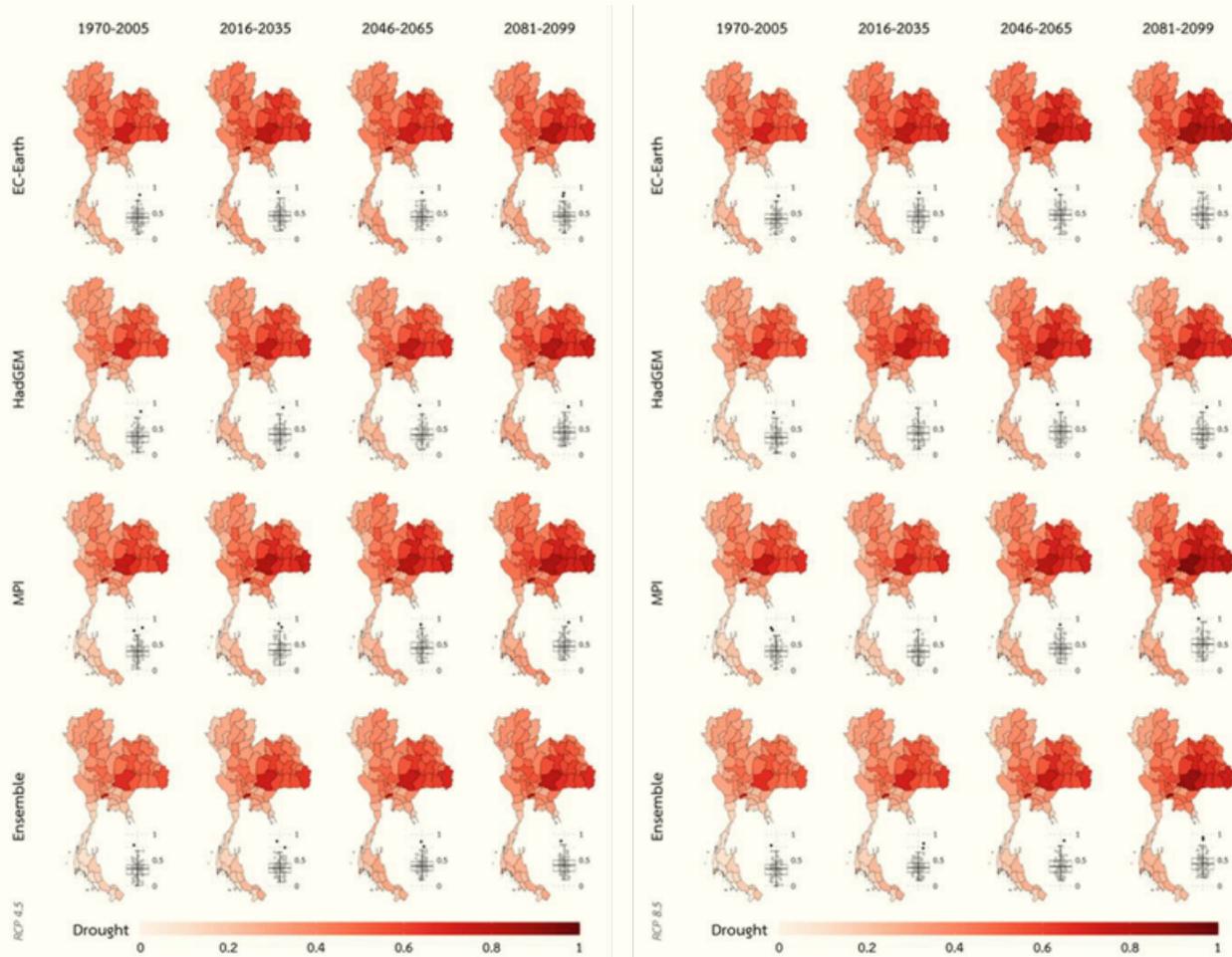


Figure A-15: Drought risk map in public health sector under RCP4.5 (Left) and RCP8.5 (Right)

Source: Office of Natural Resources and Environmental Policy and Planning (ONEP) and Ramkhamhaeng University Center of Regional Climate Change and Renewable Energy (RU-CORE) (2021)

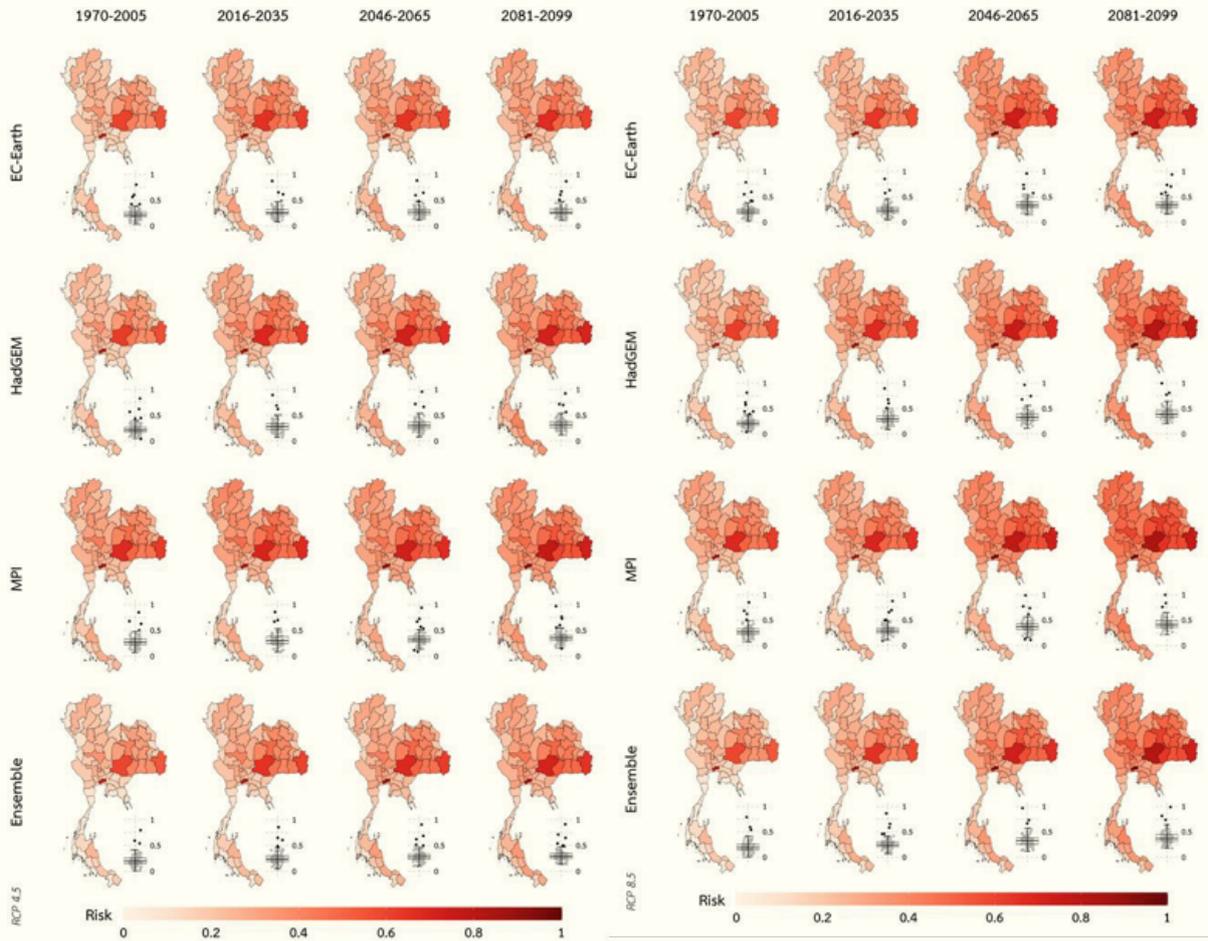


Figure A-16: Overall risk map in public health sector under RCP4.5 (Left) and RCP8.5 (Right)

Source: Office of Natural Resources and Environmental Policy and Planning (ONEP) and Ramkhamhaeng University Center of Regional Climate Change and Renewable Energy (RU-CORE) (2021)

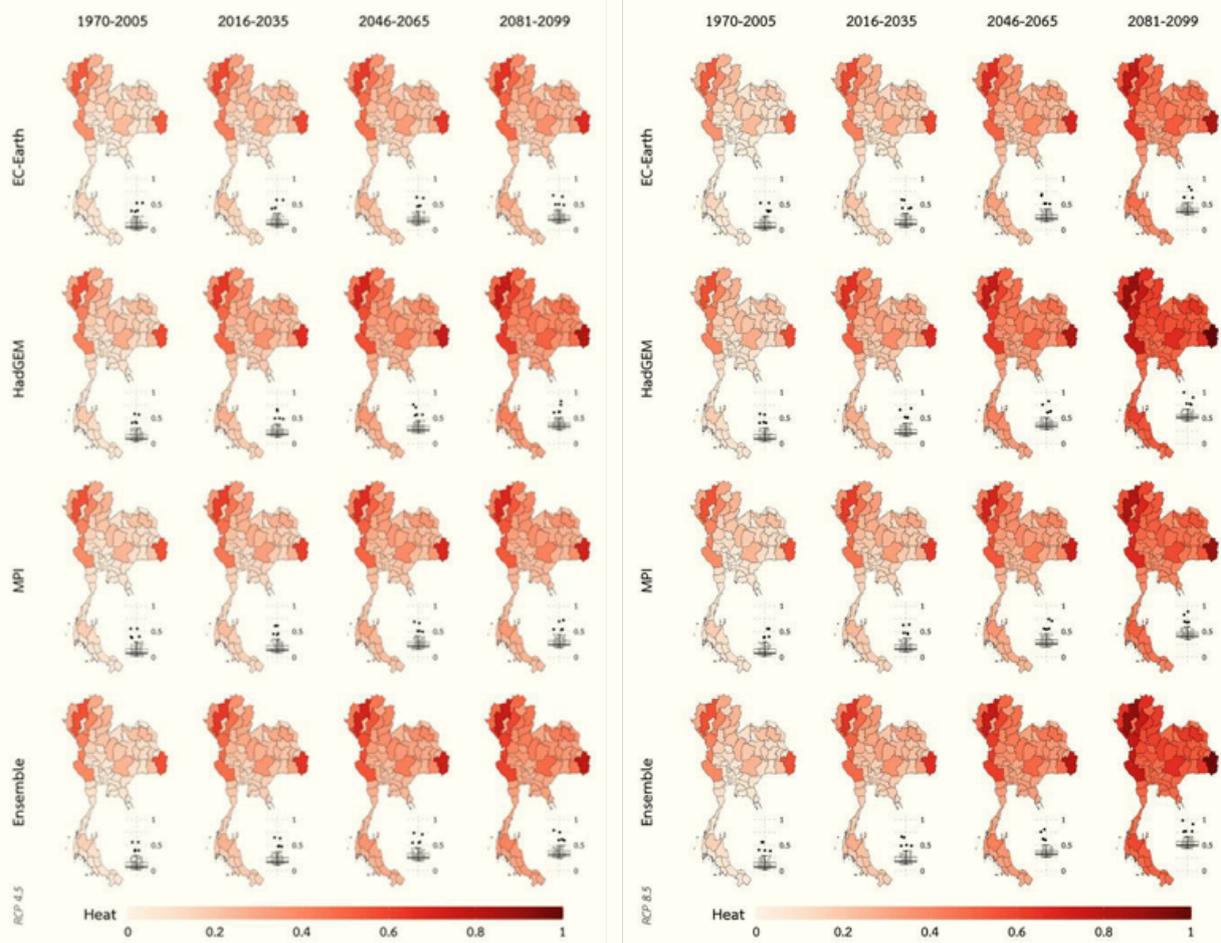


Figure A-17: Heat risk map in natural resource management sector under RCP4.5 (Left) and RCP8.5 (Right)

Source: Office of Natural Resources and Environmental Policy and Planning (ONEP) and Ramkhamhaeng University Center of Regional Climate Change and Renewable Energy (RU-CORE) (2021)

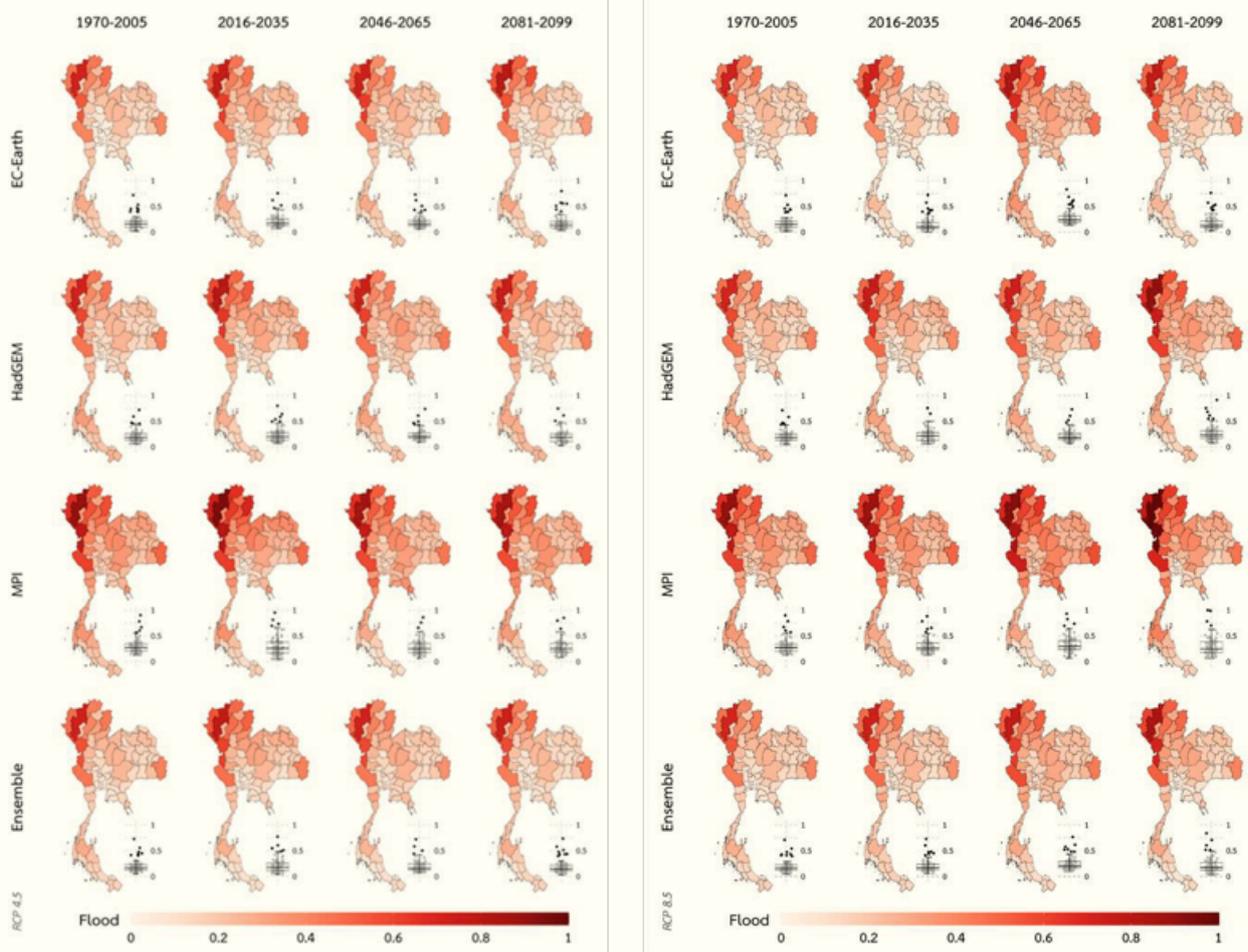


Figure A-18: Flood risk map in natural resource management sector under RCP4.5 (Left) and RCP8.5 (Right)

Source: Office of Natural Resources and Environmental Policy and Planning (ONEP) and Ramkhamhaeng University Center of Regional Climate Change and Renewable Energy (RU-CORE) (2021)

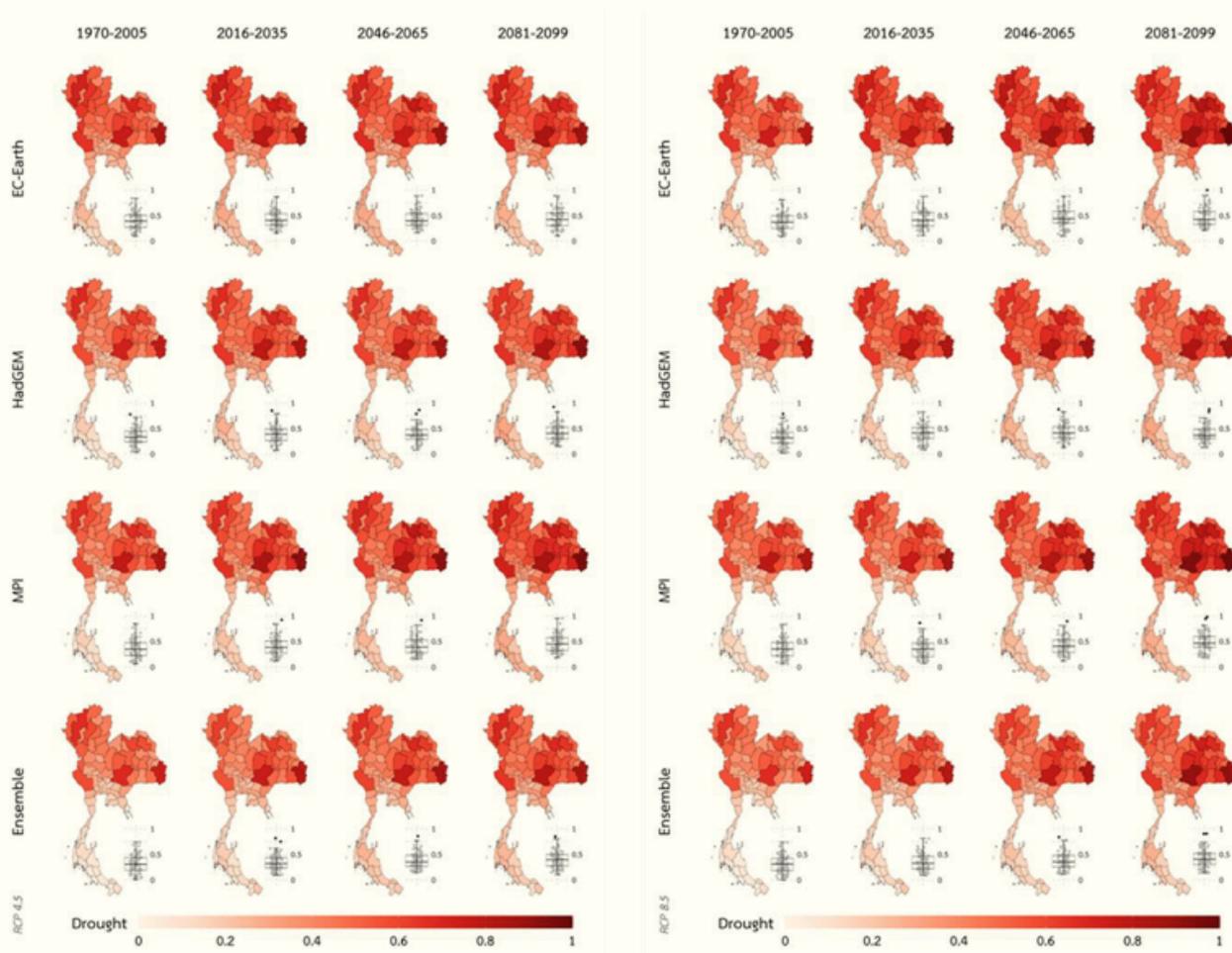


Figure A-19: Drought risk map in natural resource management sector under RCP4.5 (Left) and RCP8.5 (Right)

Source: Office of Natural Resources and Environmental Policy and Planning (ONEP) and Ramkhamhaeng University Center of Regional Climate Change and Renewable Energy (RU-CORE) (2021)

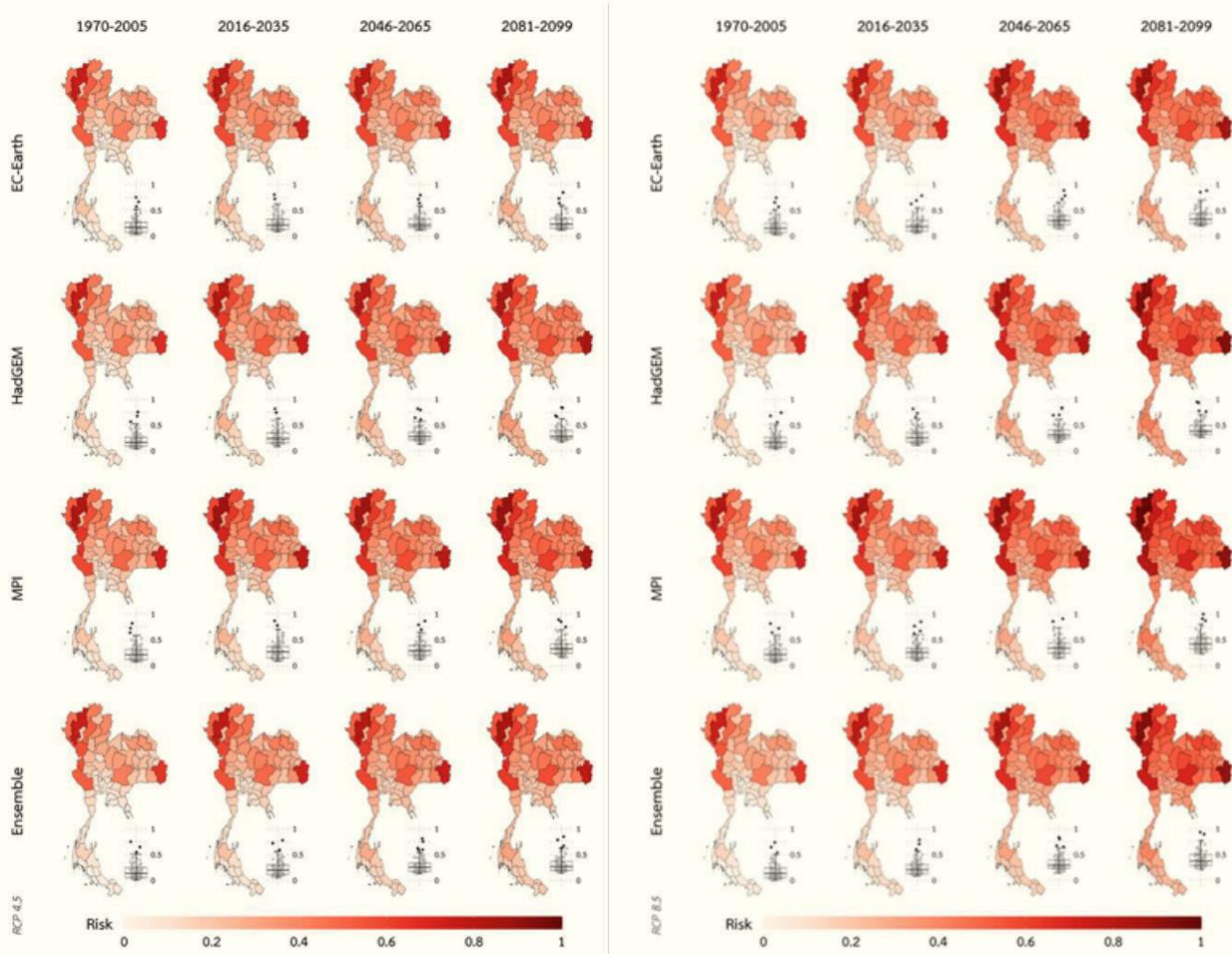


Figure A-20: Overall risk map in natural resource management sector under RCP4.5 (Left) and RCP8.5 (Right)

Source: Office of Natural Resources and Environmental Policy and Planning (ONEP) and Ramkhamhaeng University Center of Regional Climate Change and Renewable Energy (RU-CORE) (2021)

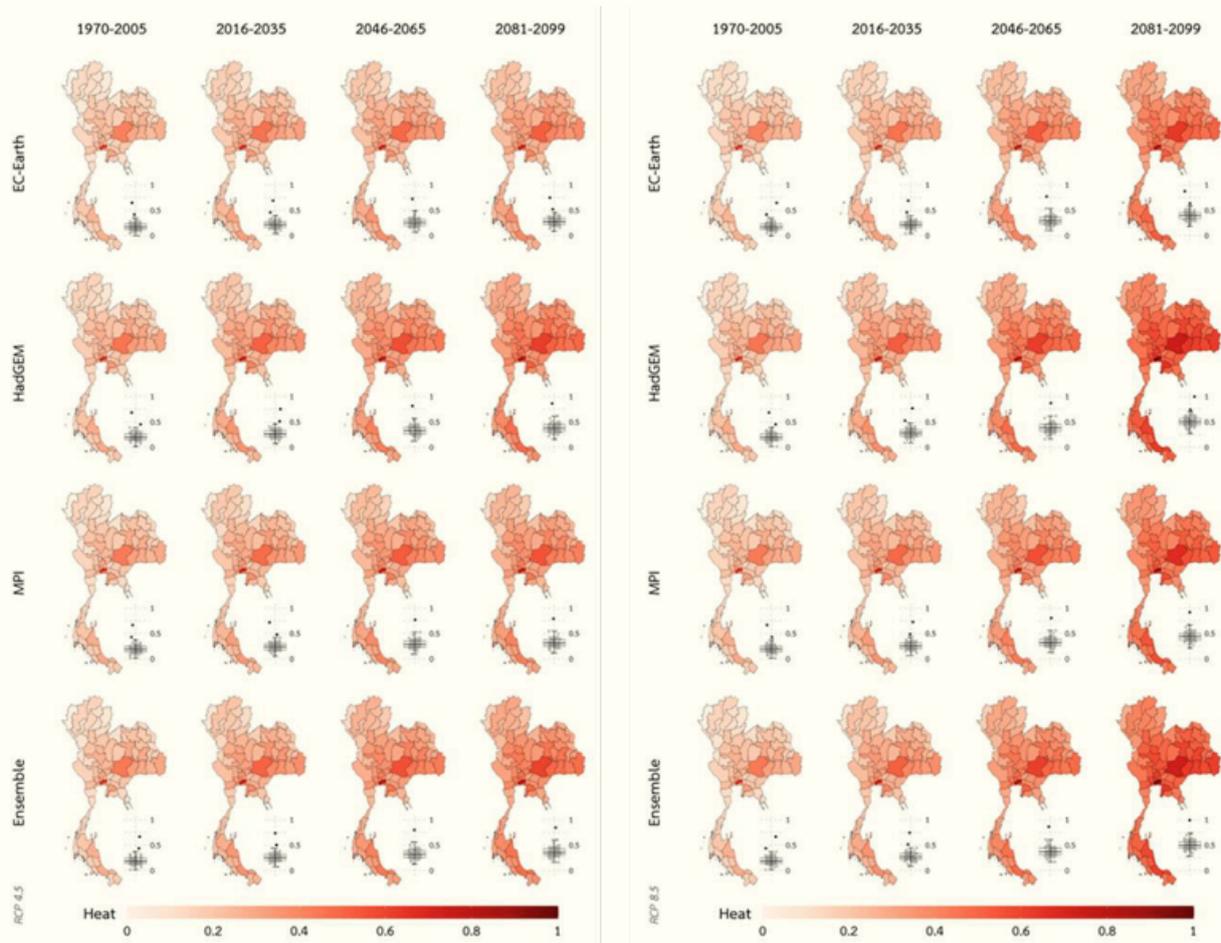


Figure A-21: Heat risk map in human settlement and security sector under RCP4.5 (Left) and RCP8.5 (Right)

Source: Office of Natural Resources and Environmental Policy and Planning (ONEP) and Ramkhamhaeng University Center of Regional Climate Change and Renewable Energy (RU-CORE) (2021)

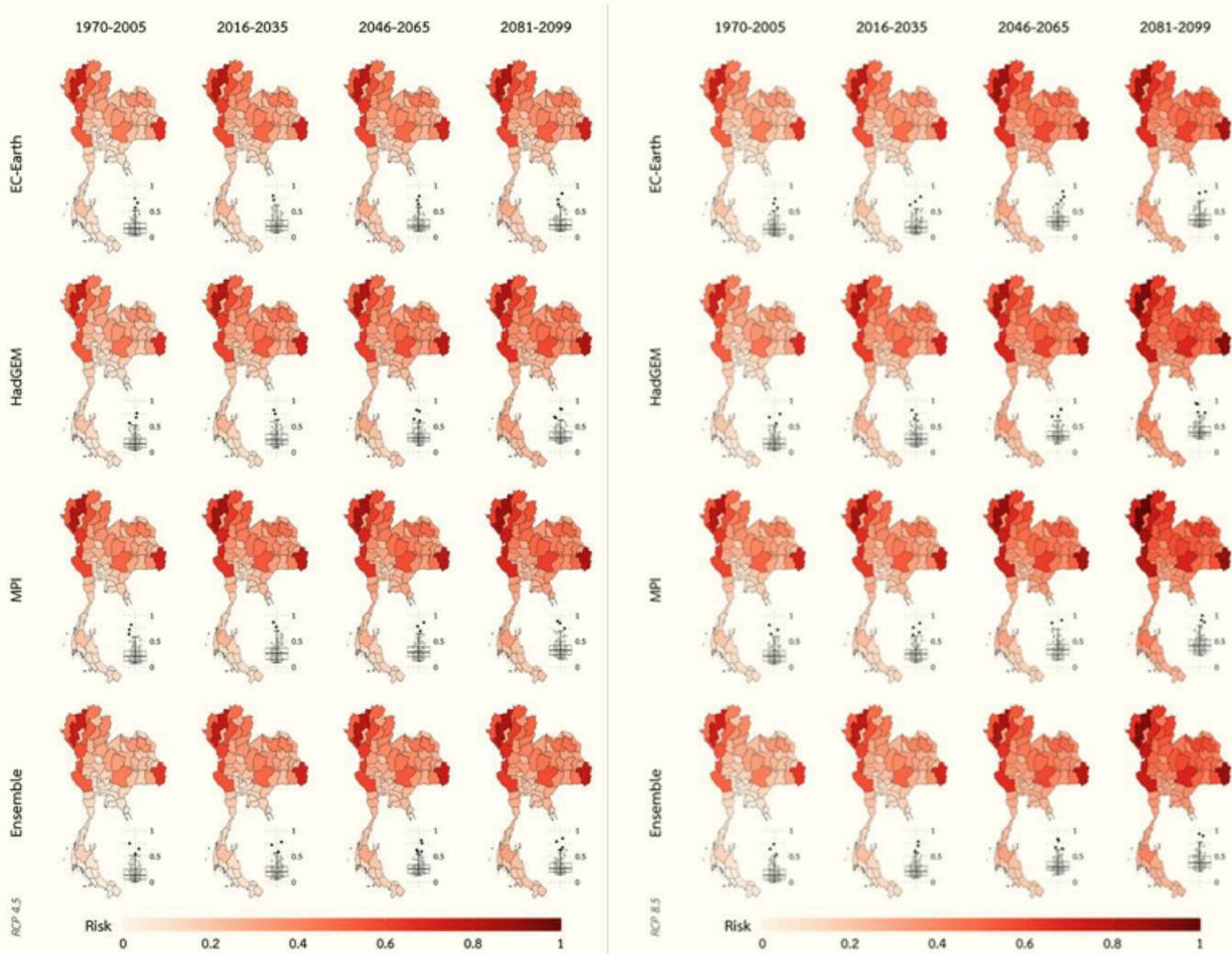


Figure A-22: Flood risk map in human settlement and security sector under RCP4.5 (Left) and RCP8.5 (Right)

Source: Office of Natural Resources and Environmental Policy and Planning (ONEP) and Ramkhamhaeng University Center of Regional Climate Change and Renewable Energy (RU-CORE) (2021)

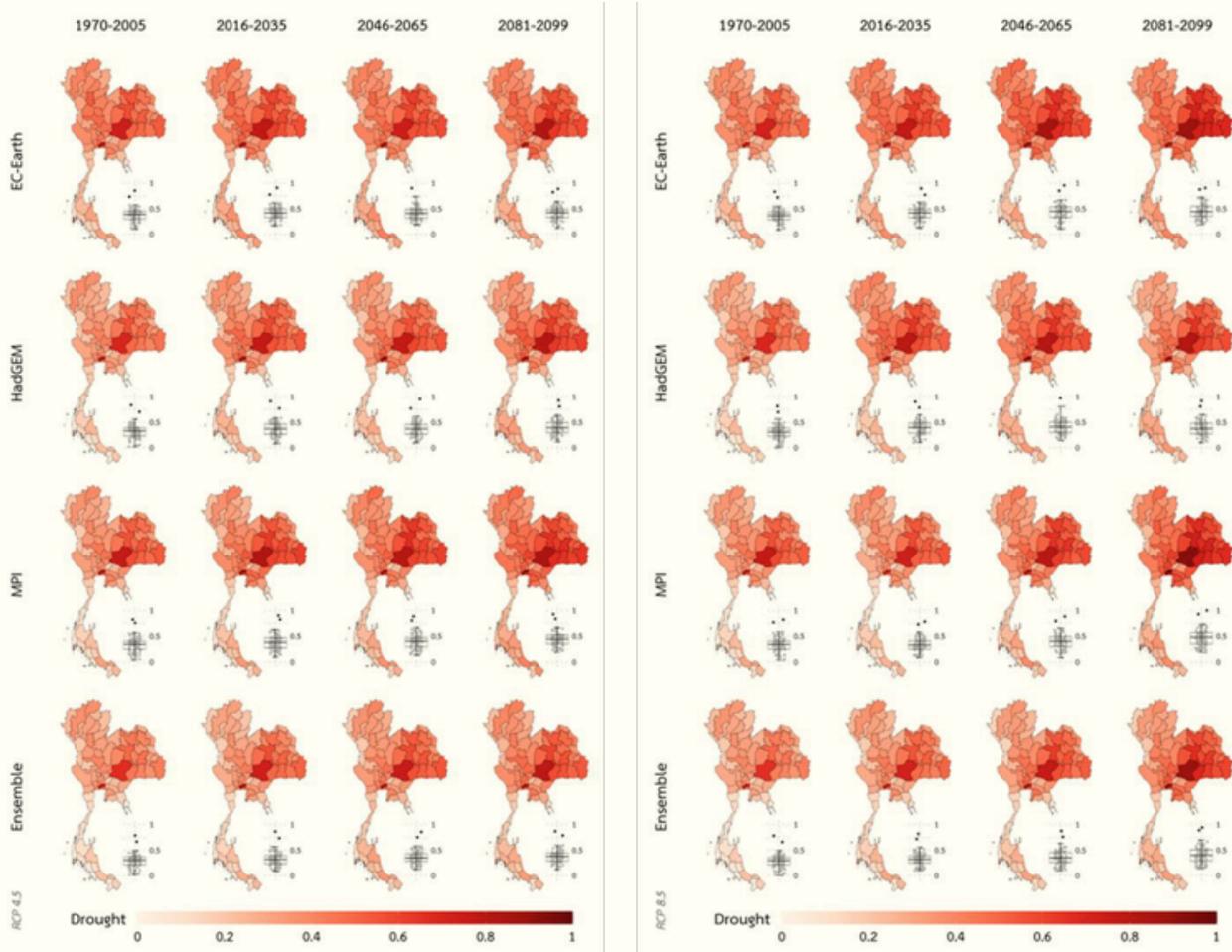


Figure A-23: Drought risk map in human settlement and security sector under RCP4.5 (Left) and RCP8.5 (Right)

Source: Office of Natural Resources and Environmental Policy and Planning (ONEP) and Ramkhamhaeng University Center of Regional Climate Change and Renewable Energy (RU-CORE) (2021)

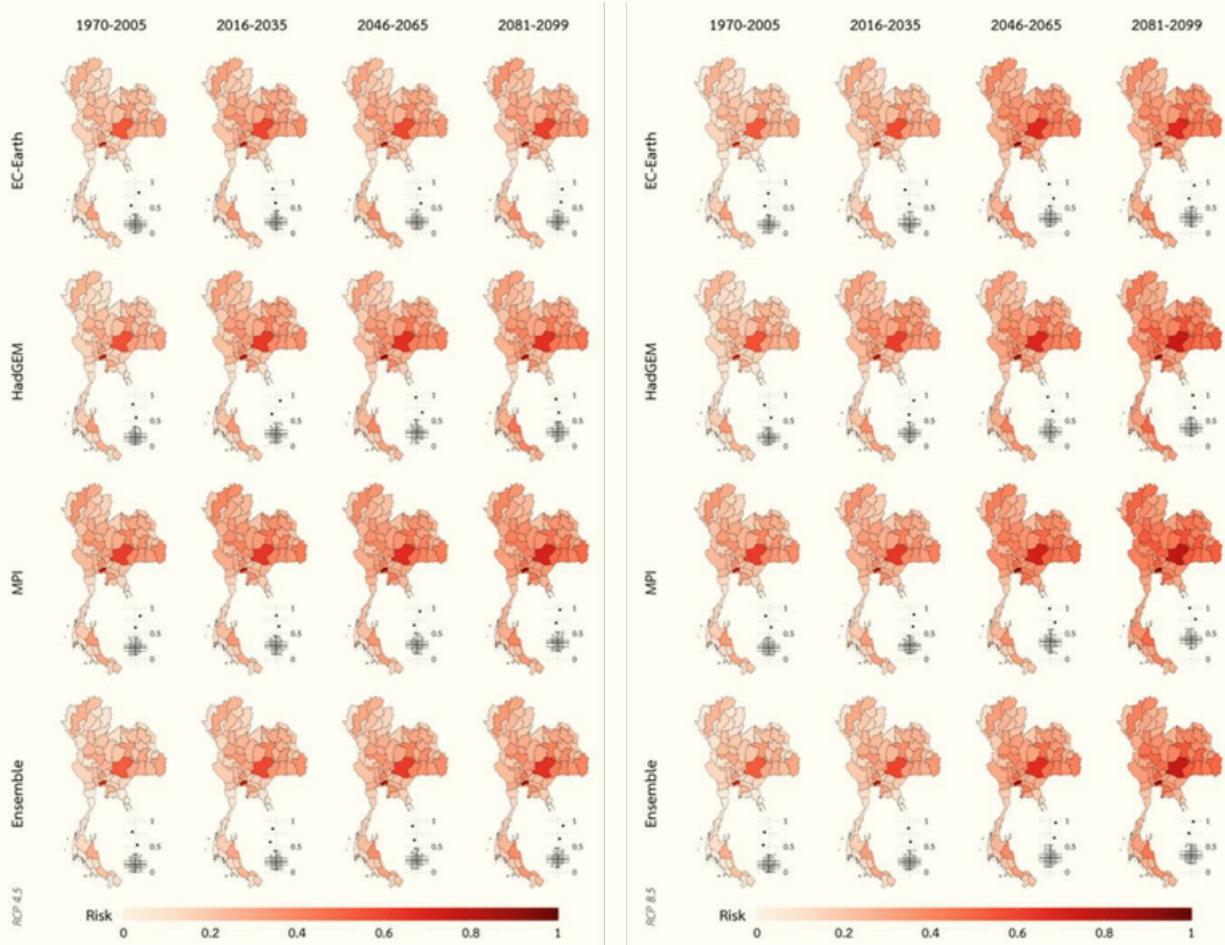


Figure A-24: Overall risk map in human settlement and security sector under RCP4.5 (Left) and RCP8.5 (Right)

Source: Office of Natural Resources and Environmental Policy and Planning (ONEP) and Ramkhamhaeng University Center of Regional Climate Change and Renewable Energy (RU-CORE) (2021)

**THAILAND'S  
FOURTH NATIONAL  
COMMUNICATION**



OFFICE OF NATURAL RESOURCES AND ENVIRONMENTAL POLICY AND PLANNING

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