THAILAND'S THIRD NATIONAL COMMUNICATION

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THE KINGDOM OF THAILAND

MINISTRY OF NATURAL RESOURCES AND ENVIRONMENT - *POLICY FORMULATION AND NATIONAL FOCAL POINT*
OFFICE OF NATURAL RESOURCES AND ENVIRONMENTAL POLICY AND PLANNING
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FOREWORD

Thailand's Third National Communication (TNC) to the United Nations Framework Convention on Climate Change presents its efforts in implementing climate actions to reduce greenhouse gas emissions and enhance climate resilience. This Communication was prepared by the Office of Natural Resources and Environmental Policy and Planning, Ministry of Natural Resources and Environment, in collaboration with national experts and relevant stakeholders during 2014-2018 receiving financial support from Global Environment Facility through the United Nations Development Programme. Thailand's TNC follows the guidelines adopted by Conference of the Parties (COP) and highlights national information on a series of greenhouse gas emissions and sinks during the period of 2000-2013 as well as Thailand's context on vulnerability and adaptation.

Even though Thailand accounts for less than 1 percent of global emission in 2013, the Royal Thai Government has placed climate change among the top national priorities. In 2014, Thailand submitted its nationally appropriate mitigation action (NAMA) pledging to reduce its greenhouse gas emission by 7-20 percent from the projected business as usual level by 2020. Up to date, the NAMA implementation evidently offers the promising mitigation outcome and ensures that we are on a strong track to meet our 2020 target. As a party to the Paris Agreement, Thailand has already submitted its (intended) nationally determined contribution ((I)NDC) in 2015, aiming ambitiously to reduce its greenhouse gas emissions by 20-25 percent from the projected business as usual level by 2030. To ensure the continuity in our mitigation actions from NAMA to NDC, the cabinet approved the NDC roadmap on mitigation (2021-2030) in May 2017. This roadmap prioritizes important mitigation measures on renewable energy and energy efficiency specified under the Power Development Plan, Alternative Energy Development Plan, and Energy Efficiency Plan as well as ambitious actions to promote road-to-rail modal shift for both freight and passenger transport, by extending mass rapid transit lines, constructing double-track railways and improving of bus transit in the Bangkok Metropolitan region, given under the Environmentally Sustainable Transport System Plan.

Considering the fact that Thailand is among the ten countries that is most vulnerable to future climate change impacts in the long-term climate risk (1997-2016) category. Hence, climate change adaptation is on our top national agenda. The National Adaptation Plan (NAP) is under development and is expected to be finalized by the end of this year to provide a strategic implementation plan at the national and local levels in 6 prioritized areas including water resources management, agriculture and food security, tourism, health, natural resources management, and human settlement and security.

To enhance domestic climate actions and to work towards the goal of Paris Agreement, we need to accelerate the transformation to low greenhouse gas emission and climate resilient development at both global and national levels. These enhanced climate actions can be effectively implemented if adequate and predictable means of implementation in terms of finance, technology transfer, and capacity building are provided to developing countries, which is the key to achieve our shared goal. Thailand will continue relentlessly to work on our parts and with the global community to address the common environmental and development challenge of climate change.

On behalf of the government of the Kingdom of Thailand, I express my acknowledgement to the Global Environment Facility for financial support, to the United Nations Development Programme for assistance in the preparation of the Third National Communication, and to national experts, government and non-government organization for their contributions in preparing this report.

General Surasak Karnjanarat

(Surasak Karnjanarat)

Minister of Natural Resources and Environment

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LIST OF ACRONYMS, ABBREVIATIONS AND UNITS

°C	Degree Celsius
µg	Microgram
AADMER	ASEAN Agreement on Disaster Management and Emergency Response
ACCCRN	Asian Cities Climate Change Resilience Network
ACE	Actions for Climate Empowerment
AD	Activity Data
ADAP-T	Advancing co-design of integrated strategies with adaptation to climate change in Thailand
ADB	Asian Development Bank
ADFIAP	Development Financing Institutions in Asia and the Pacific
AEDP	Alternative Energy Development Plan
AEEAP	ASEAN Environmental Education Action Plan
AERONET	Aerosol Robotic Network
AEZ	Agro-Ecological Zone
AGEIS	Australian Greenhouse Emissions Information System
AIT	Asian Institute of Technology
AOD	Aerosol Optical Depth
APAN	Asia Pacific Advanced Network
APN	Asia Pacific Network of Global Change Research
ARDA	Agricultural Research Development Agency
ASEAN	Association of Southeast Asian Nations
ASFN	The ASEAN Social Forestry Network
AWD	Alternate Wetting and Drying
BAU	Business as Usual
BECC	Basic Education Core Curriculum
BIOFIN	Biodiversity Finance Initiative
BMA	Bangkok Metropolitan Administration
BMUB	Federal Ministry of the Environment, Nature Conservation, Building and Nuclear Safety
BTS	Bangkok Mass Transit System Public Company Limited
BUR	Biennial Update Reports
CAAS	Chinese Academy of Agricultural Sciences
CAAT	The Civil Aviation Authority of Thailand
CapREG	Capacity Development on Renewable Energy and Grid Integration
CBD	Central Business District
CBFCM	Integrated Community - based Forest and Catchment Management through an Ecosystem Service Approach
CCBA	Climate Change Benefit Analysis
CC CBA	Climate Change Community-Based Adaption
CCCOs	Climate Change Coordinator Officers
CCM	Common Carbon Metric
CCMCD	Climate Change Management and Coordination Division
CCS	Carbon Capture and Storage

LIST OF ACRONYMS, ABBREVIATIONS AND UNITS

CDM	Clean Development Mechanism
CEERD	Centre for Energy Environment Resources Development
CFC	Chlorofluorocarbons
CFR	Carbon Footprint Reduction
CH_4	Methane
CITC	Climate Change International Technical and Training
CMA	The Conference of the Parties serving as the meeting of the Parties to the Paris Agreement
CMIP5	The Coupled Model Intercomparison Project Phase 5
CMU	Center Chiang Mai University
CNG	Compressed Natural Gas
CO	Carbon monoxide
CO_2	Carbon dioxide
CO_2eq	Carbon dioxide equivalent
COP	Conference of the Parties
CORDEX	Coordinated Regional Climate Downscaling Experiment
CORDEX-SEA	Coordinated Regional Climate Downscaling Experiment Southeast Asia
CS	Country Specific
CSIRO	Commonwealth Scientific and Industrial Research Organization
CTCN	Climate Technology Centre and Network
CU	Chulalongkorn University
DAE	Department of Agricultural Extension
DCA	Department of Civil Aviation
DDPM	Department of Disaster Prevention and Mitigation
DEB	Department of Energy Business
DECC	Department of Energy and Climate Change
DEDE	Department of Alternative Energy Development and Efficiency
DEQP	Department of Environmental Quality Promotion
DHI	Danish Hydraulic Institute
DIO	Department of International Organizations
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
DNA	Designated National Authority
DNP	Department of National Parks, Wildlife and Plant Conservation
DOA	Department of Agriculture
DOC	Department of Customs
DOC	Degradable organic carbon
DOC_F	Fraction DOC dissimilated
DOH	Department of Health

LIST OF ACRONYMS, ABBREVIATIONS AND UNITS

DPIM	Department of Primary Industries and Mines
DWP	Doha Work Programme
EbA	Ecosystem based Adaptation
EC-Earth	Global Climate Model
ECHAM5	The fifth-generation atmospheric general circulation model
ECOSWAT	Improved Management of Extreme Events through Ecosystem-based Adaption in Watersheds
ECVs	ECVs Essential Climate Variables
EE	Estimated Elsewhere
EEC	Eastern Economic Corridor
EECi	Eastern Economic Corridor of Innovation
EEDP	Energy Efficiency Development Plan
EEP	Energy Efficiency Plan
EESD	Environmental Education for Sustainable Development
EF	Emission Factor
EGAT	Electricity Generating Authority of Thailand
EI	Thailand's energy intensity
EIA	Environmental Impact Assessment
ENSO	El Niño–Southern Oscillation
EPC	Energy Performance Certificate scheme
EPIC	Ecosystems Protecting Infrastructure and Communities
EPPO	Energy Policy and Planning Office
ERTC	Environment Research and Training Center
ESGF	Earth System Grid Federation
ETS	Emission Trading Scheme
EU	European Union
EU-GSEI	European Union and Good Governance for Social Development and the Environment Foundation
EWEC	East-West Economic Corridor
FAO	Food and Agriculture Organization of the United Nations
FBUR	The First Biennial Update Report
FCPF	Forest Carbon Partnership Facility
FIT	Feed-in Tariff
FOD	First Order Decay
FREL/FRL	The Forest Reference Emission level/ Forest Reference level
GAPs	Good Agriculture Practices
GAW	Global Atmospheric Watch
GCF	Green Climate Fund
GCM	General Circulation Model
GCN	Global Core Network
GCOS	Global Climate Observing System
GDP	Gross Domestic Product
GEF	Global Environment Facility

LIST OF ACRONYMS, ABBREVIATIONS AND UNITS

GEO2TECDI	Geodetic Earth Observation Technologies for Thailand : Environmental Change Detection and Investigation
GFDL-CM3	Geophysical Fluid Dynamics Laboratory Coupled Model
$GgCO_2eq$	Giga gram Carbon dioxide equivalent
GGGI	Global Green Growth Institute
GHG	Greenhouse gases
GIS	Geographic Information System
GISTDA	Geo-Informatics and Space Technology Development Agency (Public Organization)
GIZ	Deutsche Gesellschaft für Internationale Zusammenarbeit
GLOSS	Global Sea Level Observing System
GOOS	Global Ocean Observing System
GOS	Global Observing System
GPG	Good Practice Guidance
gr	Growth rate
GSN	GCOS Surface Network
GTOS	Global Terrestrial Observing System
GUAN	GCOS Upper Air Network
GWP	Global Warming Potential
HAII	Hydro and Agro Informatics Institute
HALE	Health-Adjusted Life Expectancy
HFC	Hydrofluorocarbons
HSRI	Health Systems Research Institute
IAED	Institute of Agricultural Economics and Development
IEAT	Industrial Estate Authority of Thailand
IETDT	Institute for Environmental Technology Development and Transfer
IIEC	International Institute for Energy Conservation
IKI	International Climate Initiative
INDC	Intended Nationally Determined Contribution
IOC	Intergovernmental Oceanographic Commission
IPCC	Intergovernmental Panel on Climate Change
IPSL-CM5A-MR	Institut Pierre Simon Laplace Model CM5A-MR
IPST	Institute for the Promotion of Teaching Science and Technology
ISIT	Iron and Steel Institute of Thailand
ITS	Intelligent Transport System
IUCN	The International Union for Conservation of Nature
IWA	International Water Association
IWRM	Integrated Water Resources Management
JCM	Joint Credit Mechanism
JCOMM	Joint Technical Commission for Oceanography and Marine Meteorology
JFPR	Japan Fund for Poverty Reduction
JGSEE	Joint Graduate School of Energy and Environment
JICA	Japan International Cooperation Agency

LIST OF ACRONYMS, ABBREVIATIONS AND UNITS

JIID	Japanese Institute of Irrigation and Drainage
JST	Japan Science and Technology Agency
KCA	Key Category Analysis
km^2	Square kilometer
KMUTT	King Mongkut's University of Technology Thonburi
KTOE	Kilo Ton of Oil Equivalent
LCC	Low Carbon City
LDCF	Least Developed Countries Fund
LDD	Land Development Department
LECB	Low Emission Capacity Building
LEDS	Low Emission Development Strategies
LESS	Low Emission Support Scheme
LoR	Letter of Recognition
LPG	Liquid Petroleum Gas
LULUCF	Land Use, Land Use Change and Forestry
m^3	Cubic meter
MAPT	Measurement and Performance Tracking
MASAP	Mekong Adaptation Strategy and Action Plan
M-BRACE	Mekong-Building Climate Resilience in Asian Cities
MCF	Methane correction factor
MD	Marine Department
MEA	Metropolitan Electricity Authority
mm	Millimeter
MONRE	Ministry of Natural Resources and Environment
MOPH	Ministry of Public Health
MOU	Memorandum of Understanding
MPI-ESM-MR	Max Planck Institute for Meteorology Earth System Model MR
MRC	The Mekong River Commission
MRI-CGCM3	Meteorological Research Institute Coupled Global Climate Model
MRT	Mass Rapid Transit
MRV	Measuring, Reporting and Verification
MSW	Municipal Solid Waste
$MtCO_2eq$	Mega ton Carbon dioxide equivalent
MW	Mega Watts
N_2O	Nitrous oxide
NA	Not Applicable
NAMAs	Nationally Appropriate Mitigation Actions
NAP	National Adaptation Plan
NC	National Communication
NCCC	National Committee on Climate Change Policy
NCV	The Net Calorific Value
NDA	National Designated Authority

LIST OF ACRONYMS, ABBREVIATIONS AND UNITS

NDC	Nationally Determined Contributions
NDEs	National Designated Entities
NE	Not Estimated
NEDO	New Energy and Industrial Technology Development Organization
NESDB	Office of The National Economic and Social Development Board
NESDP	National Economic and Social Development Plan
NGOs	Non-governmental organization
NIES	National Institute for Environmental Studies
NMVOCs	Non-Methane Volatile Organic Compounds
NO	Not Occurring
NO_2	Nitrogen dioxide
NO_x	Nitrogen oxides
NRCT	NRCT National Research Council of Thailand
NSES	National Science Education Standard
NSTDA	National Science and Technology Development Agency
O_3	Ozone
OAE	Office of Agricultural Economics
OBEC	Office of Basic Education Commission
OECD	Organization for Economic Co-operation and Development
OHEC	Office of Higher Education Commission
OIE	Office of Industrial Economics
ONEP	Office of Natural Resources and Environmental Policy and Planning
OPS	Office of the Permanent Secretary
OTP	Office of Transport and Traffic Policy and Planning
PAT	Port Authority of Thailand
PCD	Pollution Control Department
PDO	The Pacific Decadal Oscillation
PDP	Power Development Plan
PEA	Provincial Electricity Authority
PFCs	Perfluorocarbons
PM	Particulate matter
PMR	Partnership for Market Readiness
ppb	parts per billion
ppm	parts per million
PRECIS	Providing Regional Climate for Impact Studies
PSMSL	Permanent Service for Mean Sea Level
PSP	Poznan Strategic Program
PTIT	Petroleum Institute of Thailand
PTT	PTT Public Company Limited
QA	Quality Assurance
QC	Quality Control
R&D	Research and development

LIST OF ACRONYMS, ABBREVIATIONS AND UNITS

RAC	Refrigeration and Air Conditioning
RADARs	The Researched Abuse, Diversion and Addiction-Related Surveillance
RAOT	Rubber Authority of Thailand
RBCN	Regional Basic Climatological Network
RBSN	Regional Basic Synoptic Network
RCCDF	Regional Climate Projections Consortium Data Facility
RCPs	Representative Concentration Pathways
RD	Rice Department
RDF	Refuse Derived Fuel
RE	Renewable Energy
RECOFTC	The Center for People and Forests
REDD+	Reducing Emissions from Deforestation and Forest Degradation in Developing Countries (REDD); and the role of conservation, sustainable management of forests and enhancement of forest Carbon stocks in Developing countries (+)
RegCM4	The Regional Climate Model Version 4
RENAC	Renewables Academy AG
RFD	Royal Forest Department
RID	Royal Irrigation Department
Risk-NAP	Risk-based National Adaptation Planning (page VI)
R-PP	Readiness Preparation Proposal
RU-CORE	Ramkamhaeng University Center of Regional Climate Change and Renewable Energy
SAICM	Strategic Approach to International Chemicals Management
SARL	Suvarnabhumi Airport Rail Link
SBUR	The Second Biennial Update Report
SCCC	Siam City Cement Public Company Limited
SCCF	Special Climate Change Fund
SCG	Siam Cement Public Company Limited
SCP	Sustainable Consumption and Production
SCWRM	Strategic Committee for Water Resources Management
SDG	Sustainable Development Goal
SEA	South East Asia
SEACLID	Southeast Asia Regional Climate Downscaling
SF_6	Sulfur hexafluoride
SIDA	Swedish International Development Cooperation Agency
SIS	The Safeguards Information System
SMEs	Small And Midsize Enterprise
SNC	Thailand's second national communication
SO_2	Sulfur dioxide
SRES	The Special Report on Emissions Scenarios
SRT	State Railway Authority of Thailand
SSNM	Site-Specific Nutrient Management
START	Southeast Asia Global Change System for Analysis, Research and Training
STI	National Science Technology and Innovation Policy Office
TA	Technical assistance
TACCC	Transparent, accurate, complete, consistent and comparable
TAI	Thailand Automotive Institute

LIST OF ACRONYMS, ABBREVIATIONS AND UNITS

TAOs	Tambon Administrative Organizations
TAP	Technology Action Plan
TARC	Thailand's Assessment Report on Climate Change
TCCMP	Thailand Climate Change Master Plan
TCCN	Thailand Climate Change Network
tCO_2eq	Tone Carbon dioxide equivalent
TEB	Thailand Environment Institute
TEC	Technology Executive Committee
TED	Technology and Innovation Enterprise Development
TERI	The Energy and Resources Institute
TGEIS	Thailand's Greenhouse Gas Emissions Inventory System
TGO	Thailand Greenhouse Gas Management Organization (Public Organization)
TGP	Thai –German Programme
THB	Thai Baht
THEOS	Thailand Earth Observation System
TIEB	Thai Integrated Energy Blueprint
TMD	The Thai Meteorological Department
TMP	Mobility Program
TNA	Technology Needs Assessments
TNC	Third National Communication Thai
TPE	Third Party Entity
TRF	Thailand Research Fund
TRON	Thailand Research Organizations Network
T-VER	Thailand Voluntary Emission Reduction Program
TWD	Thai Meteorological Department
UK	United Kingdom
UNDESD	United Nations Decade of Education for Sustainable Development
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
US EPA	United States Environmental Protection Agency
USAID LEAF	United States Agency for International Development Lowering Emissions in Asia's Forests
USD	United States dollar
USFS	U.S. Forest Service
UTC	Universal Time Coordinated
VKT	Vehicle Kilometer Traveled
VOCs	Volatile Organic Compounds
WCRP	World Climate Research Programme
WGIA	Workshop on Greenhouse Gas Inventories in Asia
WHO	World Health Organization
WMO	World Meteorological Organization
WWW	World Weather Watch

EXECUTIVE SUMMARY

As we know, the change in terminology to climate change is to emphasize and directly and indirectly attribute to human activities that alter the composition of the global atmosphere. In this context, Thailand's government is making considerable effort towards tackling climate change to meet the United Nations Framework Convention on Climate Change (UNFCCC). A relevant step forward is the Third National Communication of the Kingdom of Thailand, which laid out compliance and guidelines for the preparation of national communication for Parties, which are not included in Annex I to the Convention and is composed of six chapters.

CHAPTER 1: NATIONAL CIRCUMSTANCES

The Kingdom of Thailand is located in Southeast Asia and covers an area of 513,115 km^2. It is divided into 5 parts, made up of the Central, North, Northeast, East, and South. Thailand has 77 provinces in total with Bangkok serving as the capital city. Bangkok is governed by the Metropolitan Administration who elects a governor. The local climate of Thailand is divided into 3 seasons. It starts with the rainy season from mid-May to mid-October. Winter is from mid-October to mid-February, and summer is from mid-February to mid-May. In 2015, the population of Thailand was 65,729,098 people, based on registration records. Thailand is expected to be an aging society by 2030. In 2015, the majority of final energy consumption was petroleum products, which massed 48.77% of total consumption, followed by electricity, natural gas and coal products. Within the economic sector, the transportation sector consumed the largest share of energy with 36.61%, followed by the industrial sector, residential sector, commercial, and agricultural sector. In Thailand, approximately 47% of the nation's total area was categorized as agricultural land. Non-agricultural land use accounted for 21% and forest land accounted 32%. Finally, about 22% of agricultural land use was attributed to paddy field.

Thailand is ranked as the second-largest economy in Southeast Asia. It has experienced low single-digit GDP growth over the past decade, with the industrial and service sectors serving as the main drivers of recent growth. As an agriculture-based country, in 2015 agriculture comprised 12.70% of Thailand's GDP. However, it has been slightly increasing over the last decade. In addition, the tourism industry is a major economic factor, making a significant contribution to Thailand's GDP at 18% in 2015.

In the view of the environmental status of Thailand, the air quality improved in 2015. The overall water quality in Thailand was fair in 2015, and remained relatively stable. Nationwide, waste was generated about 26.85 million tons in 2015. Of this, 16% was generated in Bangkok. Roughly 4.94 million tons or 76% of municipal solid waste (MSW) were reused through recycling. The proportion of 21% and 3% was the utilization of organic waste and electricity generation. Moreover, there were 3.445 million tons of hazardous waste generated in 2015 nationwide, which is an increase of 0.752 million tons from 2014.

To fulfill Thailand's commitments under the Convention, a set of institutional frameworks established, including the National Committee on Climate Change Policy (NCCC). Preparing the GHG inventory, ONEP established a system, which consisted of five steps and included five working groups with

appointed representatives from 5 sectors. As part of quality control, each working group was composed of related agencies that reviewed the methodology of GHG emissions estimation. Finally, the National Communication report will be approved by the NCCC before submitting to UNFCCC.

CHAPTER 2: NATIONAL GREENHOUSE GAS INVENTORY

The GHG emissions, which are estimated in this report, are composed of direct emission (CO_2, CH_4, N_2O) and indirect emission (NO_X, CO, NMVOCs and SO_2). The results of this effort, trend of Thailand's GHG emission from 2000 to 2013 (Figure Ex-1), showed total direct emissions (excluding those from the Land Use, Land-use Change, and Forestry sector) increased from 226,086 $GgCO_2eq$ in 2000 to 318,662 $GgCO_2eq$ in 2013. The net removal of CO_2 increased from 11,995 $GgCO_2eq$ in 2000 to 86,102 $GgCO_2eq$ in 2013. Therefore, the net GHG emissions increased from 214,091 $GgCO_2eq$ in 2000 to 232,560 $GgCO_2eq$ in 2013, with an annual increase of 0.64%. With the inclusion of the Land Use, Land-use Change and Forestry (LULUCF) sector, the net emissions in 2013 increased by 8.63% when compared with the net emissions in 2000. The major source of GHG emissions was the energy sector, which increased from 161,005 $GgCO_2eq$ in 2000 to 236,936 $GgCO_2eq$ in 2013, an increase of 47.16%.

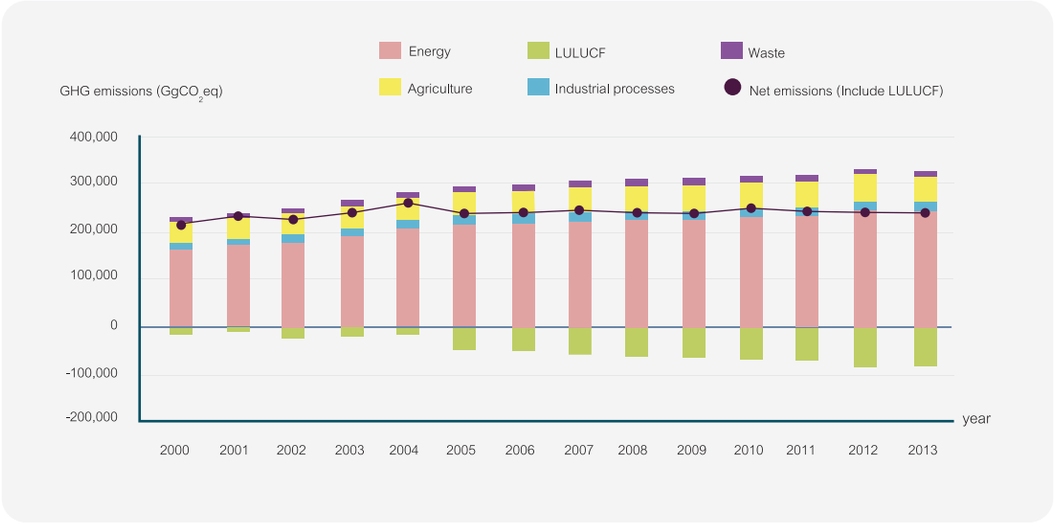


Figure Ex-1: Trends of GHG emission/removal, 2000-2013

As seen in Figure Ex-2, the proportion of GHG emissions in the energy sector accounted for 71.21% of the national emissions in 2000, and increased by 74.35% by 2013. On the other hand, and over the same period, emissions in the agriculture sector decreased from 18.54% in 2000 to 15.98% in 2013. In the agriculture sector, total GHG emissions in 2013 were 50,919.34 $GgCO_2eq$. In the industrial processes sector, the proportion of GHG emissions remained constant. In 2013, the GHG emissions in the industrial processes sector were estimated to be 18,976.79 $GgCO_2eq$. In Land Use, Land-use Change, and Forestry (LULUCF), there was a trend of increased net removal. Since 2000, LULUCF activities contributed to the net removal from the atmosphere. In 2005, when rubber plantations were included in the calculation, there was a tremendous increase of CO_2 removal.

In 2013, the LULUCF sector contributed to the net removal of 86,101.84 $GgCO_2eq$ (a six-fold increase compared with 2000). In the waste sector, the proportion of GHG emission remained constant. In 2013 the GHG emission in the waste sector were estimated to be 11,829.56 $GgCO_2eq$.

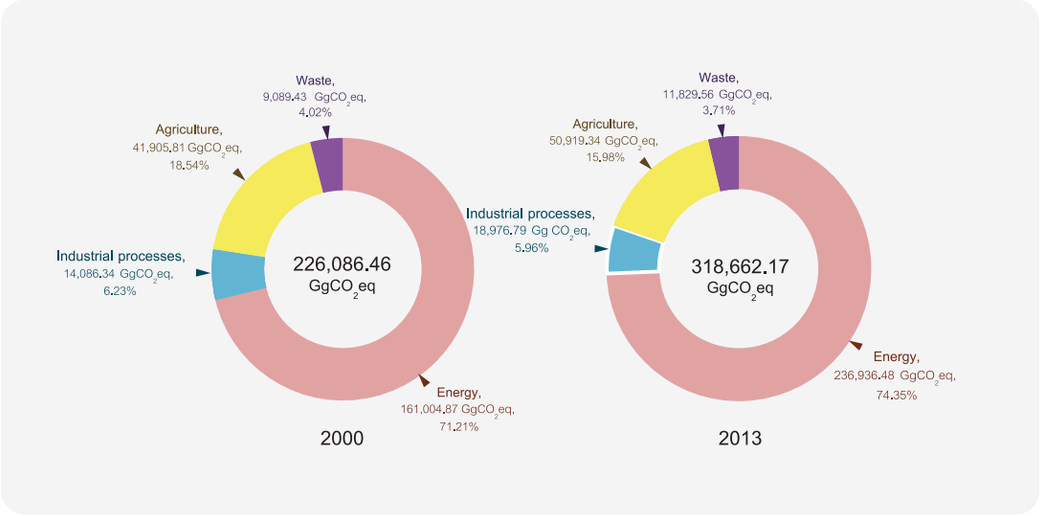


Figure Ex-2: Total GHG emissions by sector, 2000 and 2013

CHAPTER 3: MITIGATION MEASURES

Related to climate change actions, Thailand has used both top-down and bottom-up approaches at the national, sectoral and municipality levels. At the national level, the 20-year National Development Plan (2017-2036) indicates the green growth will promote sustainable development. In the short-term, the 5-year 12th National Economic and Social Development Plan (12th NESDP) is still focused on the Philosophy of Sufficiency Economy and Thailand 4.0 policy which is expected to move the country forward for a better future. This includes green growth and developments in science, technology, research and innovation.

Thailand's Climate Change Master Plan (2012-2050) is a framework of integrated policies and action plans related to climate change. Its aims to support climate change preparedness through both adaptation and mitigation actions. The National Strategies on Climate Change (2013-2017) was established to support the climate change actions in the short-term, which consist of three strategies. These strategies included adaptation, mitigation and strengthening capacity building. At the sectoral level, The Energy Efficiency Plan 2015 (EEP2015) and The Alternative Energy Development Plan 2015 (AEDP2015) directly affected the reduction of the GHG emissions in the energy sector. Moreover, related to reduction of the GHG emissions, several plans have been established, including Thailand's Transport Infrastructure Development Plan (2015-2022), The Fourth National Strategic Plan on Chemical Management (2012-2021), Thailand Industrial Development Strategy 4.0, and Eco-Industrial Strategy. In the waste sector, the National Waste Management Master Plan (2016-2021) has been established. At the sub-national level, policies related to GHG emissions mitigation, such as Bangkok Climate Change Master Plan 2013-3023, Low Carbon Municipality were developed.

Furthermore, Thailand has implemented several voluntary actions on climate change mitigation, which also support the country to achieve Thailand's mitigation target. The active action plans are Thailand Voluntary Emission Reduction Program (T-VER), Low Emission Support Scheme (LESS), Carbon Footprint Reduction Label, Partnership for Market Readiness (PMR), Achieving Low Carbon Growth in Cities through Sustainable Urban System Management in Thailand, Capacity Development on Climate Chang Mitigation/Adaptation in the Southeast Asia Region (2013-2016), and Project for Capacity Development to Accelerate Low Carbon and Resilient Society Realization in the Southeast Asia Region (2017-2020), as well as, The GREEN and CLEAN Hospitals in Thailand.

CHAPTER 4: VULNERABILITY AND ADAPTATION

The vulnerability assessment results in each sector under climate change impact, the risk assessment results with examples of adaptation to response to future uncertainty, and the status of adaptation related activities in the country. According to the result, Thai government should put efforts in infrastructure development such as energy, water, transportation which is main factor in increasing competitiveness of economic development and upgrading quality of life of citizen and to raise community adaptive capacity to cope with climate change impacts. As the key results, it found that some targeted area of agricultural production especially in northern part will affect from less precipitation caused by climate change impacts. The target of escaping middle-income trap in some agricultural community may not reach because of this water shortage. As per vulnerability assessment, it provides the vulnerability map which is divided into four sectors: water resources, agriculture, human settlement, and health and identified the vulnerability hotspots, related to economic sector and dominant hazard. In term of adaptation measures implementation, Office of Natural Resources and Environmental Policy and Planning (ONEP) conducted the National Adaptation Plan (NAP) to study and assess vulnerability from climate change on six sectors (as in Thailand's Climate Change Master Plan) in Thailand as in regional and provincial levels and set the database of the best practices in adaptation from climate change impact from both local and national levels. Currently, the draft NAP is implemented into regional and provincial pilot areas. The results will be used to improve the draft NAP for practical local base implementation.There were a number of projects related with climate change adaptation as follow: the project "Improved Management of Extreme Events through Ecosystem-based Adaption in Watersheds" (ECOSWAT), under cooperation between the Department of Water Resources and German International Cooperation (GIZ), on vulnerability and adaptation measures. For agricultural sector, the Rice Department presented measures of risk management and climate change adaptation to increase capacity building of farmers in rain-fed area of the Northeastern part of Thailand. The Japanese Institute of Irrigation and Drainage (JIID), the Royal Irrigation Department and Chulalongkorn University also showed climate change adaptation cases of farmers within the irrigation area in the Chao-Phraya river basin in Thailand. For health sector, the Ministry of Public Health declared Thailand's Climate Change Adaptation Plan on Health Sector (2018-2030) for preparedness to mitigate and adapt the impacts of climate change. For human settlement the Bangkok Metropolitan Administration presented the Bangkok Master Plan on Climate Change (2015-2050) with a number of the risk management plans and pilot projects. For international cooperation on climate change, the United Nations Development Programme (UNDP) showed Climate Change Benefit Analysis (CCBA) Guideline to support government of Thailand ensure that the investments are

properly designed to respond to climate change and receive appropriate additional funding, either from the budget or from national or international climate funds. The Japan International Cooperation Agency (JICA) supports ADAP-T Project to Thailand (2016-2021) to develop resilient and sustainable solutions for climate change in coastal, forestry, water, urban, rural and sediment sectors. "Risk-based National Adaptation Plan" (Risk-NAP) project, led under the collaboration of ONEP and GIZ is set to analyze climate risks in Thailand and implement activities aiming at integrating the NAP into sectorial and subnational planning processes, coupled to adequate budgeting. JICA and the Thailand Greenhouse Gas Management Organization (TGO) cooperated for the human resource development aspect of the climate change training. European Union and Good Governance for Social Development and the Environment Foundation (EU-GSEI) projects is generated for training activities in local communities for climate change adaptation plans for community level.

CHAPTER 5: OTHER INFORMATION AND RELEVANT ACTIVITIES

Other information and relevant activities were considered in this chapter, including technology transfer, which is a key factor to enhance mitigation and adaptation to climate change. Thailand has been systematically promoting the implementation of the National Science and Technology Development Act 1991. The climate change technology development, both for mitigation and adaptation, have been focused in (a) local emissions factors for agriculture, (b) energy efficiency and renewable energy technologies, and (c) technologies and expertise on impact, vulnerability, and adaptation. According to the Thailand Technology Needs Assessment, the water resource management, agriculture sector and modeling sector have been focused in adaptation and the energy sector is considered in mitigation side. The current 12th National Economic and Social Development Plan (2017-2021) listed science and technology, research, and innovation as the main ways to transform the country's economy towards a high-income country and low carbon society. Among areas of research priorities detailed in the National Research Policy and Strategy (2017-2021) are sustainable green economic growth, food-water-energy security, and enhancing climate change adaptation. Since the 2nd National Communication, constraints and gaps in climate change research and systematic observations still remained due to inadequate resources and expertise. Thus, support from developed countries and international communities is necessary.

Climate change issues are included in Thailand's basic and higher-level education which aims to increase primary and secondary student's understanding of various processes on the Earth's surface and the Earth's interior. Climate change-related subjects and topics are also addressed by universities in Thailand. In recent years, various stakeholders have increasingly carried out a number of awareness-raising activities on climate change-related issues cross Thailand. The Department of Environmental Quality Promotion (DEQP), part of the Action for Climate Empowerment (ACE) is a national focal point responsible for regularly launching public awareness campaigns and activities on climate change, both at national and sub-national levels. The public awareness has been promoted at the organization levels, such as carbon footprint for organizations, green industry certifications and low carbon municipality certifications.

Climate actions are increasingly recognized as part of sustainable development. Mitigation and adaptation activities, with a wide range of stakeholder engagements, are being integrated into national development strategies. As climate change is a cross-divisional issue, Thailand places particular attention on empowering local governments, municipalities and communities and enhancing their

capacities to better cope with climate change impact and extreme weather events, as well as, to participate in sub-national and national efforts to reduce greenhouse gas emissions. These efforts have also improved coordination among key ministries involved in sectoral climate change planning and between central and local government agencies, as well as, the engagement of non-state actors.

CHAPTER 6: CONSTRANINTS AND GAPS, AND SUPPORT RECEIVED

Although, Thailand received supports from regional and international agencies, on both climate change mitigation and adaptation, many improvement policies and technologies, as well as, research and database still have several limitation, barriers and constraints. Some gaps and constraints on the National GHG inventory development include (a) capacity building and enhancement of local experts in GHG inventory; (b) research to obtain country-specific emission factors in many sub-sectors the agricultural sector, and accurate estimation on activity data of solid waste disposal; and (c) developing a MRV system for the LULUCF sector. Moreover, the GHG emissions mitigation capacity should be well understood as the ability of individuals, groups, organizations and institutions assigned to solve the problems associated with climate change. This mitigation capacity is considered an integral part of a series of efforts toward becoming a low carbon society. For adaptation, three areas of support are needed. The first is community and urban planning to avoid inundation and impact during high-tide in the mouth of the rivers or during flooding season. This includes investments in housing, walkways and streets. The second area is to invest in hard structures to protect rising sea levels along coastlines or shoreline to reduce damages from floods, and to prevent agricultural damage from droughts. The last area includes expenses related to the promotion of soft structures (e.g. regulations and public services) to protect vulnerable lands and coastal areas from immigrants or settlements, as well as raising awareness and adaptive capacity for health problems related to climate change.

Chapter 1:

NATIONAL CIRCUMSTANCES

CHAPTER 1:
NATIONAL CIRCUMSTANCES

1.1 PHYSICAL CONTEXT

1.1.1 Geographical Location

Thailand is located in a tropical region (5° 37′ to 20° 27′ N and 97° 22′ to 105° 37′ E). It has a total area of 513,115 km^2. Myanmar borders Thailand to the west. Laos borders Thailand to the north. Cambodia borders Thailand to the east. Malaysia borders Thailand to the south. The Gulf of Thailand is situated to Thailand's southeast coast, while the Andamen Sea is situated to Thailand's southwest coast (Figure 1-1). Thailand has 23 coastal provinces. Seventeen of these provinces are on the Gulf of Thailand, with a coastline of approximately 2,039.77 km, and six provinces border the Andaman Sea, with 1,111.36 km of coastline. Prachuap Khiri Khan province has the longest coastline (251 km) while Bangkok (Bang Khun Thian District) has the shortest (5.81 km). Coastal erosion is a major coastal problem, which is more prevalent on the Gulf of Thailand coast than the Andaman Sea coast. It affects local fishing communities, as well as, major seaports and industrial estates along the coast. According to a survey by the Department of Marine and Coastal Resources, coastal erosion problems occurred on 23% of the country's coastline or 704.44 km. Of these 558.71 km have been prevented.

Thailand can be divided into 5 geographic parts, each with its own topography. The northern region is hilly and mountainous, the northeastern region is a natural high plain, the central region is a large, low plain, the eastern region is also a plain but has valleys with small hills, and the western region is hilly and mountainous. Finally, the south is a peninsula with the Andaman Sea to the west and the Gulf of Thailand and South China Sea to the east.

Source: Department of Field Support Cartographic Section UNITED NATIONS

Figure 1-1: Map of the Kingdom of Thailand

1.1.2 Politics and Government

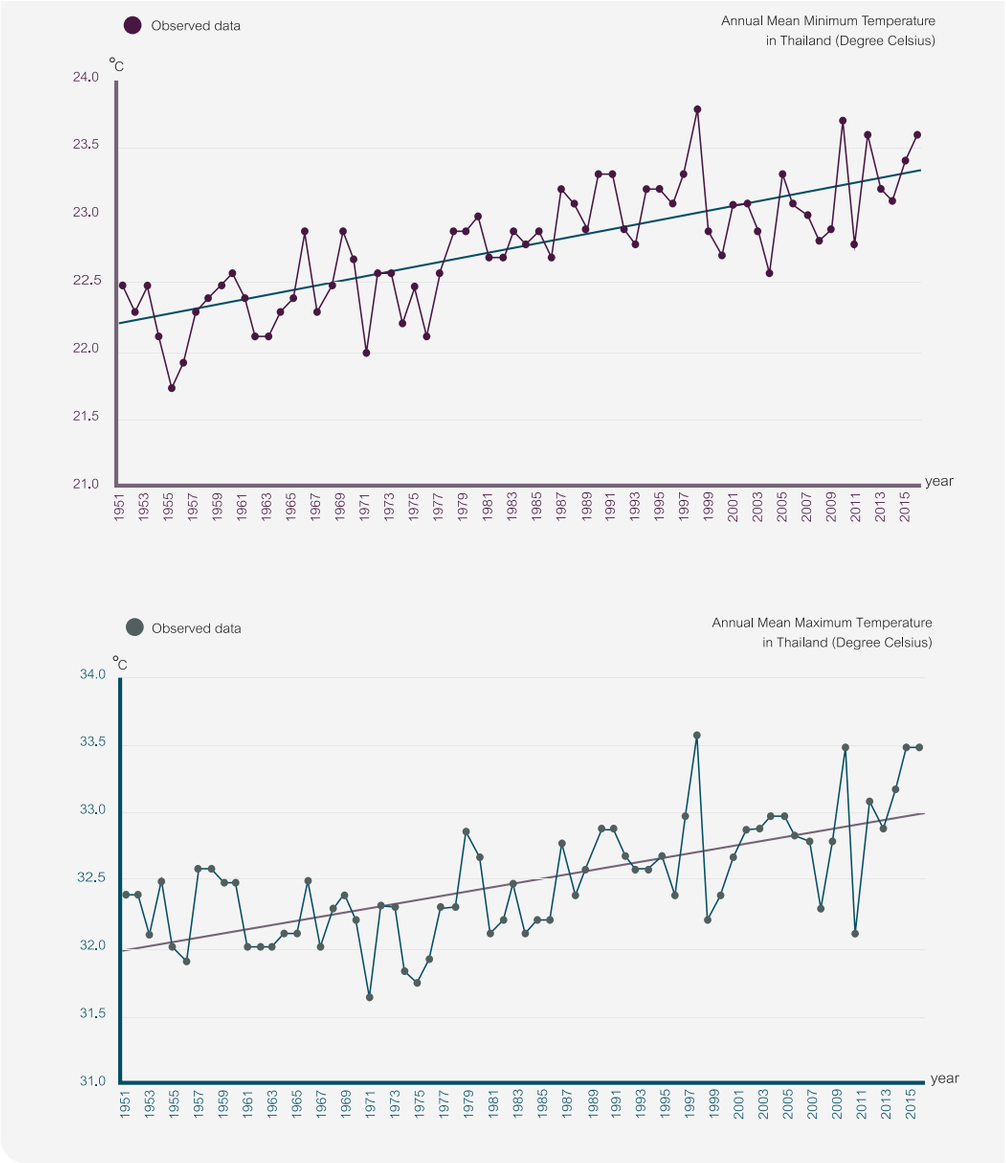
Thailand went through a peaceful transformation in 1932 when sovereign power was passed to the Thai people. Thailand has a King who is the Head of State. He is above partisan politics and discharges his role in accordance with the national constitution. The administration of the country is carried out by the Prime Minister. The Prime Minister forms the cabinet. Thailand's public administration is divided into three tiers: central, provincial, and local administrations. Local authorities consist of provincial administrative organizations, district organizations, sub-district organizations or Tambon Administrative Organizations (TAOs). The Ministry of the Interior appoints governors for all 77 provinces. Bangkok, the capital of Thailand, is governed by the Metropolitan Administration, from which a governor is elected. The TAO Act of 1994 and the 1998 Decentralization Act stated that it is the mandate and duty of TAOs to protect and maintain natural resources and the environment within their jurisdiction.

1.1.3 Climate

1.1.3.1 Season and Temperature

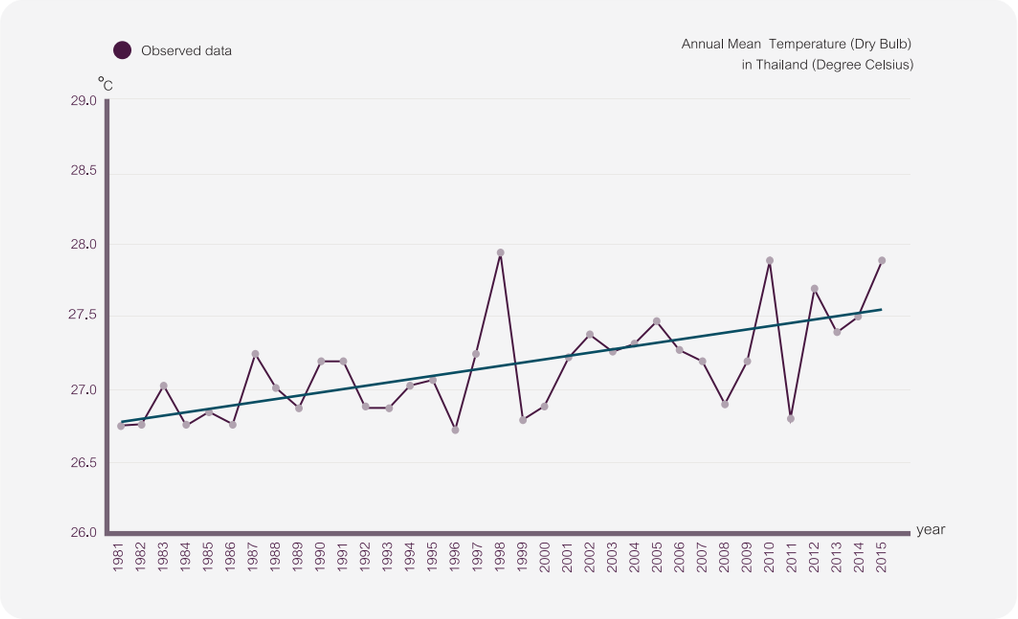
From a meteorological point of view, Thailand has three distinct seasons. The rainy or southwest monsoon season provides abundant rainfall throughout the country from mid-May to mid-October. The wettest period of the year is August to September. The exception is on the east coast of Southern Thailand where abundant rain continues until the end of the year. The winter or northeast monsoon season occurs from mid-October to mid-February. This is a mild period, and can become cool in

December and January in northern (non-peninsular) Thailand. There is a great amount of rainfall on the east coast of Southern Thailand, especially during October to November. The summer, or pre-monsoon season, occurs from mid-February to mid-May, and is the transitional period from the northeast to southwest monsoons. The weather becomes warmer, especially in upper Thailand. April is the hottest month. Figure 1-2 and Figure 1-3 show the annual maximum and minimum mean temperatures in Thailand from 1951 to 2015. Over these six decades, all temperature measures have shown an upward trend. The rate of change has been more volatile since 1997, as can be observed by the wider deviations from year to year. The highest temperature ever recorded in Thailand was 44.6 °C, recorded in Mae Hong Son province in 2016. The lowest temperature ever recorded was -1.4 °C, which in Sakon Nakhon province on 2 January 1974.



Source: Thai Meteorological Department

Figure 1-2: Trends of annual maximum and minimum mean air temperature in degree Celsius: 1951-2015

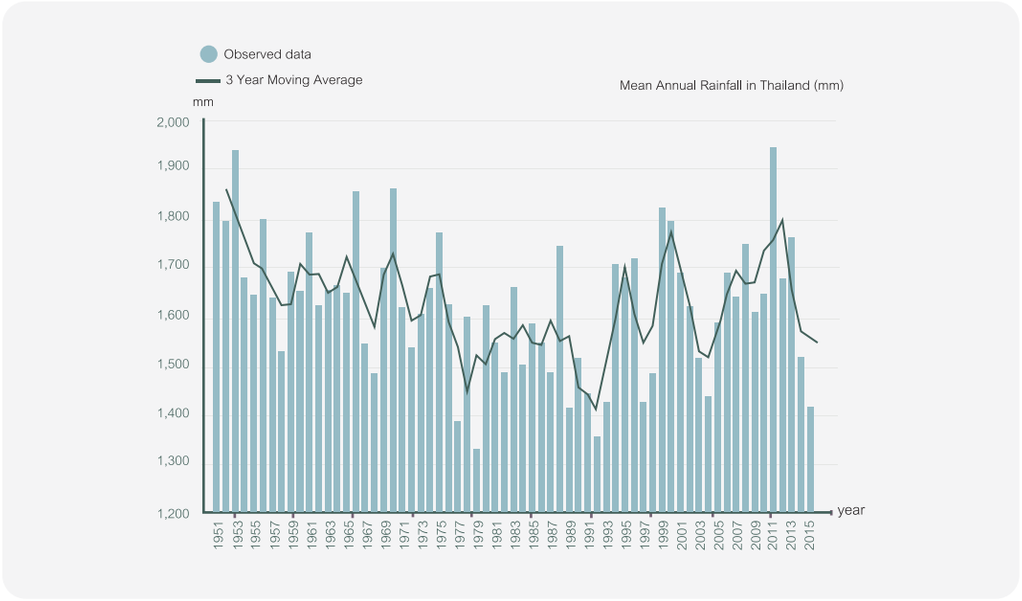


Source: Thai Meteorological Department

Figure 1-3: Trends of annual air temperature in degree Celsius: 1981-2015

1.1.3.2 Precipitation

Based on Thailand's annual rainfall pattern, the average range of annual rainfall is 1,300–2,000 mm per year (Figure 1-4). In winter, northern Thailand usually experiences dry weather as a result of the northeast monsoons. In summer, thunderstorms and increased rainfall often occurs. From May to October, rainfall and thunderstorms increase due to the southwest monsoons. Peak rainfall occurs in August and September, and often causes flooding. There is a difference in rainfall between the south (peninsular) and the north (non-peninsular) of Thailand. During the southwest monsoon, the west coast of southern Thailand gets peak rainfall in September. Peak rainfall on the east coast is in November, but significant rainfall continues until January of the following year when the northeast monsoons begin.

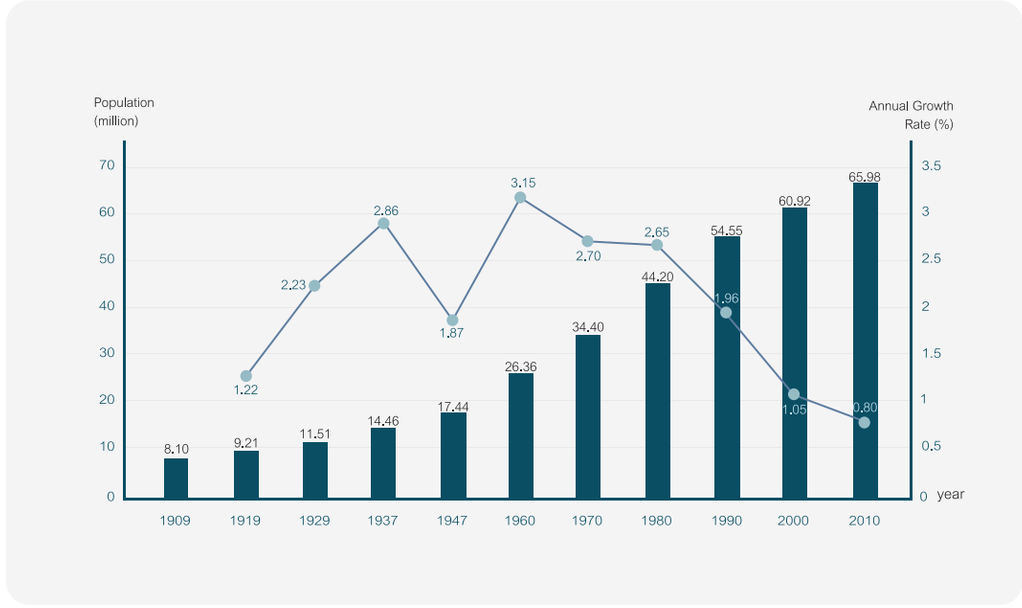


Source: Thai Meteorological Department

Figure 1-4: Trends of mean annual rainfall in Thailand (mm): 1951-2015

1.1.4 Population

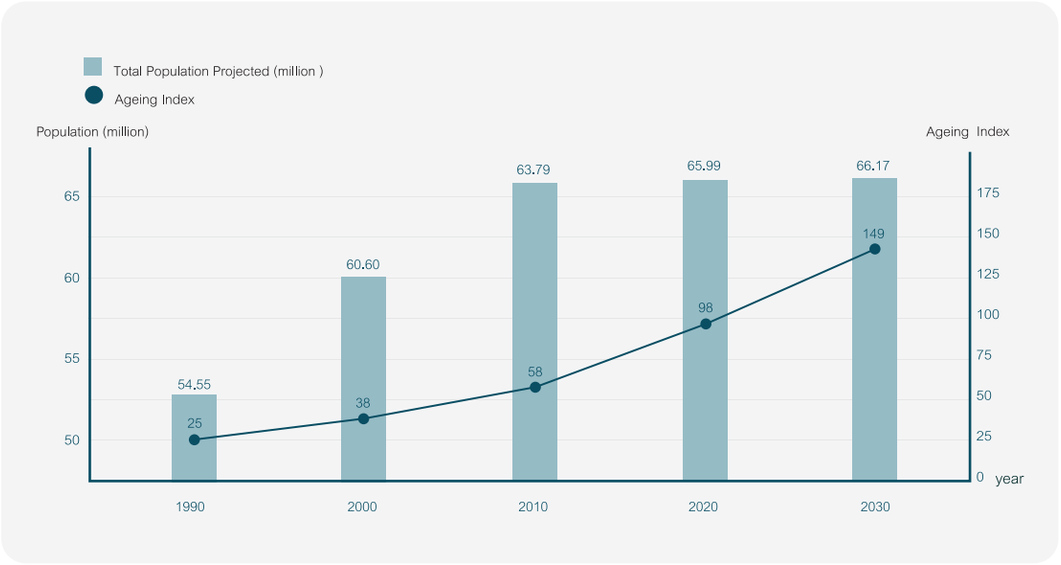
The total population of Thailand was 65,981,659 people as measured by the 2010 Thailand Population and Housing Census. In 2015, the estimated population was 65,729,098 people according to registration records. While Thailand's population has increased over the past decades, the annual population growth rate has declined since 1960 (from 2.70% per decade to only 0.80% in 2010; Figure 1-5). According to population projections, Thailand's population will continue to increase at this slower rate and will reach 66,174,658 people in 2030 (Figure 1-6)



Source: National Statistical office

Figure 1-5: Population and growth rates: 2010 Thailand Population and Housing Census data

A decline in the birth rate with a concurrent increase in life expectancy has shaped Thailand's population structure into an aging society. Figure 1-6 shows that the projected ageing index will continue to rise at an increased rate. In 2020, the number of people aged 60 and over will catch up with the youth (i.e., ageing index of 98%). By 2030, the aging population will be one and a half times larger than the youth. This demographic transition translates into challenges in the care and support of aging members of society. Pension spending, health care, and long-term care systems for the elderly will pose large financial burdens. The anticipated shrinking labor force could also potentially harm Thailand's economy; thus, enhancing labor productivity is required.



Source: Office of the National Economic and Social Department Board

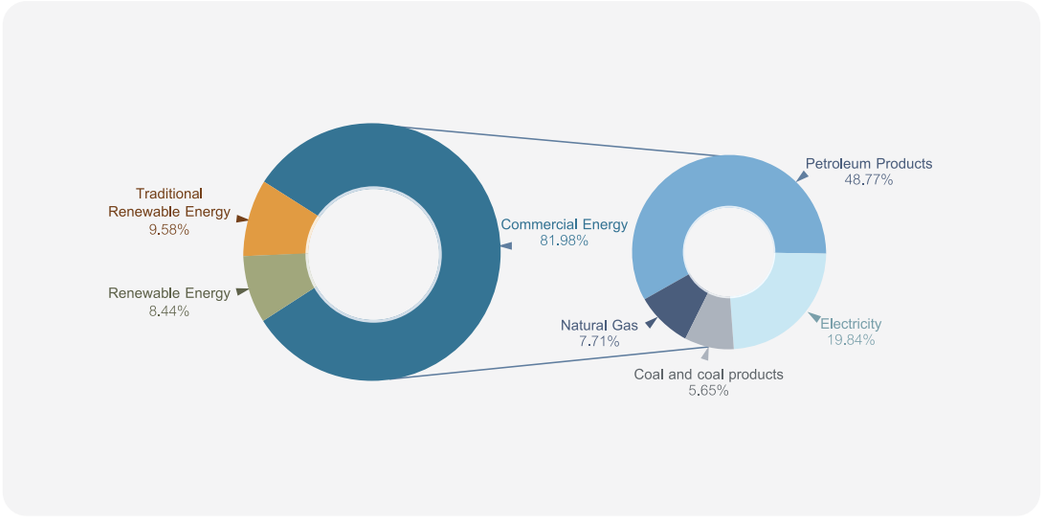
Figure 1-6: Ageing Index, total population (1990-2030) and total projected population (2020-2030)

1.2 ENERGY

Thailand's energy intensity (EI) reached its peak at 9.32 ktoe/thousand million baht in 2004. The number has steady declined and stabilized between 8.21 to 8.23 ktoe/thousand million baht between 2012 and 2015, roughly 12% below from its peak. Thailand has launched a 20-years Energy Efficiency Development Plan (EEDP) targeting to reduce energy intensity by 30% by 2036 compared with that in year 2010 or accounting for 56,142 ktoe.

1.2.1 Energy Consumption

In 2015, the majority of energy consumption was for commercial use, which amounted to 63,844 ktoe (82% of total). Among the energy sources, petroleum consumption had the largest proportion (48.77%), followed by electricity (19.84%), natural gas (7.71%), and coal-based products (5.65%) (Figure 1-7).



Source: Energy Balance of Thailand 2015, Department of Alternative Energy Development and Efficiency: Ministry of Energy

Figure 1-7: Final energy consumption by fuel type: 2015

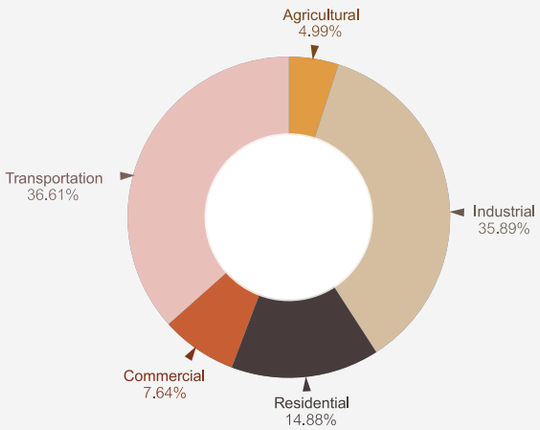
Table 1-1 shows Thailand's final energy consumption trend by fuel type. In 2015, the total amount of Thailand's energy consumption was 77,881 ktoe (a 2.74% increase from 2014). While commercial and renewable energy consumption (solar, fuel wood, paddy husk, bagasse, agricultural waste, municipal solid waste (MSW), and biogas) increased in 2015, traditional energy consumption (fuel wood, charcoal, paddy husk, and agricultural waste) dropped by 10.31%. The consumption of coal and coal products decreased significantly (22.16% to 4.88% in 2014 and 2015).

Table 1-1 Final energy consumption by fuel type: 2013-2015

Final Energy Consumption by Fuel Type	Quantity (ktoe)			Growth (%)	
	2013	2014	2015	2014	2015
Commercial Energy	61,236	61,075	63,844	-0.26	4.53
• Petroleum Products	35,948	36,570	37,981	1.73	3.86
• Electricity	14,002	14,371	15,455	2.64	7.54
• Coal and Coal Products	5,947	4,629	4,403	-22.16	-4.88
• Natural Gas	5,339	5,505	6,005	3.11	9.08
Renewable Energy	5,902	6,408	6,574	8.57	2.59
Traditional Renewable Energy	8,076	8,321	7,463	3.03	-10.31
Final Energy Consumption	75,214	75,804	77,881	0.78	2.74

Source: Energy Balance of Thailand 2015, Department of Alternative Energy Development and Efficiency: Ministry of Energy

In 2015, the transportation sector consumed the largest share of energy (36.61%), followed by the industrial sector (35.89%), residential sector (14.88%), commercial sector (7.64%), and agricultural sector (4.99%), (Figure 1-8).



Source: Energy Balance of Thailand 2015, Department of Alternative Energy Development and Efficiency: Ministry of Energy

Figure 1-8: Shares of final energy consumption by economic sectors: 2015

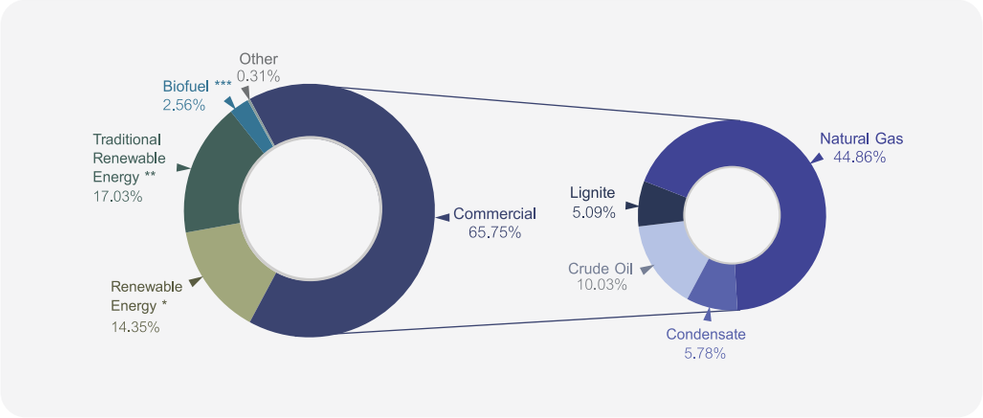
1.2.2 Energy Production

Total energy production was 75,838 ktoe in 2015 (Table 1-2). Commercial energy constituted the largest source of energy production at 49,866 ktoe (65.75% of the total), renewable energy at 10,879 ktoe (14.35%), traditional renewable energy at 12,917 ktoe (17.03%), biofuel at 1,941 ktoe (2.56%), and all other energy sources at 235 ktoe (0.31%) (Figure 1-9). While the production of crude oil and biofuel increased from its 2014 levels, Thailand's total energy production decreased by 4.37% as a result of reduced lignite, natural gas, and traditional renewable energy production. In 2015, total energy exports amounted to 11,971 ktoe, almost entirely of petroleum products (96.88%) and electricity (1.61%) (Figure 1-10). Energy imported totaled 74,928 ktoe, which included crude oil (58.31%), coal (18.48%), and natural gas (17.42%) (Figure 1-11).

Table 1-2 Energy production by fuel type: 2013-2015

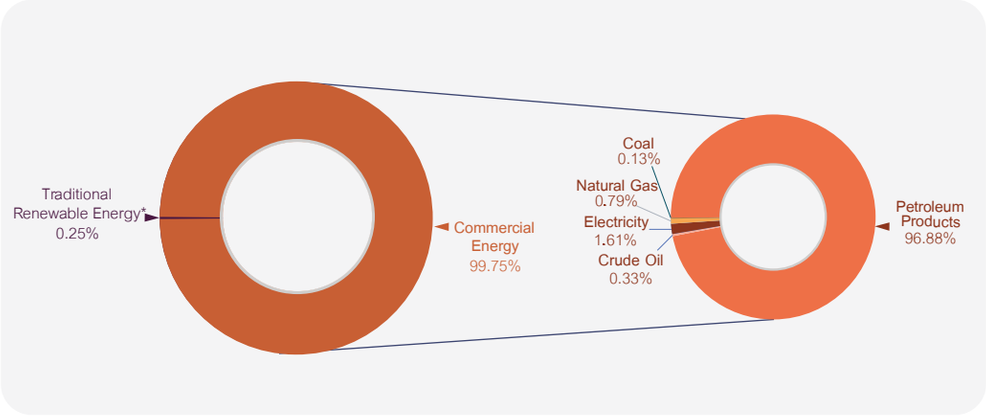
Final Energy Production by Fuel Type	Quantity (ktoe)			Growth (%)	
	2013	2014	2015	2014	2015
Total Energy Production	78,074	79,303	75,838	1.57	-4.37
Commercial Production	52,736	52,888	49,866	0.29	-5.71
• Crude Oil	7,363	6,906	7,604	-6.21	10.11
• Lignite	4,459	4,622	3,858	3.66	-16.53
• Natural Gas	36,405	37,035	34,020	1.73	-8.14
• Condensate	4,509	4,325	4,384	-4.08	1.36
Renewable Energy*	9,706	10,608	10,879	9.29	2.55
Traditional Renewable Energy**	13,739	13,740	12,917	0.01	-5.99
Biofuel***	1,609	1,799	1,941	11.81	7.89
Other	284	268	235	-5.63	-12.31

* Includes solar (heat), solar (electricity), wind, hydro, geothermal, fuel wood, paddy husk, bagasse, agricultural waste, MSW and biogas
** Includes fuel wood, paddy husk and agricultural waste
*** Includes ethanol and biodiesel
Source: Energy Balance of Thailand 2015, Department of Alternative Energy Development and Efficiency: Ministry of Energy



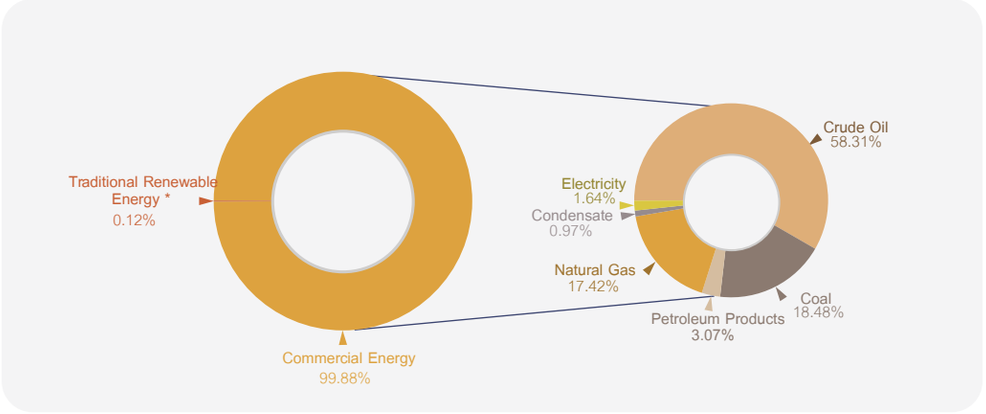
* Includes solar (heat), solar (electricity), wind, hydro, geothermal, fuel wood, paddy husk, bagasse, agricultural waste, MSW and biogas
** Includes fuel wood, paddy husk and agricultural waste
*** Includes ethanol and biodiesel
Source: Energy Balance of Thailand 2015, Department of Alternative Energy Development and Efficiency: Ministry of Energy

Figure 1-9: Shares of final energy production by fuel type: 2015



* Includes solar (heat), solar (electricity), wind, hydro, geothermal, fuel wood, paddy husk, bagasse, agricultural waste, MSW and biogas
Source: Energy Balance of Thailand 2015, Department of Alternative Energy Development and Efficiency: Ministry of Energy

Figure 1-10: Shares of exported energy: 2015



* Includes solar (heat), solar (electricity), wind, hydro, geothermal, fuel wood, paddy husk, bagasse, agricultural waste, MSW and biogas
Source: Energy Balance of Thailand 2015, Department of Alternative Energy Development and Efficiency: Ministry of Energy

Figure 1-11: Shares of imported energy: 2015

1.2.3 Alternative Energy

Thailand's alternative energy consumption has consistently increased. In 2015, total alternative energy usage increased by 11.70% from the previous year. Biodiesel and renewable heat consumption (solar, biomass, municipal solid waste (MSW) and biogas) increased by 16.90% and 13.90%, while renewable electricity consumption (solar, wind, hydro, biomass, MSW and biogas) increased by 6.10% (Table 1-3). Thailand has formulated the Alternative Energy Development Plan (AEDP) 2015 aiming to promote alternative energy and reduce dependency on energy imported such as oil and natural gas. The overall goal is to increase the share of renewable energy consumption to 30% by 2036.

Table 1-3 Alternative energy consumption: 2013-2015

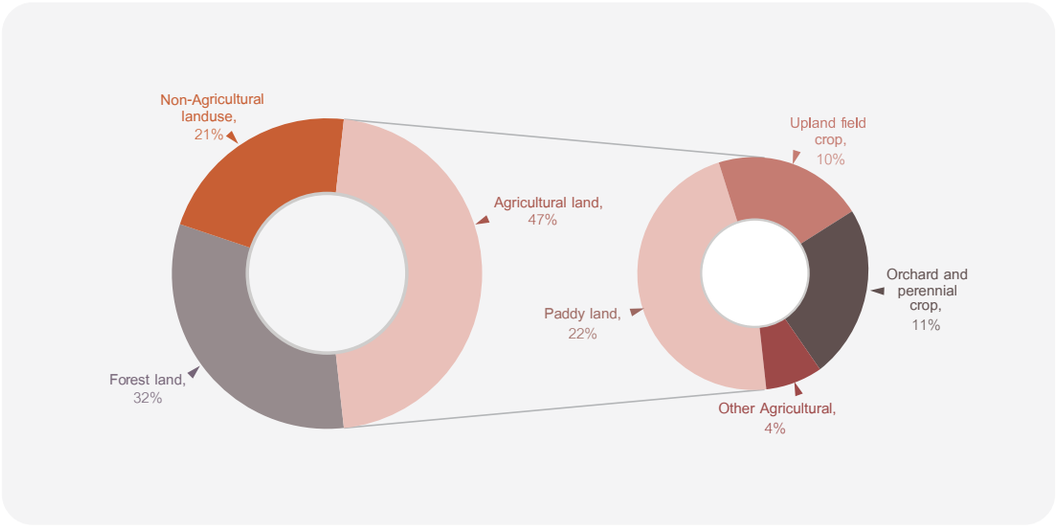
Alternative Energy Consumption	Quantity (ktoe)			Growth (%)
	2013	2014	2015	2015
1. Electricity (solar, wind, hydro, biomass, MSW and biogas)	1,341	1,467	1,556	6.10
2. Heat (solar, biomass, MSW and biogas)	5,279	5,775	6,579	13.90
3. Biofuel				
• Ethanol	707	847	879	0.60
• Biodiesel	905	909	1,063	16.90
Total	8,232	9,025	10,077	11.70

Source: Energy Balance of Thailand 2015, Department of Alternative Energy Development and Efficiency: Ministry of Energy

1.3 NATURAL RESOURCES

1.3.1 Land Resources and Forestry

Thailand has a total land area of approximately 51.3 million hectares. As of 2015, 47% of the nation's total land area (or 24 million hectares) was zoned as agricultural land (Figure 1-12). Non-agricultural land use and forested land accounted for 21 and 32% of the total area. Paddy use accounted for half of agricultural land use, equal to 11 million hectares or 22% of Thailand's total land area.



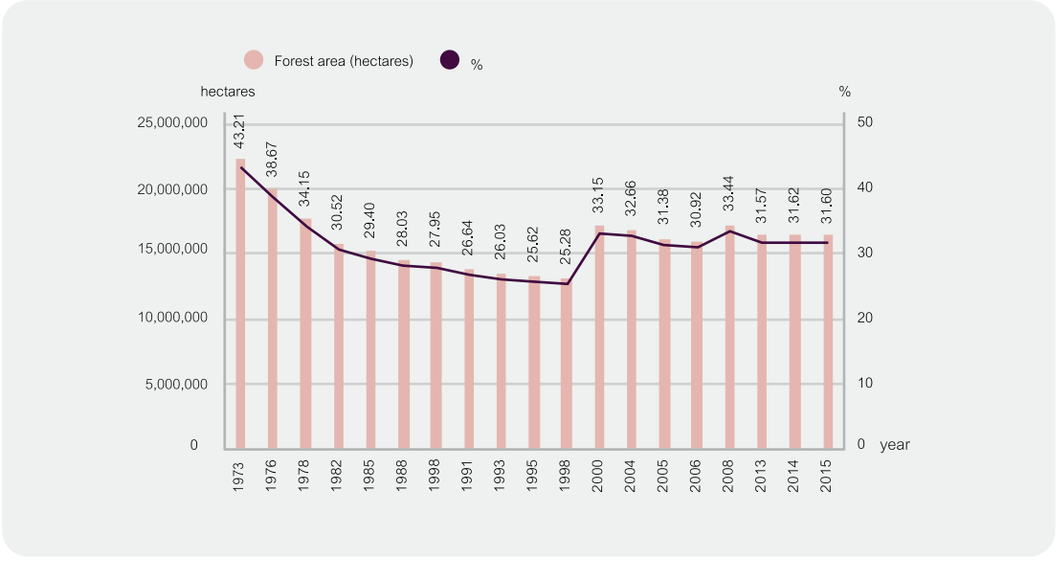
Source: Agricultural Statistics of Thailand 2015, Office of Agricultural Economics

Figure 1-12: Shares of land use in Thailand: 2015

Slash-and-burn farming, shifting cultivation, land resettlement, and dam and road construction have encroached on forested areas. The Thai government imposed a nationwide logging ban by emergency decree in January 1989. In 1973, the total forested area of Thailand covered over 43% of the country but the portion of forested area declined to 25.28% in 1998 (Figure 1-13). Forested area increased in 2000 as a result of changes in the scale and method of calculation, establishing a new benchmark for this land use. One of the threats facing Thailand's forests is illegal logging, which is destroying Thailand's remaining forests. To reduce deforestation, several actions have been taken such as improving forest law enforcement, declaring national conserved forests, rehabilitating degraded forests, and promoting community forest management. These implementations have reduced the deforestation rate, and the current (2015) estimate of forested area is 16,358,557 hectares.

In 2016, Thailand received a grant for 3.6 million USD from the Forest Carbon Partnership Facility (FCPF) to carry out activities for the REDD+ Readiness Phase during 2016–2019. The implementation of this project officially started on 17 June 2016 and the Implementing Agency for the FCPF REDD+ Readiness Preparation project was the Department of National Parks, Wildlife, and Plant Conservation (DNP), in the Ministry of Natural Resources and Environment.

The objective of the grant was to support the development of the Readiness Preparation Activities. The objectives will be met by supporting the preparation of the REDD+ strategy for Thailand, the technical and accounting methods of Measurement, Reporting and Verification System (MRV), the Forest Reference Emission level/Forest Reference level (FREL/FREL), the Safeguards Information System (SIS), the strategic Environmental and Social Assessment and Environmental and Social Management Framework, and readiness organization and consultation. In 2019, Thailand will submit the FREL/FRL to the UNFCCC, and that the National REDD+ Strategic will be completed in 2020.



Source: Royal Forest Department

Figure 1-13: Thailand's forest area: 1973-2015

1.3.2 Water Resource

Based on geographical characteristics, Thailand can be divided into 25 river basins, with the Chao Phraya River as the main river basin running through the center of the country. Thailand's average annual rainfall is approximately 1,455 mm, while the average annual runoff is 33,123 million m^3. In the northern section of the basin, the total storage capacity is estimated at 25,773 million m^3, while the central area can store only 2,124 million m^3.

Due to the lack of a fully developed water infrastructure, deforestation, and climate change during the last decade, Thailand has become particularly vulnerable to drought and flooding. This has resulted in several recent extreme climatic events. In 2011, Thailand faced major flooding that impacted over 13 million people and cost more than 1.44 trillion THB in economic losses (estimated by the World Bank). In 2015, Thailand experienced one of the worst droughts in decades, leading to critically low levels of water in reservoirs countrywide. Rapid economic growth has also increased water demand in the main economic sectors of agriculture, industry, and tourism. The construction of dams and reservoirs, however, is often delayed due to concerns over adverse environmental impacts. In response to the threat of flooding, drought, and an increased water demand, the government set up the Strategic Committee for Water Resource Management (SCWRM) to formulate a Master Plan on Sustainable Water Resource Management. The plan addressed both urgent and long-term issues to ensure continuous development, even under the threats of future drought and flooding.

1.3.3 Biodiversity

According to Thailand's Fifth National Report on the Implementation of the Convention on Biological Diversity, Thailand is located in the Oriental biogeographic region, also called the Indo Malayan Region. This region ranked second out of the three regions in terms of biodiversity. Its diverse ecosystems comprise many habitats supporting abundant flora and fauna. Despite several new policies, Thailand is facing the loss of its natural habitats including forests, wetlands, and natural reservoirs due to agricultural and urban expansion resulting from population and economic growth.

1.4 CURRENT STATE OF THE NATIONAL ECONOMY

1.4.1 National Economy or Economic Profile

Thailand has experienced low single-digit GDP growth over the past decade, with the industrial and service sectors as the main drivers of recent growth. Thailand is the second-largest economy in Southeast Asia, but ranks fourth behind Singapore, Brunei, and Malaysia in GDP per capita. The economy is heavily export-dependent, with exports accounting for more than one-third of the GDP. Both exports and imports have recently faced negative growth over the past few years. In recent years, Thailand's balance of payments has averaged approximately five billion USD, compared to total outstanding debt of 130–140 billion USD. Thailand has one of the world's lowest unemployment rates (about 1%). This is due to a large proportion of the population working in subsistence agriculture or in other vulnerable employment (own-account work and unpaid family work).

Thailand is entering its fourth industrial revolution, known as "Thailand 4.0." Thailand 4.0's policy promotes five new industries (called the "New S-Curve") in which Thailand has the potential to succeed. The New S-Curve industries include robotics, aviation and logistics, biofuels and biochemicals, the digital industry, and the medical hub. Currently, Thailand is implementing the 12th National Economic and Social Development Plan that will continue until 2021. The 12th NESDP will run in tandem with the 20-year National Strategy, a larger framework for Thailand's development.

Table 1-4 Thailand's Economic indicators: 2012-2015

Economic indicators	2012	2013	2014	2015
GDP growth (%)	7.20	2.70	0.80	2.90
GDP per capita (THB)	138,114	147,735	141,735	143,958
GDP per capita (USD) (@33THB:USD)	4,185	4,477	4,295	4,362
GDP growth- Agriculture (%)	2.70	0.80	0.70	- 5.70
GDP growth - Non-Agriculture (%)	7.80	2.90	0.80	3.90
Export growth (%)	3.00	-0.10	-0.30	-5.60
Import growth (%)	8.40	-0.10	-7.90	-10.60
Current accounts as % of GDP (%)	-0.40	-1.20	3.70	-8.10
Net capital movements (billion USD)	12.80	-2.50	-16.20	-17.10
Balance of payments (billion USD)	5.30	-5.00	-1.20	5.90
Total debt outstanding (billion USD)	130.70	141.90	141.70	131.40
Labor force (million people)	38.32	38.23	38.08	38.02
Employment rate (%)	0.71	0.70	0.69	0.69

Source: Office of the National Economic and Social Development Board, National Statistical Office

1.4.2 National Economic Policy

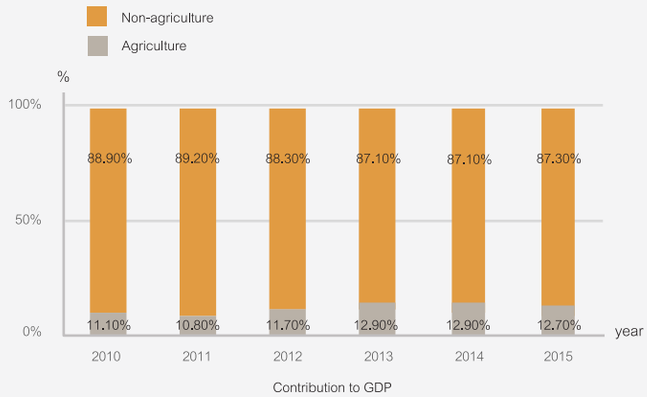
Thailand is currently undertaking the 20-year national strategic plan that consists of six areas, six primary strategies, and four supporting strategies. The six areas include (1) security, (2) competitiveness enhancement, (3) human resource development, (4) social equality, (5) green growth, and (6) rebalancing and public sector development. The six primary strategies seek to (1) enhance and develop the potential of human capital, (2) ensure justice and reduce social disparities, (3) strengthen the economy and enhance competitiveness on a sustainable basis, (4) promote green growth for sustainable development, (5) bring about national stability for national development toward prosperity and sustainability, (6) and enhance the efficiency of public sector management and promote good governance.

The four supporting strategies for efficient national development involve (1) infrastructure development and the logistics system, (2) science and technology, research, and innovation, (3) urban, regional, and economic zone development, (4) and international cooperation for development.

To promote the 10 targeted industries, the Eastern Economic Corridor Development project will be implemented in three eastern provinces; Chon Buri, Chachoengsao and Rayong, with a total area of 13,000 km^2. This project will be divided into three areas: an industrial zone, an infrastructure development zone, and an urban development zone. Under the Eastern Special Economic Zone Act, special investment incentives will be offered. A 15-year exemption of corporate income tax, a land lease for 50 years and could extend the term of the lease of 49 years, and a fast-tracked environmental impact assessment (EIA) are all examples of special investment incentives. The EEC will be linked by the high-speed railway lines to the three international airports Suvarnabhumi, Don Muang, and U-Tapao. It will also serve as ASEAN's sea transportation hub, which can connect with the Dawei deep-sea port in Myanmar, Sihanoukville Port in Cambodia, and Vung Tau Port in Vietnam.

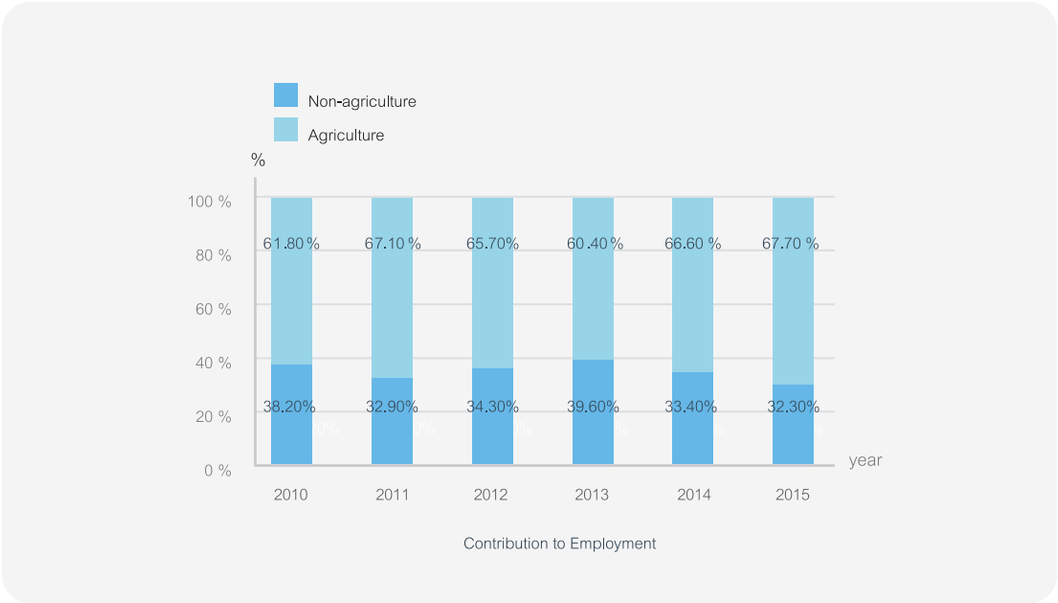
1.4.3 Agriculture Sector

As noted in Section 1.3.1, agriculture accounts for 47% of land in Thailand. In 2015, however, agriculture accounted for 12.7% of Thailand's GDP (Figure 1-14) while utilizing about one-third of the nation's labor force (Figure 1-15). The sector's GDP contribution has slowly decreased over the last decade. While Thailand's total GDP expanded 3.2% between 2010 and 2015, while the GDP from the agricultural sector only grew by 0.8%. This is compared with the 3.4% growth achieved by the non-agriculture sector. At the same time, agriculture's contribution to employment decreased from 38.2% of total employment in 2010 to 32.3% in 2015.



Source: Office of the National Economic and Social Development Board

Figure 1-14: Agriculture and Non-Agriculture contributions to GDP in billion THB: 2010-2015

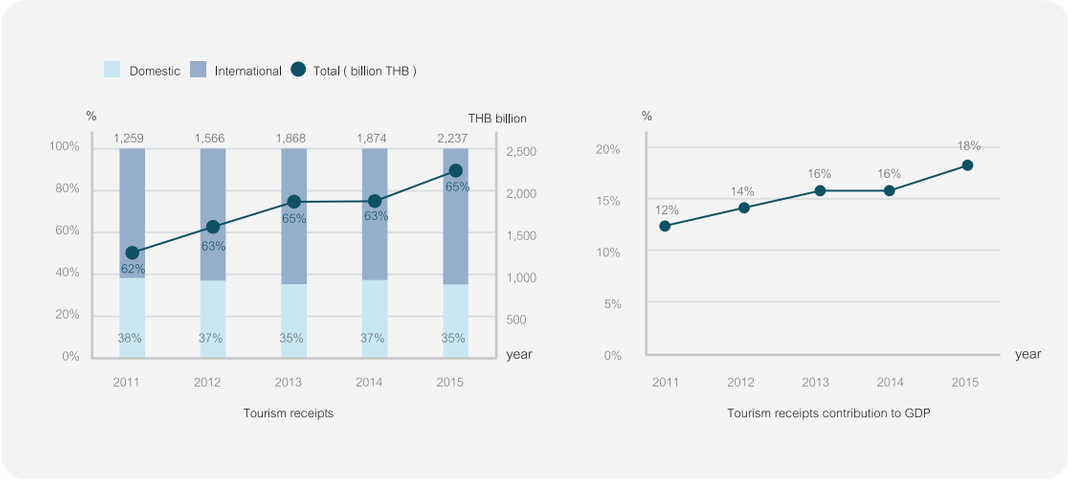


Source: National Statistical Office

Figure 1-15: Agriculture and Non-Agriculture contributions to employment in billion THB: 2010-2015

4.4 Tourism Industry

The tourism industry is a major contributor to Thailand's GDP. In 2015, tourism receipts amounted to 2,237 billion THB, or 18% of the total GDP (Figure 1-16). Thailand's tourism industry has been growing at a double-digit rate, except in 2014. The industry recovered in 2015. Average receipts from international tourists have grown at 20% per year, while domestic tourism has been growing moderately.



Source: Thailand's Department of Tourism

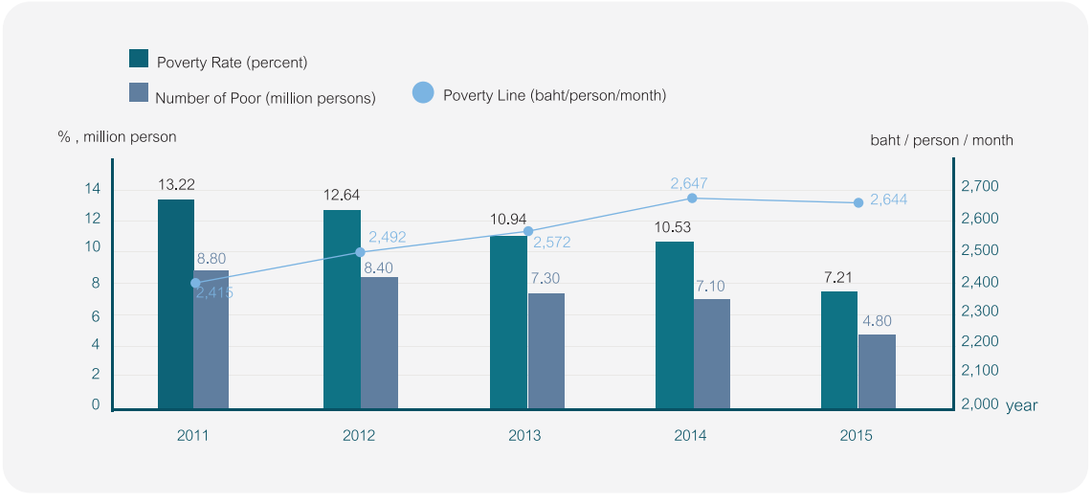
Figure 1-16: Tourist Receipts: 2011-2015

Thailand's natural resources are a main draw for tourists, with the country's beach destinations being ranked globally for their appeal. These resources, however, face serious environmental concerns that must be addressed immediately to maintain their status and value. Global warming has begun to have obvious adverse impact on the country's tourism. One of Thailand's best-known islands, Koh Tachai has been closed indefinitely due to degradation of natural resources and the environment. This includes coral bleaching connected to climate change, as well as, damage from tourism. Coral bleaching has accentuated the impacts of tourism on Thailand's coral reefs. Thailand likely will continue to be disproportionately affected by the consequences of climate change. The southern part of Thailand, where most of the famous islands and beaches are located, is the most vulnerable area.

1.4.5 Poverty and Inequality

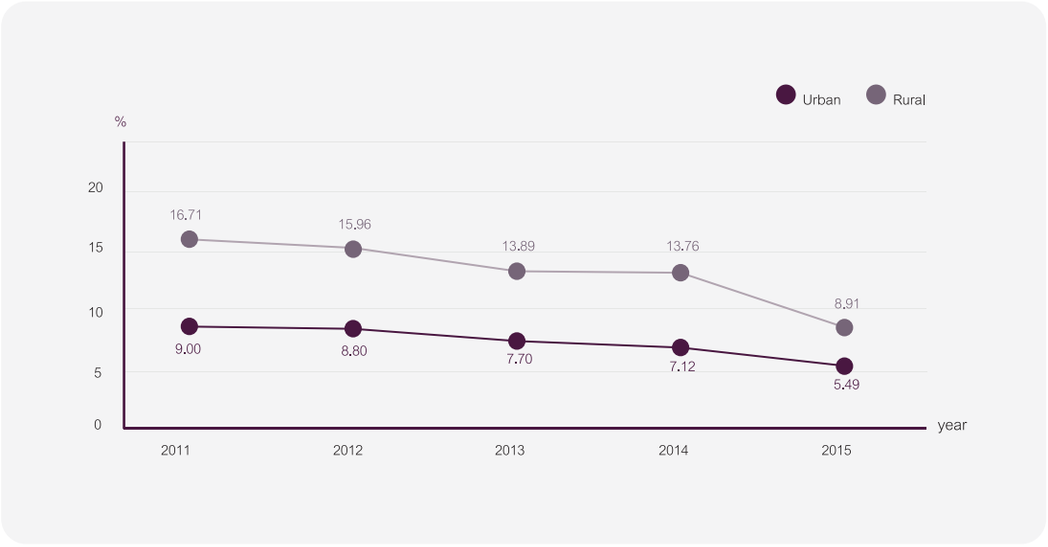
Thailand's poverty line increased between 2000 and 2014 until it declined in 2015 (2,644 THB per person per month) resulting in a slight decrease from the previous year. The poverty rate has declined continuously over time. In 2011, 13.22% of the population lived under the poverty line. By 2015, that number declined to 7.21%. This translates to a reduction, by nearly half, of those below the poverty line (from 8.80 to 4.80 million) within a five-year period (Figure 1-17).

Regarding inequality between urban and rural areas, poverty is more concentrated in rural areas. Figure 1-18 shows that the poverty rate gap between urban and rural areas has declined and tapered since 2011. In 2015, 8.91% of the population lived in poverty in rural areas, compared to 5.49% in urban areas.



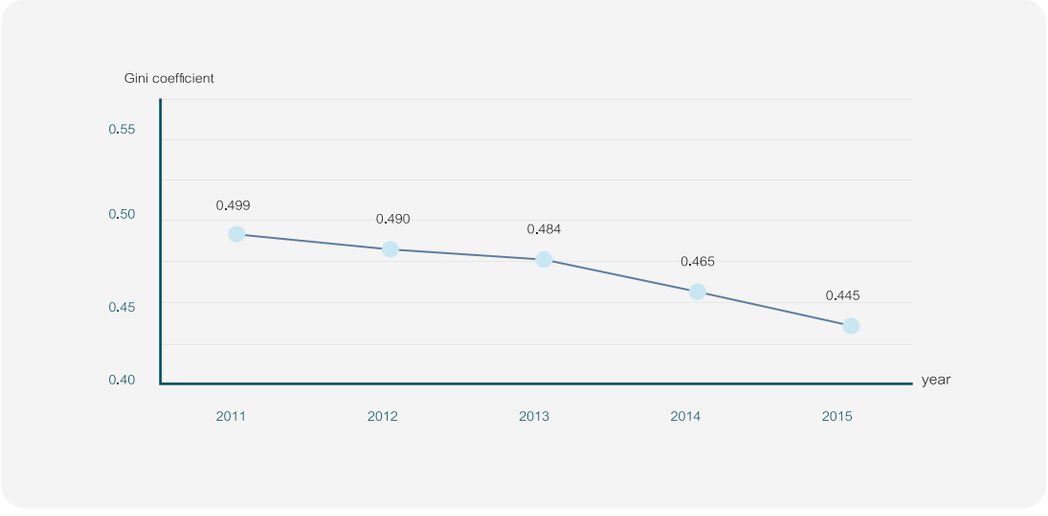
Source: Office of the National Economic and Social Department Board

Figure 1-17: Poverty line, poverty rate and number of the poor: 2011-2015



Source: Office of the National Economic and Social Department Board

Figure 1-18: Poverty rate in Urban and Rural areas: 2011-2015



Source: Office of the National Economic and Social Department Board

Figure 1-19: Gini coefficient for all of Thailand: 2007-2015

In Thailand, income inequality is considered to be moderate and improving, and the Gini coefficient has fallen from 0.49 in 2007 to 0.44 in 2015 (Figure 1-19). Inequality in urban areas is higher than in rural areas. In 2015, the Gini coefficient was 0.43 in urban areas and 0.41 in rural areas (Figure 1-20)

Source: Office of the National Economic and Social Department Board

Figure 1-20: Gini coefficient in Rural and Urban areas: 2007-2015

1.4.6 Transportation

Thailand has an extensive road transportation network connecting each region of the country. 98.5% of roadways are concrete or asphalt paved. The Greater Mekong area road network includes north-south and east-west economic corridors linking Thailand and all neighboring ASEAN countries. Thailand has a development plan for motorways totaling 707 km for five highway projects, which will become part of the East-West Economic Corridor (EWEC) linking the South China Sea with the Bay of Bengal, and the North-South Corridor, which will link Singapore with Kunming in China.

Table 1-5 Number of registered vehicles in Thailand by fuel type

Type	Quantity		Growth		
	Number	%	2013	2014	2015
Petrol	25,248,828	68.70%	2,738,048	2,228,195	2,166,662
Diesel	9,507,337	25.90%	755,407	588,330	548,806
LPG	24,136	0.10%	1,040	888	170
LPG & Petro	1,219,689	3.30%	25,466	19,560	10,699
LPG & Diesel	4,852	0.00%	33	20	20
CNG	65,600	0.20%	7,499	4,849	2,719
CNG & Petrol	345,880	0.90%	64,887	27,588	19,777
CNG & Diesel	4,724	0.00%	137	249	187
Electricity	1,820	0.00%	145	245	76
Non Fuel	190,809	0.50%	24,985	18,938	15,524
Hybrid	70,285	0.20%	16,175	9,101	7,629
Others	47,059	0.10%	-	-	-
Total	36,731,017	100.00%	3,633,822	2,897,963	2,772,269

Source: Department of Land Transport

Passenger transport in Thailand is dominated by personal vehicles. As of December 2015, there were 36,731,017 cumulated registered vehicles (Table 1-5). The majority of fuel used in Thailand is unleaded petrol, which accounted for about 70% of cars, while diesel accounts for about 30%. Few vehicles run on alternative fuels with only small percentages of cars using gaseous fuels (Liquid Petroleum Gas (LPG) or Compressed Natural Gas (CNG)), bio-diesel, electric or hybrid.

Thailand vehicle emission regulations were based on Euro 4 emission standards, which were adopted in 2012. In 2015, to help promote fuel economy and encourage consumers to buy more efficient vehicles, eco-sticker indicating carbon emission ratings, fuel economy and vehicle emission standards, became compulsory. Since 1 January 2016, the tax rates on cars has been computed based on the carbon emission factor, instead of the engine capacity.

Bangkok, the capital city, has a modern public transportation system including the Skytrain (BTS), underground rail system (MRT) and Suvarnabhumi Airport Rail Link (SARL). Bangkok has undertaken the Mass Transit Master Plan to expand the existing networks and to improve their interconnection. Regarding air transportation, there are eight international airports, of which two are located in Bangkok. Suwarnabhumi International Airport is the country's main airport while Don Meang International Airport has become one of the world's largest low-cost carrier airports.

1.4.7 Health

A universal health-coverage scheme was established in Thailand in 2002. Eligible people received a gold card entitling them to accessibility and equality of health treatment services in their home district and contracted hospitals in their home district. Thailand's report on injuries and diseases revealed that in 2014 the average life expectancy at birth was 71 years for males and 78 years for females while health-adjusted life expectancy (HALE) was 68 years for male and 74 years for females.

Due to recent climate change, many climate hazards and extreme weather events have become more frequent and more intense. Heat-related morbidity has increased in recent years, from 0.77 per 100,000 population in 2013 to 5.17 per 100,000 population in 2015. The majority of these are agriculture workers and people aged over 60. Higher temperatures and rainfall led to higher transmission rates of vector-borne diseases, such as malaria and dengue due to warm and wet environments, which are perfect for mosquitoes to breed. Between 2013 and 2015, however, dengue morbidity rate fell from 241.03 to 219.46 per 100,000 population. The mortality rate, on the other hand, increased from 0.21 to 0.22 per 100,000 population. During the same period, malaria's morbidity rate fell significantly from 0.82 to 0.34 per 1,000 population, while malaria's mortality rate was around 0.07 per 100,000 population.

1.5 STATE OF THE ENVIRONMENT

1.5.1 Air quality

The overall air quality in Thailand improved in 2015. The five major air pollutants were sulphur dioxide (SO_2), nitrogen dioxide (NO_2), carbon monoxide (CO), ozone (O_3), and particulate matter (PM: <10 microns: PM10) and < 2.5 microns: PM2.5). The annual national average of PM10 was 42 µg/m^3 (a 2% decrease from the levels in 2014). For PM2.5, the annual national average was 28 µg/m^3, which was a 3% decrease. For ozone, the maximum one-hour average was 125 parts per billion (ppb), which was a 4% decrease compared to 2014. The national annual average of SO_2 and NO_2 was 2 and 14 ppb, respectively: unchanged from the previous year. The maximum one-hour average of CO detected at all stations was in the range of 1.6 –9.2 parts per million (ppm). The level of Benzene, 1,3-butadiene, 1,2-dichloroethane, and chloroform exceeded the standard in Rayong Province, where an industrial park is located.

Sources of pollution differed from area to area. In general, the main sources of air pollutants were activities that required energy consumption. In Bangkok, the main sources were motor vehicles and dust from construction. On the eastern seaboard, the main sources of volatile organic compounds (VOCs) were petrochemical industries. In Thailand's northern and southern regions, haze resulted from open-burning agricultural practices. Thailand was also adversely affected by transboundary haze pollution resulting from wildfire and agricultural burning in neighboring countries. This has become a crucial problem that requires cooperation among members under the ASEAN Agreement on Transboundary Haze Pollution.

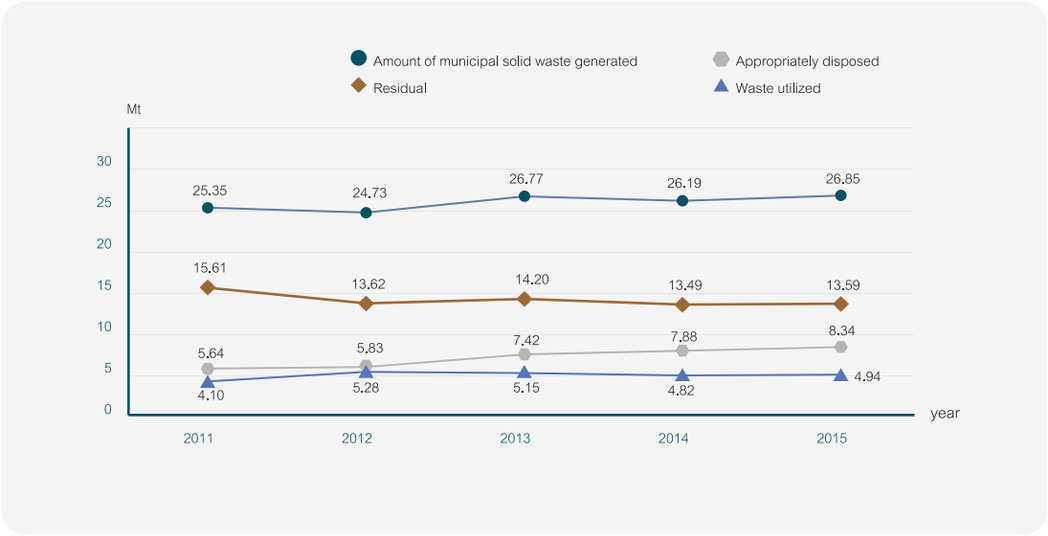
1.5.2 Water Quality

The overall water quality in Thailand was fair in 2015. For surface water, 41% was of fair quality, 34% was good, and 25% was water of deteriorated quality. In terms of a 10-year trend (2006–2015), water quality remained relatively stable. For coastal water quality, most of the monitoring data showed that 72% of the water quality was fair, 16% was good, 9% was deteriorated, and 3% was water of severely deteriorated quality. As for the 10-year trend (2006–2015) of coastal water, most was of fair quality, but the quality did deteriorate as predicted. The main water quality problems involved contamination from communities, wastewater effluent from industrial factories, and agricultural activities such as leachate release from paddy fields and livestock farms.

Overall, the quality of coastal water was fair. The inner Gulf of Thailand, however, the water quality was much lower (deteriorated to very deteriorated) because of bacteria and chemical contaminants. The aforementioned contaminants are one of the causes of the red tide phenomena, which often occur in the Gulf of Thailand.

1.5.3 Waste

In 2015, the total amount of municipal solid waste (MSW) generated nationwide was 26.85 Mt, or 73,560 t/d. Of this waste, 16% was generated in Bangkok. Only 8.34 Mt of waste (31%), was appropriately disposed. About 4.94 Mt MSW was reused through waste recycling (76%), utilization of organic waste (21%), and electricity generation (3%) (Figure 1-21).



Source: Thailand State of Pollution Report 2015

Figure 1-21: Amount of waste generated, utilized, and correctly disposed (million tons): 2011-2015

Hazardous waste refers to hazardous waste generate by communities, industrial activities, and infectious waste. In 2015, it was estimated that 3.44 Mt of hazardous waste was generated nationwide, an increase of 0.75 Mt (28%) from 2014. From that amount, 81% (or 2.8 Mt) was industrial hazardous waste, approximately 17% (0.59 Mt) was household hazardous waste (including electrical and electronic equipment waste), while 2% (0.05 Mt) was infectious waste. The recorded amount of hazardous and non-hazardous industrial waste sent for disposal outside of factories showed that 0.97 Mt of hazardous waste (34.6%) was managed correctly. Most infectious waste was disposed of using waste incinerators, however, the waste from small-scale hospitals might have been inappropriately treated as MSW.

1.6 INSTITUTIONAL ARRANGEMENTS

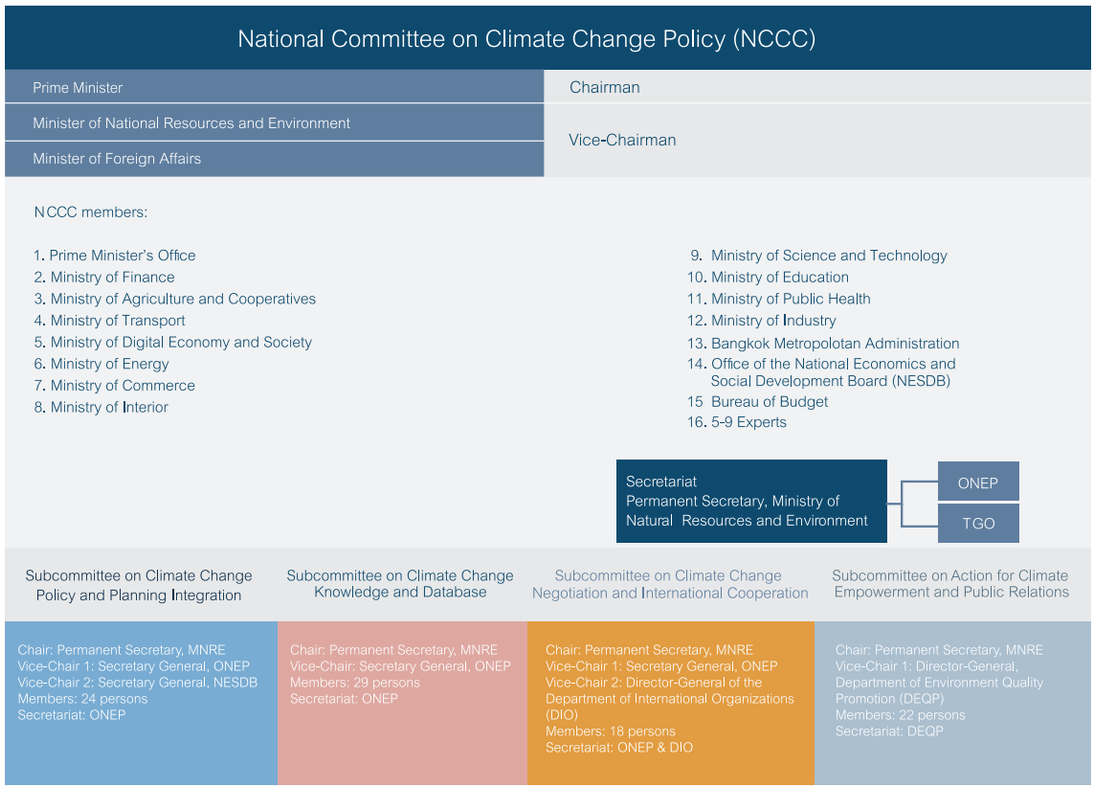
1.6.1 National Committee on Climate Change Policy (NCCC)

The Government has established the National Committee on Climate Change Policy (NCCC), chaired by the Prime Minister. The NCCC is responsible for (i) national climate change policy and strategy; (ii) determination of national positions in international negotiations under the UNFCCC and any relevant international agreements; and (iii) monitoring and evaluating implementation results of government agencies, as stated in the national policy and strategy.

There are four subcommittees under the NCCC (Figure 1-22): the Subcommittee on Climate Change Policy and Planning Integration, the Subcommittee on Climate Change Knowledge and Database, the Subcommittee on Climate Change Negotiation and International Cooperation, and the Subcommittee on Action for Climate Empowerment and Public Relations. The latter was revised from its previous structure. Under the subcommittee on Climate Change Knowledge and Database, five sectoral working groups were set up to review the GHG inventory and provide recommendations on which Measurement, Reporting, and Verification (MRV) systems were suitable for the country.

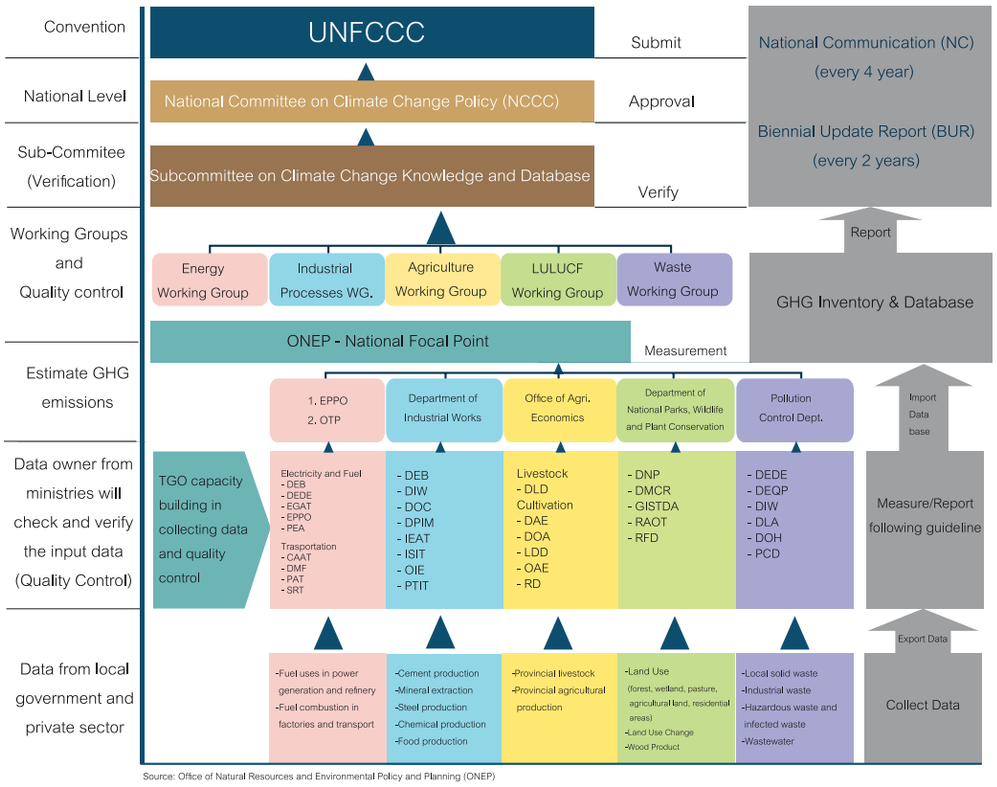
1.6.2 Institutional Arrangements for Greenhouse gas inventory preparation

The ONEP established a GHG inventory system to prepare BURs in 2015. The process of preparing the GHG inventory consisted of five steps. First, the lead agencies of five economic sectors (namely energy, industrial processes, agriculture, LULUCF, and waste) compiled activity data from related agencies (e.g., agencies under their supervisors, local government, and the private sector). Second, lead agencies checked and verified the data (QA) before submitting them to ONEP. Third, ONEP and expert teams estimated GHG emissions for all sectors based on the data provided by the lead agencies. Fourth, the results of this GHG emission estimation were submitted to five working groups: the appointed representatives of the five sectors. Each working group of related agencies reviewed the methodology of the GHG emission estimation as part of quality control to ensure that the GHG emission estimates of their sectors were valid, accurate, and complete. After the GHG emissions were approved by the five working groups, GHG inventories of the five sectors were submitted as part of the BUR to the Subcommittee on Climate Change Knowledge and Database for verification. Then, in the final step, as secretariat of the NCCC, ONEP submitted the BUR to the NCCC for approval before submitting it to the UNFCCC.



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

Figure 1-22: Structure of the National Committee on Climate Change Policy



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

CAAT	= The Civil Aviation Authority of Thailand	IEAT	= Industrial Estate Authority of Thailand
DAE	= Department of Agricultural Extension	ISIT	= Iron and Steel Institute of Thailand
DEB	= Department of Energy Business	LDD	= Land Development Department
DEDE	= Department of Alternative Energy Development and Efficiency	OAE	= Office of Agricultural Economics
DEQP	= Department of Environmental Quality Promotion	OIE	= Office of Industrial Economics
DIW	= Department of Industrial Works	ONEP	= Office of Natural Resources and Environmental Policy and Planning
DLA	= Department of Local Administration	OTP	= Office of Transport and Traffic Policy and Planning
DLD	= Department of Livestock Development	PAT	= Port Authority of Thailand
DMCR	= Department of Marine and Coastal Resources	PCD	= Pollution Control Department
DMF	= Department of Mineral Fuels	PEA	= Provincial Electricity Authority
DNP	= Department of National Parks, Wildlife and Plant Conservation	PTIT	= Petroleum Institute of Thailand
DOA	= Department of Agriculture	RAOT	= Rubber Authority of Thailand
DOC	= Department of Customs	RD	= Rice Department
DOH	= Department of Health	RFD	= Royal Forest Department
DPIM	= Department of Primary Industries and Mines	RID	= Royal Irrigation Department
EGAT	= Electricity Generating Authority of Thailand	SRT	= State Railway Authority of Thailand
EPPO	= Energy Policy and Planning Office		
GISTDA	= Geo-Informatics and Space Technology Development Agency (Public Organization)		

Figure 1-23: Structure of National Communication and Biennial Update Report Preparation

Chapter 2:

NATIONAL GREENHOUSE GAS INVENTORY

CHAPTER 2:
NATIONAL GREENHOUSE GAS INVENTORY

2.1 INVENTORY PROCESS IN THAILAND

Thailand's GHG inventory was compiled and submitted in agreement with Article 4.1(a) of the Convention in accord with Article 12: national inventories of anthropogenic emissions by sources and removal by sinks of all greenhouse gases not controlled by the Montreal Protocol. This inventory report was prepared to the extent of the country's capabilities using the Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories (IPCC, 1997) that were agreed upon by the Conference of the Parties (COP). This inventory report presented Thailand's national GHG emissions by sources, and GHG emissions removal by sinks from 2000 to 2013. The GHG emissions estimated in this report include direct emissions (CO_2, CH_4, and N_2O) and indirect emissions (NO_x, CO, NMVOCs, and SO_2).

2.1.1 Methodology of Calculation of GHG Emission and Removals

All the methodologies and tools used for GHG inventory reporting followed the Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories (IPCC, 1997) Good Practice Guidance, and Uncertainty Management in National Greenhouse Gas Inventories (IPCC, 2000). The methodologies used were from Tier 1 to Tier 2, wherever activity data and country-specific emission factors were available. In this inventory report, Tier 1 was adopted for all activity data in the energy and industrial processes sectors, while Tier 2 was adopted for the agriculture, LULUCF, and waste sectors. GHG emissions from the energy and industrial processes sectors were calculated using the default emission factors provided in the IPCC Guidelines. Country specific emission factors were used for some sub-sectors of waste, LULUCF, and agriculture sectors. Table 2-1 provided a summary table of the methods and emission factors used in this inventory report.

Table 2-1 Summary of methods and emission factors

Greenhouse gas source and sink categories	CO_2		CH_4		N_2O		NO_x		CO		NMVOCs		SO_2	
	Method applied	Emission factor	Method applied	Emission factor	Method applied	Emission factor	Method applied	Emission factor	Method applied	Emission factor	Method applied	Emission factor	Method applied	Emission factor
1. Energy	T1	D	T1	D	T1	D	T1	D	T1	D	T1	D	T1	D
A Fuel Combustion Activities	T1	D	T1	D	T1	D	T1	D	T1	D	T1	D	T1	D
1. Energy Industries	T1	D	T1	D	T1	D	T1	D	T1	D	T1	D	T1	D
2. Manufacturing Industries and Construction	T1	D	T1	D	T1	D	T1	D	T1	D	T1	D	T1	D
3. Transport	T1	D	T1	D	T1	D	T1	D	T1	D	T1	D	T1	D
4. Other Sectors	T1	D	T1	D	T1	D	T1	D	T1	D	T1	D	T1	D
B. Fugitive Emissions from Fuels			T1	D										
1. Solid Fuels			T1	D										
2. Oil and Natural Gas			T1	D										
2. Industrial Processes	T1	D	T1	D	T1	D	T1	D	T1	D	T1	D	T1	D
A. Mineral Products	T1	D									T1	D	T1	D
B. Chemical Industry	T1	D	T1	D	T1	D	T1	D	T1	D	T1	D	T1	D
C. Metal Production	T1	D					T1	D	T1	D	T1	D	T1	D
D. Others Production	T1	D			T1	D	T1	D	T1	D	T1	D	T1	D
E. Production of Halocarbons and Sulphur Hexafluoride														
F. Consumption of Halocarbons and Sulphur Hexafluoride														
3. Agriculture			T1, T2	CS, D	T1, T2	D	T1, T2	D	T1, T2	D				
A. Enteric Fermentation			T1, T2	CS, D										
B. Manure Management			T1, T2	CS, D	T2	D								
C. Rice Cultivation			T2	CS										
D. Agricultural Soils					T1	D								
E. Prescribed Burning of Savannas														
F. Field Burning of Corp Residues			T1, T2	D	T1, T2	D	T1, T2	D	T1, T2	D				
4. Land Use, Land-Use Change & Forestry (LULUCF)	T1, T2	CS, D	T1, T2	D	T1, T2	D	T1, T2	D	T1, T2	D				
A. Change in Forest and Other Woody Biomass Stocks	T2	CS												
B. Forest and Grassland Conversion	T1, T2	CS, D	T1, T2	D	T1, T2	D	T1, T2	D	T1, T2	D				
C. Abandonment of Management Land	T1, T2	CS, D												
D. CO_2 Emission and Removal Soils														
5. Waste	T1, T2	CS, D	T1, T2	CS, D	T1, T2	CS, D								
A. Solid Waste Disposal on Land			T2	CS, D										
B. Wastewater Handling			T1	D	T1	CS, D								
C. Waste Incineration	T1, T2	CS, D			T1, T2	CS, D								

Note: T1 = Tier 1
T2 = Tier 2
T3 = Tier 3
CS = Country specific
D = IPCC default

According to Decision 17/CP.8, for aggregated GHG emissions and removal expressed in CO_2 equivalents, Global Warming Potential (GWP) was recommended. The use of GWP was provided by the IPCC in its Second Assessment Report ("1995 IPCC GWP Values") which was based on the effects of GHGs over a 100-year period.

2.1.2 Uncertainty Analysis

An uncertainty analysis aimed to provide information on where inventory resources should be allocated in order to improve inventory quality. Inventories prepared in accord with the Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories (IPCC, 2000), typically contain a wide range of emission calculations. In this report, Tier 1 uncertainty analysis of the aggregated figures followed the IPCC Good Practice Guidance. The uncertainties in total emissions, based on IPCC guidance for both excluding and including emissions and removals from the LULUCF sector, are presented in Table 2-2. The overall uncertainty when excluding the LULUCF sector ranged from 5.04 to 5.63%.

Table 2-2 Overall uncertainty of excluding and including the LULUCF

Unit: Percentage

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
Excl. LULUCF	5.34	5.16	5.16	5.37	5.16	5.04	5.15	5.43	5.39	5.63	5.50	5.51	5.45	5.54
Incl. LULUCF	11.05	11.21	10.47	11.09	12.10	20.30	20.76	21.35	22.93	23.54	23.66	24.43	28.06	29.29

2.1.3 Key Category Analysis

A key category analysis (KCA) presented the importance of emission sources and sinks. The key categories were the emission sources and sinks that contributed 95% of the total annual emissions when ranked from greatest to least. A key source had a significant influence on the national inventory of direct GHG emissions in terms of the absolute level. The KCA reported in this inventory followed the Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories (IPCC, 2000), and estimated for both level and trend assessment. The results for the level assessment in 2013 are presented in Table 2-3, and trend assessment in Table 2-4. There were 15 key categories in the level assessment, among which public electricity and heat production led the KCA, followed by changes in forest and other woody biomass stocks, road transportation, manufacturing industries and construction, and rice cultivation. Results of the KCA changed slightly under the trend assessment, where public electricity and heat production still dominated. These were followed by road transportation, manufacturing industries and construction, rice cultivation, and abandonment of managed lands.

Table 2-3 Key category analysis for the year 2013: Approach 1 – Level assessment

A	B	C	D	E	F	G
IPCC category code	IPCC category	GHG	2013 Ex,t ($Gg\ CO_2eq$)	2013 |Ex,t| ($Gg\ CO_2eq$)	Lx,t	Cumulative Total of Column F
1A1a	Public Electricity and Heat Production	CO_2	88,089.54	88,089.54	20.38	20.38
5A	Changes in Forest and Other Woody Biomass Stocks	CO_2	-83,385.22	83,385.22	19.29	39.67
1A3b	Road Transportation	CO_2	58,646.11	58,646.11	13.57	53.24
1A2	Manufacturing Industries and Construction	CO_2	45,690.41	45,690.41	10.57	63.81
4C	Rice Cultivation	CH_4	27,862.90	27,862.90	6.45	70.26
2A	Mineral Products	CO_2	18,591.18	18,591.18	4.30	74.56
5C	Abandonment of Managed Lands	CO_2	-16,451.66	16,451.66	3.81	78.36
5B	Forest and Grassland Conversion	CO_2	13,330.14	13,330.14	3.08	81.45
4D	Agricultural Soils	N_2O	11,687.34	11,687.34	2.70	84.15
1A4c	Agriculture/Forestry/Fishing	CO_2	11,398.75	11,398.75	2.64	86.79
1A1b	Petroleum Refining	CO_2	9,954.94	9,954.94	2.30	89.09
1B2b	Natural Gas	CH_4	9,397.52	9,397.52	2.17	91.27
4A	Enteric Fermentation	CH_4	6,004.73	6,004.73	1.39	92.66
6B	Wastewater Handling	CH_4	5,347.83	5,347.83	1.24	93.89
6A	Solid Waste Disposal on Land	CH_4	5,346.02	5,346.02	1.24	95.13

Table 2-4 Key category analysis for the year 2013: Approach 2 – Trend assessment

A	B	C	D	E	F	G	H
IPCC category code	IPCC category	GHG	2000 Ex,0 ($Gg\ CO_2eq$)	2013 Ex,t ($Gg\ CO_2eq$)	Tx,t	% Contribution to Trend	Cumulative Total of Column G
1A1a	Public Electricity and Heat Production	CO_2	57,873.29	88,089.54	7.13	21.05	21.05
1A3b	Road Transport	CO_2	45,452.68	58,646.11	5.64	16.65	37.69
1A2	Manufacturing Industries and Construction	CO_2	30,733.62	45,690.41	3.79	11.19	48.88
4C	Rice Cultivation	CH_4	22,304.74	27,862.90	2.77	8.18	57.06
5C	Abandonment of Managed Lands	CO_2	- 20,832.02	-16,451.66	2.59	7.65	64.71
5B	Forest and Grassland Conversion	CO_2	15,962.62	13,330.14	2.01	5.93	70.64
2A	Mineral Products	CO_2	13,765.49	18,591.18	1.70	5.03	75.67
5A	Changes in Biomass Stocks	CO_2	-7,618.66	-83,385.22	1.23	3.64	79.31
4D	Agricultural Soils	N_2O	8,421.93	11,687.34	1.04	3.08	82.38
4A	Enteric Fermentation	CH_4	7,164.27	6,004.73	0.90	2.66	85.04
1A1b	Petroleum Refining	CO_2	6,900.49	9,954.94	0.85	2.52	87.56
1A4c	Agriculture/Forestry/Fishing	CO_2	6,708.60	11,398.75	0.82	2.43	89.98
6B	Wastewater Handling	CH_4	5,310.61	5,347.83	0.66	1.96	91.95
1B2b	Natural Gas	CH_4	4,523.00	9,397.52	0.57	1.67	93.62
1A4b	Residential	CO_2	4,330.83	5,069.95	0.54	1.59	95.21

2.1.4 Time Series Consistency

Under this inventory, the activity data for each source category were drawn from the same sources as the national statistics for all years between 2000 – 2013. The same emission factors were used following the Revised 1996 IPCC Guidelines. Thus, the inventory allowed a consistent time series to be built with confidence in the emission trends.

2.1.5 Quality Assurance and Quality Control

As defined in the IPCC Guidelines, quality control (QC) and quality assurance (QA) procedures were implemented during the preparation of this inventory. In addition, under Thailand's Institutional Arrangements and Inventory Preparation, Thailand utilized its own national system for quality control (QC) of data collection among the ministerial agencies (Figure 1-23). At each stage of the data collection process, all data were controlled by the respective institute until the final quality assurance process was collected by the lead agency of each sector.

2.1.6 Completeness Assessment

Within each source category, the completeness assessment of the inventory was conducted following the IPCC guidelines. Results of the assessment for the Energy and Industrial Processes sectors are presented in Table 2-5. The following notation keys are used in the assessment.

- NA Not Applicable
- NO Not Occurring
- NE Not Estimated
- EE Estimated Elsewhere

Table 2-5 National greenhouse gas inventory of Thailand: 2013

Unit: Gg

Greenhouse gas source and sink categories	CO_2 emissions	CO_2 removals	CH_4	N_2O	NO_x	CO	NMVOCs	SO_2
Total national emissions and removals	286,170	-130,654	2,852	55	1,351	7,037	828	573
1. Energy	223,309	NO	586	4	1,289	5,531	583	553
A. Fuel Combustion Activities	223,309		104	4	1,289	5,531	583	553
1. Energy Industries	98,044		6	1	289	164	14	57
2. Manufacturing Industries and Construction	45,690		13	2	167	1,318	23	433
3. Transport	60,684		17	0	611	2,305	424	7
4. Other Sectors	18,890		68	1	223	1,745	122	56
B. Fugitive Emissions from Fuels	NO		482		NO	NO	NO	NO
1. Solid Fuels			32		NO	NO	NO	NO
2. Oil and Natural Gas			450		NO	NO	NO	NO
2. Industrial Processes	18,609	NO	10	1	1	7	244	20
A. Mineral Products	18,591				0	NA	8	14
B. Chemical Industry			10	1	0	3	79	1
C. Metal Production	18		NA	NA	0	0	0	0
D. Others Production	NA				1	4	157	5
E. Production of Halocarbons and Sulphu Hexafluoride								
F. Consumption of Halocarbons and Sulphur Hexafluoride								
3. Solvent and other product use	NA			NA			NA	
4. Agriculture			1,730	47	56	1,345	NA	NA
A. Enteric Fermentation			286					
B. Manure Management			53	8			NA	
C. Rice Cultivation			1,327				NA	
D. Agricultural Soils			NA	38			NA	
E. Prescribed Burning of Savannas			NO	NO	NO	NO	NA	
F. Field Burning of Corp Residues			64	2	56	1,345	NA	
5. Land Use, Land - Use Change and Forestry (LULUCF)	44,147	-130,654	18	1	4	153		
A. Change in Forest and Other Woody Biomass Stocks	30,817	-114,202						
B. Forest and Grassland Conversion	13,330		18	0.12	4	153		
C. Abandonment of Managed Lands		-16,452						
D. CO_2 Emission and Removal Soils	NE	NE						
6. Waste	104		509	3	NO/NA	NO/NA	NA	NA
A. Solid Waste Disposal on Land			255				NA	
B. Wastewater Handling			255	3	NO	NO	NA	
C. Waste Incineration	104		NA	0	NA	NA	NA	NA
7. Other (please specify)	NA	NA	NA	NA	NA	NA	NA	NA
Memo Items								
International Bunkers	NA		NA	NA	NA	NA	NA	NA
International Aviation	NA		NA	NA	NA	NA	NA	NA
International Water-Borne Navigation	NA		NA	NA	NA	NA	NA	NA
CO_2 emission from biomass	NA							

2.2 KEY FINDINGS FROM THE NATIONAL GHG INVENTORY

This report covered the trends of Thailand's GHG emissions for the period of 2000 to 2013. All emission sources and removal followed the Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories (IPCC, 1997). Emissions were estimated for the energy, industrial processes, agriculture, LULUCF, and waste sectors. Emissions in the solvent and other product sector were not estimated due to insufficient activity data. The emissions were presented in the form of direct and indirect GHGs and sulphur dioxide (SO_2). Direct GHGs consisted of carbon dioxide (CO_2), methane (CH_4), and nitrous oxide (N_2O); whereas indirect GHGs consisted of nitrogen oxides (NO_x), carbon monoxide (CO), and non-methane volatile organic compounds (NMVOCs).

2.2.1 Trend of Thailand's GHG Emissions from 2000 to 2013

Between 2000 and 2013, total emissions (excluding those from the LULUCF sector) increased from 226,086 $GgCO_2eq$ in 2000 to 318,662 $GgCO_2eq$ in 2013. The net removal of CO_2 increased from 11,995 $GgCO_2eq$ in 2000 to 86,102 $GgCO_2eq$ in 2013. Therefore, the net GHG emission increased from 214,091 $GgCO_2eq$ in 2000 to 232,560 $GgCO_2eq$ in 2013, with an annual increase of 0.64%. With the inclusion of the LULUCF sector, net emissions in 2013 increased by 8.63% when compared with net emissions in 2000 (Table 2-6 and Figure 2-1). The major source of GHG emissions was the energy sector, which increased from 161,005 $GgCO_2eq$ in 2000 to 236,936 $GgCO_2eq$ in 2013, an increase of 47.16%.

Table 2-6 National GHG emissions/removals by sector: 2000-2013

Unit: Gg CO_2eq

Year	Source category					Net emissions
	Energy	Industrial processes	Agriculture	LULUCF	Waste	
2000	161,005	14,086	41,906	-11,995	9,089	214,091
2001	168,939	16,389	43,208	-7,718	9,767	230,585
2002	178,226	18,661	41,845	-20,183	11,066	229,615
2003	188,039	16,215	45,350	-20,987	12,282	240,899
2004	204,007	17,423	44,931	-17,254	12,772	261,879
2005	209,214	19,235	46,294	-51,551	12,985	236,177
2006	210,752	20,085	46,398	-53,467	13,749	237,517
2007	215,955	20,008	50,979	-60,521	14,113	240,535
2008	218,180	18,800	50,997	-65,341	15,050	237,686
2009	218,646	18,650	52,238	-66,690	14,925	237,769
2010	230,364	18,698	52,316	-65,262	13,542	249,658
2011	229,886	18,690	52,927	-70,938	12,769	243,334
2012	240,001	19,039	55,682	-84,839	10,058	239,941
2013	236,936	18,977	50,919	-86,102	11,830	232,560

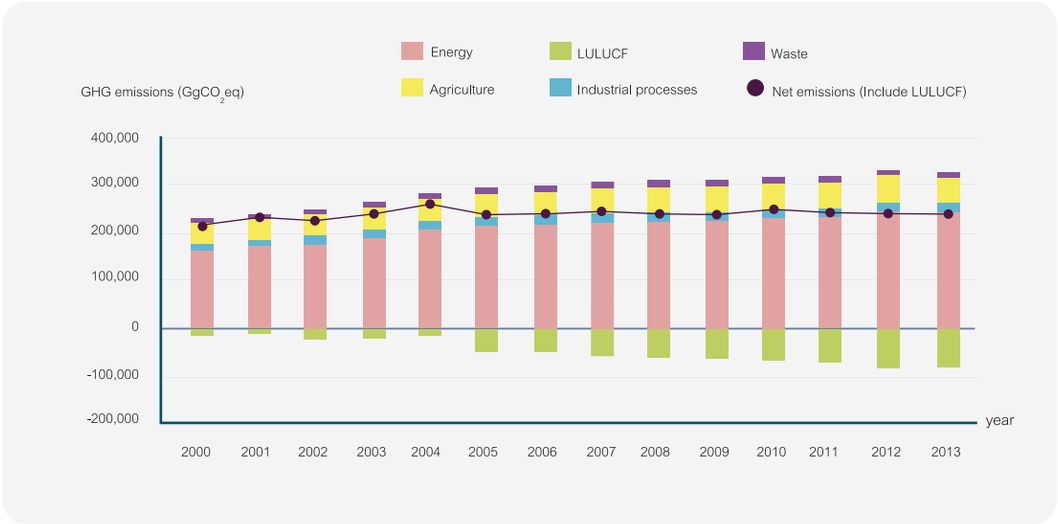


Figure 2-1: Trends of GHG emissions/removal, 2000–2013

The proportion of GHG emissions in the energy sector accounted for 71.21% of the national net emissions in 2000, and increased by 74.35% by 2013. On the other hand, and over the same period, emissions in the agriculture sector decreased from 18.54% in 2000 to 15.98% in 2013, Emissions in the industrial processes sector remained constant (Figure 2-2).

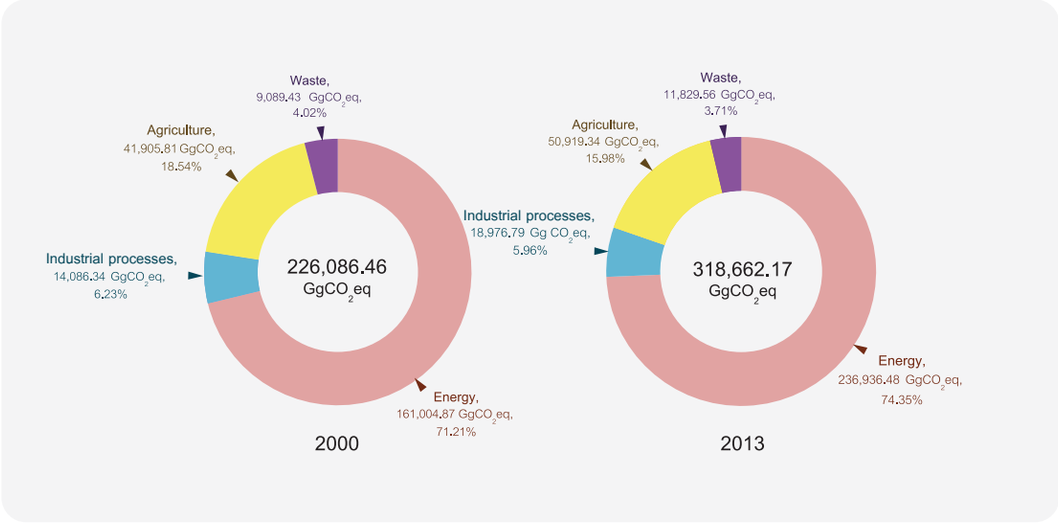


Figure 2-2: Total GHG emissions by sector, 2000 and 2013

2.2.2 Trend of Indirect GHG Emissions

This section concluded the trends of indirect GHG emissions and SO_2. The indirect GHG emissions were NO_x, CO, and NMVOCs. These four gases were included and reported as indirect GHG emission, but they were not included in the national inventory. Emissions of these gases for the period of 2000 to 2013 are shown in Table 2-7. Emissions of CO increased from 5,180 Gg in 2000 to 7,037 Gg in 2013. Thus, CO accounted for an increase of 1,857 Gg in that period, followed by NO_x (increase of 413 Gg), and NMVOCs (increase of 251 Gg).

Table 2-7 Indirect GHG emissions by gas and SO_2: 2000 – 2013

Unit: Gg

Year	Indirect Gases			
	NO_x	CO	NMVOCs	SO_2
2000	938	5,180	577	601
2001	987	5,312	597	650
2002	1,037	5,453	638	698
2003	1,108	5,811	811	627
2004	1,199	6,100	1,525	730
2005	1,204	5,752	1,938	783
2006	1,198	5,984	2,447	721
2007	1,230	6,174	848	649
2008	1,223	6,287	745	658
2009	1,247	6,402	771	627
2010	1,290	6,671	781	655
2011	1,318	6,761	821	661
2012	1,364	6,792	821	549
2013	1,351	7,037	828	573
% Change 2000-2013	44.03%	35.85%	43.50%	-4.67%

2.2.3 Recalculations

The previous inventories submitted in the SNC were recalculated to provide for a consistent series. Recalculations were performed for past inventories during the years 2000 to 2004 to maintain consistency for the years 2005 to 2013. The emissions for the period 2000 to 2004 were recalculated with updated activity data and the revised emission factors. Recalculation of national GHG emissions for the years 2000 to 2004 results are presented in Figure 2-3.

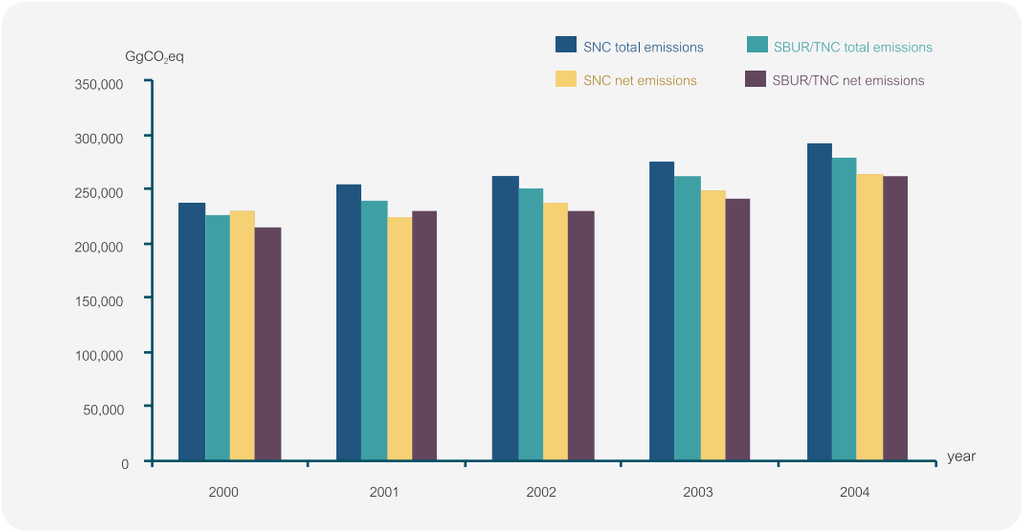


Figure 2-3: Comparison of Thailand's GHG emissions between SNC and present inventories

2.3 GREENHOUSE GAS EMISSIONS BY SECTOR

2.3.1 Energy Sector

Methodology

The methodologies used in the Energy Sector were based on the Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories (IPCC,1997), and the Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories (IPCC, 2000). The basis of Tier 1 in both Fuel Combustion Activities and Fugitive Emissions from Fuels Categories, and subcategories included 1A1 Energy Industries, 1A2 Manufacturing Industries and Construction, 1A3 Transport, 1A4 Other Sectors, 1B1 Fugitive Emissions from Solid Fuels, and 1B2 Fugitive Emissions from Oil and Natural Gas. Emissions of SO_2 and direct and indirect greenhouse gases from energy sources, comprising CO_2, CH_4, N_2O, NO_x, CO and NMVOCs were estimated by using activity data (AD) reported in the national statistics, as well as, the default emission factors of related fuels provided by the IPCC. The net calorific value (NCV) of each fuel, however, followed the official annual reports of the Ministry of Energy.

Greenhouse Gas Emissions

The majority of GHG emissions in the energy sector arose from fuel combustion, mostly from the production of public electricity and heat. This accounted for 98,537.77 $GgCO_2eq$ (41.59%) of total emissions in 2013. GHG emissions from transport, and manufacturing industries and construction, were 61,175.42 $GgCO_2eq$ (25.82%) and 46,537.39 $GgCO_2eq$ (19.64%). Fugitive Emission from fuels only emitted 10,123.99 $GgCO_2eq$, a little over 4% of the total GHG emissions from the energy sector. Details of GHG emissions from the energy sector by gas type and source in 2013 are presented in Table 2-8 and Figure 2-4.

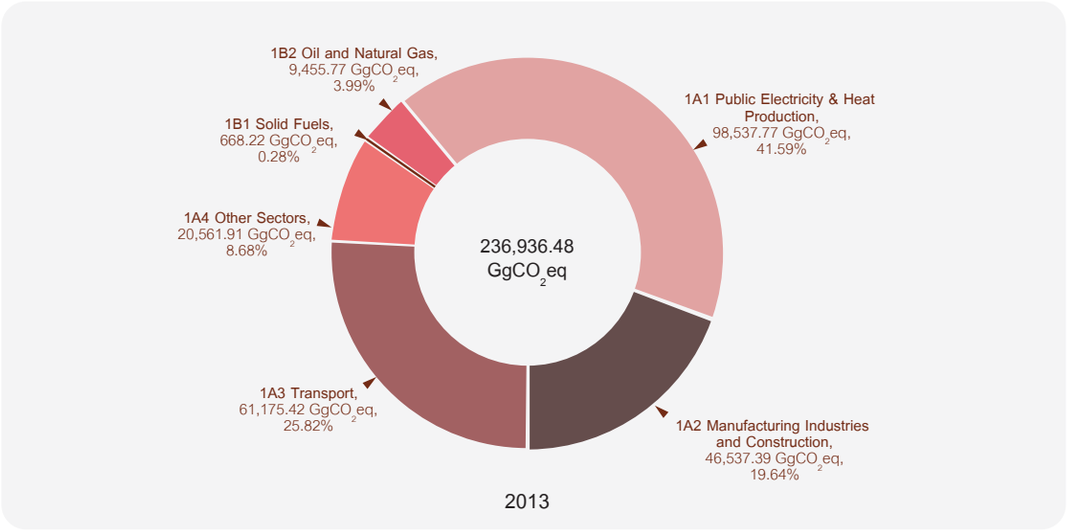


Figure 2-4: GHG emissions in the energy sector, 2013

Table 2-8 GHG emissions from various sources relative to total GHG emissions in the energy sector: 2013

Greenhouse gas source and sink categories	CO_2 emissions	CO_2 removals	CH_4		N_2O		NO_x	CO	NMVOCs	SO_2	Total
Unit	$GgCO_2eq$	$GgCO_2eq$	Gg	$GgCO_2eq$	Gg	$GgCO_2eq$	Gg	Gg	Gg	Gg	$GgCO_2eq$
1. Energy	223,309.28	NO	585.73	12,300.43	4.28	1,326.77	1,289.47	5,531.48	583.44	553.24	236,936.48
1A Fuel Combustion	223,309.28	NO	103.64	2,176.44	4.28	1,326.77	1,289.47	5,531.48	583.44	553.24	226,812.49
1A1 Public Electricity & Heat Production	98,044.48	NO	5.83	122.43	1.20	370.86	288.55	164.16	14.05	56.94	98,537.77
1A2 Manufacturing Industries and Construction	45,690.41	NO	13.48	283.05	1.82	563.92	167.06	1,317.57	23.28	433.41	46,537.39
1A3 Transport	60,684.23	NO	16.74	351.50	0.45	139.69	611.01	2,304.76	423.98	6.81	61,175.42
1A4 Other Sectors	18,890.15	NO	67.59	1,419.46	0.81	252.29	222.85	1,744.99	122.14	56.08	20,561.91
1B Fugitive Emissions from Fuels	NO	NO	482.09	10,123.99	NO	NO	NO	NO	NO	NO	10,123.99
1B1 Solid Fuels	NO	NO	31.82	668.22	NO	NO	NO	NO	NO	NO	668.22
1B2 Oil and Natural Gas	NO	NO	450.27	9,455.77	NO	NO	NO	NO	NO	NO	9,455.77

Note: NO = Not Occurring

2.3.2 Industrial Processes Sector

Methodology

The methodologies used in the Industrial Processes Sector were based on the Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories (IPCC,1997), and the Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories (IPCC, 2000) on the basis of Tier 1 in 2A Mineral Product, 2B Chemical Industry and 2C Metal Production. Emissions of direct and indirect greenhouse gases from industrial processes sector, comprising SO_2, CO_2, CH_4, N_2O, NO_x, CO and NMVOCs, were estimated by using activity data (AD) reported by the related agencies and the default emission factors of related fuels provided by the IPCC.

Greenhouse Gas Emissions

Total direct GHG emissions from the industrial processes sector in 2013 accounted for 18,976.79 $GgCO_2eq$. The emissions from mineral products were 18,591.18 $GgCO_2eq$ or 97.97%, chemical industry was 367.72 $GgCO_2eq$ or 1.94%, and metal production was 17.89 $GgCO_2eq$ or 0.09%. 2013 details of direct and indirect GHG emissions in the industrial processes sector by gas type and source are presented in Table 2-9 and Figure 2-5.

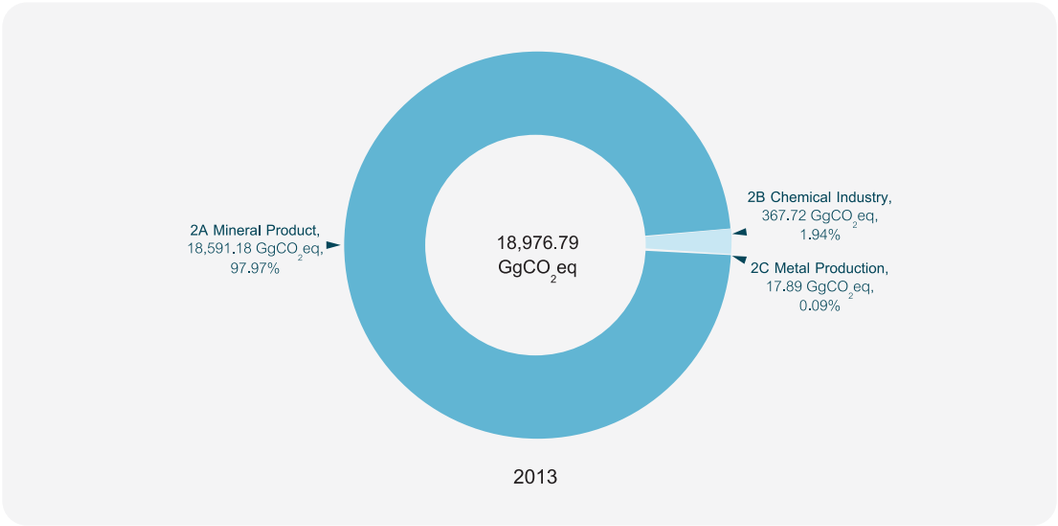


Figure 2-5: GHG emissions in the industrial processes sector, 2013

Table 2-9 GHG emissions from various sources in relation to total GHG emissions in the industrial processes sector: 2013

Greenhouse gas source and sink categories	CO_2 emissions	CO_2 removals	CH_4		N_2O		NO_x	CO	NMVOCs	SO_2	Total
Unit	$GgCO_2eq$	$GgCO_2eq$	Gg	$GgCO_2eq$	Gg	$GgCO_2eq$	Gg	Gg	Gg	Gg	$GgCO_2eq$
2. Industrial Processes	18,609.07	NO	9.68	203.28	0.53	164.44	1.39	7.25	244.24	19.79	18,976.79
2A Mineral Product	18,591.18						0.18	NA	8.05	13.64	18,591.18
2A1 Cement Production	18,377.68						0.18			13.64	18,377.68
2A4 Soda Ash Production and Use	213.50								0.03		
2A7 Glass Production									8.02		
2B Chemical Industry			9.68	203.28	0.53	164.44		3.26	79.47	1.01	367.72
2B2 Nitric Acid Production					0.53	164.44					
2B5 Other Chemicals			9.68	203.28				3.26	79.47	1.01	
2C Metal Production	17.89		NA	NA			0.14	0.00	0.11	0.16	17.89
2C1 Iron and Steel	17.89						0.14	0.00	0.11	0.16	
2D Other Production	NA						1.07	3.99	156.62	4.98	
2D1 Pulp and Paper							1.07	3.99	2.63	4.98	
2D2 Food and Drink									153.99		

Note: NA = Not Applicable , NO = Not occuring

2.3.3 Agriculture Sector

Methodology

In this inventory, the methodologies used were based on the Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories (IPCC, 1997) and Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories (IPCC, 2000). GHG estimations were calculated for 5 sub-sectors, including 4A enteric fermentation, 4B manure management, 4C rice cultivation, 4D agricultural soils, and 4F field burning of agricultural residues. Methodology tiers were chosen according to the decision trees in the GPG 2000. Tier 1 and Tier 2 methods were applied for the agriculture sector. Activity data were obtained from the relevant government agencies' published reports, including the Department of Livestock Development (DLD), the Office of Agricultural Economics (OAE), and the Department of Agriculture (DOA) under the Ministry of Agriculture and Cooperatives. Country specific emission factors were developed for enteric fermentation (cattle and buffalo), manure management (CH_4: cattle, buffalo and swine) and rice cultivation. The Tier 2 approach was applied to the estimates of the GHG emissions in those sub-sectors. The others were estimated in Tier 1 using the default value from the 1996 IPCC Guidelines and GPG 2000. Supporting data for estimating Tier 2 emission factors were acquired from the published data and expert judgment in the country and from the IPCC defaults.

For enteric fermentation (4A) and the manure management system (4B: CH_4), Tier 2 approach was used for dairy cattle, beef cattle, buffalo and swine (only for manure management). The supporting data for estimating Tier 2 emission factors were animal and feed characteristics, daily volatile solids excreted, methane producing potentials of manure, fraction of manure handled in manure management system, etc. These data were obtained from literature reviews (more than 15 national journal articles and handbooks), expert judgment, and IPCC defaults. Enteric Tier 1 emission factor for swine was applied from developed countries. For rice cultivation (4C), the qualified data used to estimate country-specific emission factors were screened based on several requirements. These requirements included conducting the field experiments in Thailand, similar CH_4 measurements being performed (chamber methods), and measuring CH_4 emissions routinely (e.g., at least once or twice a week). According to these criteria, supporting data for the Tier 2 emission factors were derived from literature reviews of more than 20 national and international articles from proceedings and journals. For agricultural soils (4D) and field burning of agricultural residues (4F), the Tier 1 emission factors were applied.

Greenhouse Gas Emissions

Total GHG emissions from the agriculture sector in 2013 accounted for 50,919.34 $GgCO_2eq$. The emissions from enteric fermentation and manure management were 6,004.73 $GgCO_2eq$ (11.79%) and 3,538.60 $GgCO_2eq$ (6.95%). Meanwhile, rice cultivation and agricultural soils were 27,862.90 $GgCO_2eq$ (54.72%) and 11,687.34 $GgCO_2eq$ (22.95%). Residue from field burning contributed the least GHG emissions of 1,825.76 $GgCO_2eq$ (3.59%). Details of GHG emissions in the agriculture sector by gas type and source in 2013 are presented in Table 2-10 and Figure 2-6.

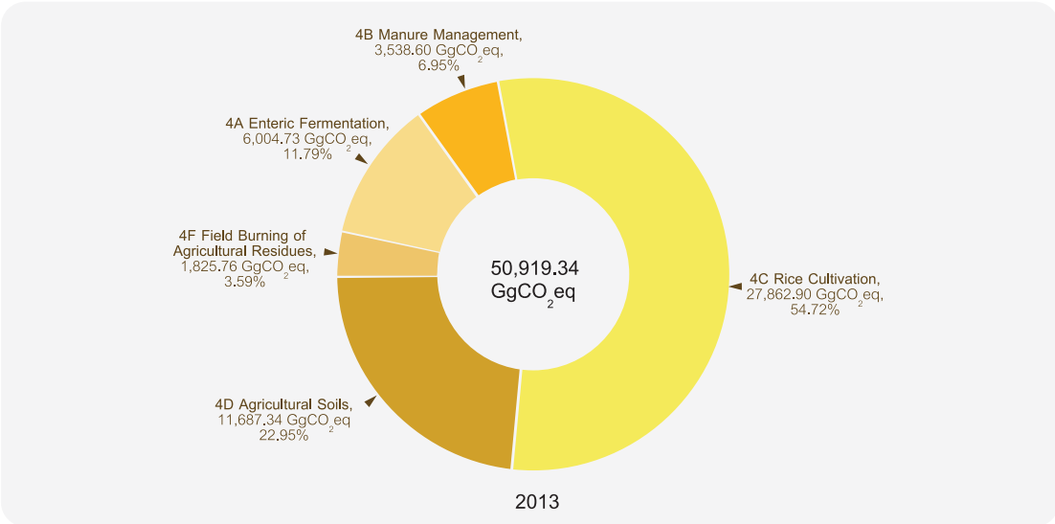


Figure 2-6: GHG emissions in the agriculture sector: 2013

Table 2-10 GHG emissions from various sources in relation to total GHG emissions in the agriculture sector: 2013

Greenhouse gas source and sink categories	CO_2 emissions	CH_4		N_2O		NO_x	CO	NMVOCs	SO_2	Total
Unit	$GgCO_2eq$	Gg	$GgCO_2eq$	Gg	$GgCO_2eq$	Gg	Gg	Gg	Gg	$GgCO_2eq$
4. Agriculture		**1,729.66**	**36,322.78**	**47.09**	**14,596.55**	**56.04**	**1,345.08**	**NA**		**50,919.34**
4A Enteric Fermentation		285.94	6,004.73							6,004.73
4B Manure Management		52.86	1,110.07	7.83	2,428.53			NA		3,538.60
4C Rice Cultivation		1,326.80	27,862.90					NA		27,862.90
4D Agricultural Soils		NA	NA	37.70	11,687.34			NA		11,687.34
4E Prescribed Burning of Savannas		NO	NO	NO	NO	NO	NO	NA		
4F Field Burning of Agricultural Residues		64.05	1,345.08	1.55	480.68	56.04	1,345.08	NA		1,825.76

Note: NA = Not Applicable , NO = Not Occurring

2.3.4 Land Use, Land-Use Change, and Forestry

Methodology

Methodologies applied in this national inventory were based on the Revised 1996 IPCC Guideline for National Greenhouse Gas Inventories (IPCC, 1997) and the uncertainty analysis of the activity data and emission factor was undertaken according to the Good Practice Guidance for Land Use, Land-Use Change and Forestry (IPCC, 2003). Forest carbon pools were classified into 6 categories including living above-ground biomasses, living below-ground biomasses, dead wood, litter, soil organic carbon and harvested wood products (IPCC, 1997). Only the fate and amount of aboveground biomass, however, were taken into account. Appropriate methodology tiers, either with or without change of forest land to other land use were chosen according to the Good Practice Guidance for Land Use, Land-Use Change and Forestry (IPCC, 2003). Similar to previous reports, Thailand adopted multiple tiers in the national GHG inventory for LULUCF sector in this report. Activity data were obtained from the interpretation of satellite imageries and statistical reports from relevant agencies. Tier 2 emission factors were adopted in most activities using country-specific data from local publications and IPCC defaults were applied as Tier 1 emission factors when appropriate. This was mostly for estimation of non-CO_2 trace gases emissions. For 5A Changes in Forest and Other Woody Biomass Stocks, the annual increment in biomass, wood density and carbon fraction of dry matter for EFs estimation were obtained from local publications that were reported in the Guideline of the Potential Tree Species Used for Promoting under Clean Development Mechanism by Faculty of Forestry (1997). Reviewing more recent research in regards to large areas and tree samples showed that the average annual biomass increment decreased. Therefore, the EFs used in this study were lower than those used in the previous report. For 5B Forest and Grassland Conversion, the aboveground biomass by forest type before conversion, carbon fraction of dry matter by forest type were obtained from local publications. Fractions of biomass burned on-site and off-site by forest type and fraction of biomass left to decay by forest type were country-specific data, which was obtained from the literature review and expert judgment. For 5C Abandonment of Managed Lands, the supporting data for estimating Tier 2 EFs were the annual rates of aboveground biomass growth for land abandoned in the last twenty years and land abandoned between 20 and 100 years ago classified by forest type. These were country-specific data derived from the literature reviews and expert judgment considered Tier 2.

Greenhouse Gas Emissions

The LULUCF sector in Thailand showed a trend of increased net removal, due to the fact that total removal exceeded the total emissions. Since 2000, LULUCF activities contributed to the net removal from the atmosphere. In 2005, when rubber plantations were included in the calculation, the results showed a tremendous increase of CO_2 removal. In 2013, the LULUCF sector contributed to the net removal of 86,101.84 $GgCO_2eq$ (a six-fold increase compared with 2000). Details of GHG emissions in the LULUCF Sector by gas type and source in 2013 are presented in Table 2-11 and Figure 2-7.

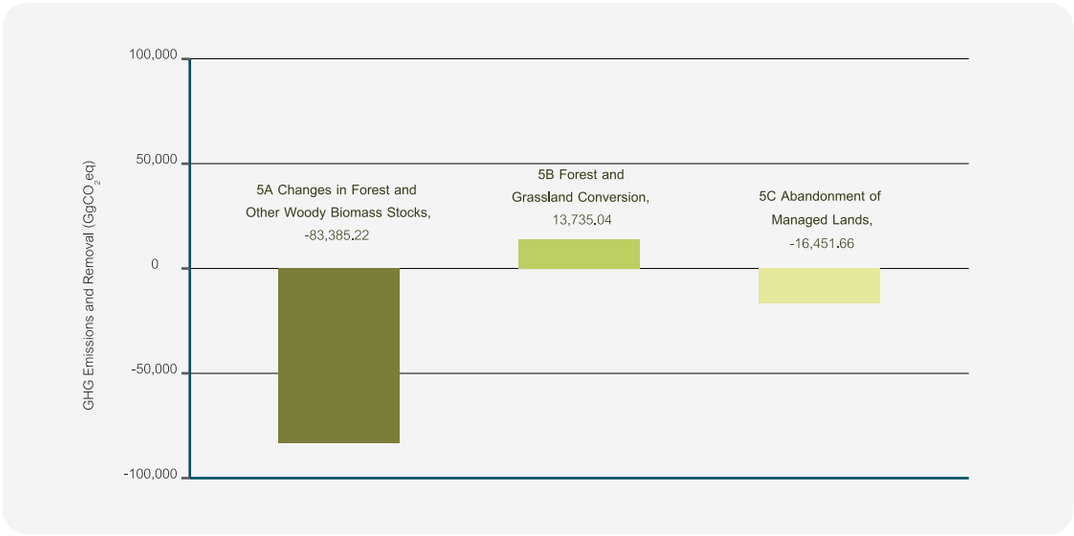


Figure 2-7: GHG emissions relative to the land use, land-use change, and forestry sector, 2013

Table 2-11 GHG emissions from the various sources relative to total GHG emissions related to the in Land Use, Land-Use Change and Forestry sector: 2013

Greenhouse gas source and sink categories	CO_2 emissions	CO_2 removals	Net	CH_4		N_2O		NO_x	CO	NMVOCs	SO_2	Total
Unit	$GgCO_2eq$	$GgCO_2eq$	$GgCO_2eq$	Gg	$GgCO_2eq$	Gg	$GgCO_2eq$	Gg	Gg	Gg	Gg	$GgCO_2eq$
5. Land Use, Land-Use Change and Forestry	**44,147.17**	**-130,653.91**	**-86,506.74**	**17.51**	**367.61**	**0.12**	**37.29**	**4.35**	**153.17**	**NO**	**NO**	**-86,101.84**
5A Changes in Forest and Other Woody Biomass Stocks	30,817.03	-114,202.25	-83,385.22	NO	NO	NO	NO	NO	NO	NO	NO	-83,385.22
5B Forest and Grassland Conversion	13,330.14		13,330.14	17.51	367.61	0.12	37.29	4.35	153.17	NO	NO	13,735.04
5C Abandonment of Managed Lands	NO	-16,451.66	-16,451.66	NO	NO	NO	NO	NO	NO	NO	NO	-16,451.66
5D Change in Soil Carbon	NE	NE	NE	NO	NO	NO	NO	NO	NO	NO	NO	NE

Notes: NE = Not Estimated , NO = Not Occurring

2.3.5 Waste

Methodology

Methodological approaches for estimating greenhouse gas emission in waste sector followed the Revised 1996 IPCC Guidelines for National GHG Inventories (IPCC, 2007) and were supported by the 2000 IPCC Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories (IPCC, 2000). Tier 1 and Tier 2 methods were applied depending on the availability of data. Estimating CH_4 emissions from 6A Solid Waste Disposal on Land used the first order decay (FOD) model with Tier 2 level as described in the 2000 IPCC Good Practice Guidance (GPG). Emission factors used in this report were a mix of default emission factors presented in the IPCC guidelines and country-specific emission factors. Methane generation potential (L_o) and degradable organic carbon (DOC) were derived from municipal solid waste (MSW) composition which was country specific data. Methane generation rate constant (k), methane correction factor (MCF), fraction DOC dissimilated (DOC_F), fraction by volume of CH_4 in landfill gas (F), and oxidation factor corresponded to the recommended values from the 2000 IPCC Good Practice Guidance and the 2006 IPCC Guidelines. GHG emissions including CO_2 and N_2O from 6C Waste Incineration, however, were estimated by Tier 1 method presented in the 2000 IPCC GPG. Activity data used in estimation of GHG from waste incineration consisted of the amount of incinerated waste, fraction of carbon content in waste, and fraction of fossil carbon in waste. Waste types considered in this report included MSW, clinical waste, and industrial waste. The amount of MSW and clinical waste incinerated were reported by the Pollution Control Department (PCD), while industrial waste was provided by the Department of Industrial Works (DIW). It was noted that the GHG emissions from some MSW incineration facilities, where energy was recovered, were accounted for the energy sector. Emission factors for waste incineration used the default values presented in the 2000 IPCC GPG and the 2006 IPCC guidelines.

Greenhouse Gas Emissions

Most of the total GHG emissions in the waste sector were estimated from wastewater treatment which accounted for 6,375.94 $GgCO_2eq$ or 53.90% and the emissions from solid waste disposal on land were 5,346.02 $GgCO_2eq$ or 45.19%, including from waste incineration were 107.61 $GgCO_2eq$, which was the least proportion, accounting for 0.91% of the total GHG emissions in this sector. Details of the GHG emissions in waste sector by gas type and source in 2013 are presented in Table 2-12 and Figure 2-8.

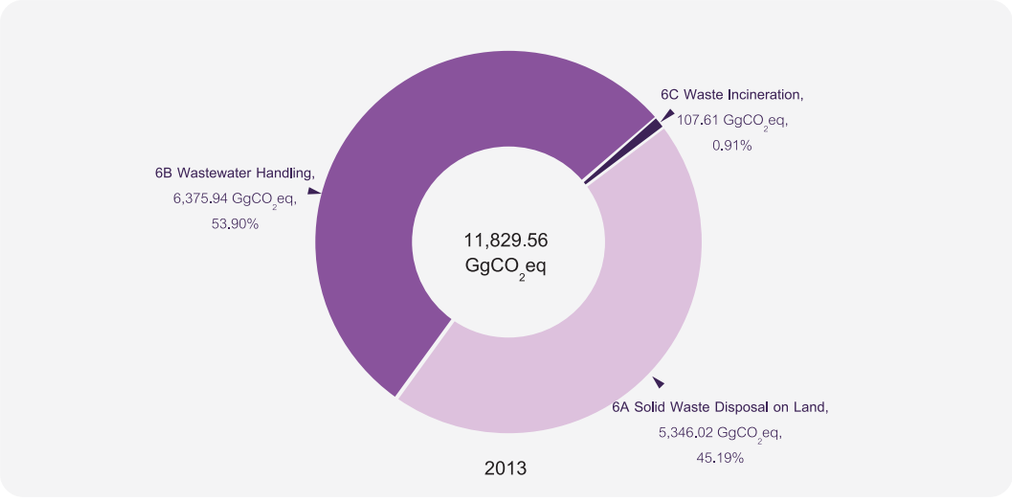


Figure 2-8: GHG emissions in the waste sector, 2013

Table 2-12 GHG emissions from various sources in relation to total GHG emissions in the waste sector: 2013

Greenhouse gas source and sink categories	CO_2 emissions	CH_4		N_2O		NO_x	CO	NMVOCs	SO_2	Total
Unit	$GgCO_2eq$	Gg	$GgCO_2eq$	Gg	$GgCO_2eq$	Gg	Gg	Gg	Gg	$GgCO2_eq$
6. Waste	104.27	509.23	10,693.85	3.33	1,031.44	NO/NA	NO/NA	NA	NA	11,829.56
6A Solid Waste Disposal on Land		254.57	5,346.02				NA	NA		5,346.02
6A1 Landfill Site		206.26	4,331.52				NA	NA		
6A2 Open Dump		48.31	1,014.50				NA	NA		
6B Wastewater Handling		254.66	5,347.83	3.32	1,028.10	NO	NO	NA		6,375.94
6B1 Industrial Wastewater		142.48	2,992.04			NO	NO	NA		
6B2 Domestic Wastewater		112.18	2,355.79	3.32	1,028.10	NO	NO	NA		
6C Waste Incineration	104.27	NA	NA	0.01	3.34	NA	NA	NA	NA	107.61

Note: NA = Not Applicable , NO = Not Occurring

2.4 CONSTRAINTS, GAPS, AND NEEDS IN THE NATIONAL INVENTORY

As a developing country, Thailand has limitations, barriers, and constraints that affect the quality of its GHG inventory estimation and compilation. Improvements in the national statistics and reporting of activity data by the relevant agencies could improve the inventory quality. The country aims to improve inventory quality in terms of transparency, accuracy, completeness, consistency, and comparability. Thailand should, in particular, improve its inventory quality regarding two issues, activity data and emission factors. For example:

- Data collection on fuels used by end-users and technologies in the energy industries category should be improved to estimate emissions using Tier 2 or Tier 3 levels.
- Activity data on bio-fuel consumption should be improved and collected accurately by relevant agencies.
- Country-specific emission factors should be developed and introduced for the main fuels used in each country, including bio-fuels.
- Approaches need to be developed to collect activity data up to Tier 3 for manufacturing and construction categories for the benefit of both inventory quality and transparency in mitigation.
- Gradual transition to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories in all sectors while enhancing the professional capacities of national experts involved in the inventory process. A transition from default EFs and Tier 1 methodologies to country-specific emission factors and Tier 2 and 3 methodologies is needed with particular focus on key categories.

The national inventory in the energy sector has improved due to the support from both bilateral and international organizations, such as:

- In terms of GHG inventory improvement, the Department of the Environment and Energy Australia has supported the development of Thailand Greenhouse Gas emissions Inventory System (TGEIS), which will improve the management of Thailand's GHG inventory system in the near future;
- In the transport category, the Ministry of Transport, via the Department of Land Transport Thailand, is developing an approach to collect data on vehicle characteristics such as mileage, vehicle kilometer traveled (VKT), and fuel economy; and
- In the transport category, 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.

Regarding improvements in the industrial processes sector:

- An advanced technique to obtain activity and emission data is required to fill an information gap. A methodology is needed to obtain both activity and emission data in a higher tier by means of measurement or modeling. GHG estimation could improve to meet the IPCC 2006 version, if this need was fulfilled.
- For the calculation of uncertainty, the default values for each subcategory were adopted. If a system for collection of activity data were developed, the uncertainty data calculation might be made more appropriate.
- Promoting an understanding among industrial owners and other stakeholders regarding the significance of GHG estimation is the highest priority for supporting a new data collection,

Regarding improvements in the agricultural sector:

- Routine, more accurate GHG estimations, and goals to adopt the higher IPCC methodologies in the agriculture sector are required for 1) improving systematic data collection, 2) better understanding in the IPCC Guidelines for relevant government agencies, 3) developing country-specific emission factors in some sub-sectors, and 4) improving the QA/QC procedure and uncertainty analysis. Hence, more research investigations and capacity are of importance for the relevant agencies for technical trainings of systematic data collection and IPCC methodology for GHG estimation. Together these techniques will fill the data gaps.

In the land use, land-use change, and forestry (LULUCF) sector:

- Steps are needed regarding activity data related to areas in the LULUCF sector involving multiple departments (i.e., Royal Forest Department and Forest Industry Organization) that report activity data in different formats that are not comparable.
- There is also a gap between public and private data. For instance, activity data on area planted and wood harvested by the private sector are not reported elsewhere. Thus, an approach must be developed for the private sector to report essential activity data.
- A change is needed in how forest areas are classified into forest types. This will provide a more accurate GHG estimation.
- Due to limitation of information, some emission factors are adopted from IPCC defaults (i.e., biomass after land conversion, trace gases emission ratio, and uncertainty estimation). Thus, it is suggested that a new process for the development of country-specific values should be established for the LULUCF sector.
- Development of an MRV system for the LULUCF sector is needed.

Regarding improvement in the waste sector:

- Technical issues need to be addressed. For example, 1) the development of MRV systems for solid waste disposal on land, waste composition, wastewater handling (including domestic and industrial wastewater), estimation of carbon fraction and fossil fraction in incinerated waste; and 2) development of country-specific emission factors in the waste sector.
- Some crosscutting issues need to be addressed. For instance, 1) archiving procedures and plans; 2) procedures for documentation of inventory data at the national level; 3) the development and implementation of a QA/QC system; and 4) a process for assessing uncertainty.

Chapter 3:

MITIGATION MEASURES

CHAPTER 3:
MITIGATION MEASURES

Thailand has made significant efforts as a signatory party to implement the UNFCCC. Thailand has actively participated in the Clean Development Mechanism (CDM) after its ratification of the Kyoto Protocol in August 2002 and entry into force in February 2005. In COP20, Thailand pledged its first Nationally Appropriate Mitigation Action (NAMA) to the UNFCCC. Thailand's NAMA represents an opportunity for sustainable development, as well as, mitigation through domestic support for the development of GHG mitigation actions from 2010 to 2020.

Since the submission of the NAMA pledge in 2014 and the submission of its first Biennial Update Report in 2015 to the UNFCCC, several climate change mitigation policies and measures have been put in place at the national level to fulfill Thailand's drive toward a low carbon and resilient society. This was stated in the 12th National Economic and Social Development Plan (NESDP), 2017- 2021. The NESDP supports Thailand's NAMA and strives to reduce GHGs by 7% to 20% by 2020. The target of 7% in 2020 will be achieved by using domestic resources. The 20% GHG mitigation level by 2020 is subject to sufficient international support under the UNFCCC.

Thailand also ratified the Paris Agreement in September 2016 which entered into force in November 2016. The outcomes of COP21 and Thailand's Intended Nationally Determined Contribution (INDC) have accelerated Thailand's domestic structure to focus on the NDC Roadmap 2030. Thailand's INDC aims to reduce emission levels by 20 to 25% over the BAU level. The 25% reduction in GHG emissions is subject to sufficient technological development and transfer, financial resources and capacity building. The contributions to the economy will be nation-wide. The domestic MRVs were developed and approved by Thailand's NCCC to track the annual GHG reduction towards the 2020 target. In May 2017, Thailand's government approved the NDC Roadmap 2030. It envisages mitigation in all sectors, with the primary reductions implemented in the energy, industrial processes and waste sectors (Table 3-1). The related ministries were involved and created the targets for 2030.

Table 3-1 Summary information on Thailand's NDC mitigation measures

Sector	Measure	Description
Energy and transport		Thailand's NDC Roadmap on Mitigation 2021-2030 was formulated based on the following plans already approved or in the pipeline for approval by the Cabinet. The example are as follows: • National Economic and Social Development Plans • Climate Change Marter Plan B.E.2558-2593 (2015-2050) • Power Development Plan B.E.2558-2579 (2015-2036) • Thailand Smart Grid Development Master Plan B.E. 2558-2579 (2015-2036) • Energy Efficiency Plan B.E.2558-2579 (2015-2036) • Alternative Energy Development Plan B.E.2558-2579 (2015-2036) • Master Plan for Sustainable Transport System and Mitigation of Climate Change Impacts • National Industrial Development Master Plan B.E.2555-2574 (2012-2031) • National Waste Management Master Plan B.E. 2559-2564 (2016-2021) • Thailand Transport System Development Strategy 20 years B.E 2560-2579 (2017-2036) • Environmental Quality Management Plan B.E. 2560-2564 (2017-2021)
• Power generation	• Energy efficiency improvement • Substitution of RE	
• Manufacturing industry	• Energy efficiency improvement • Substitution of RE	
• Transportation	• Energy efficiency improvement • Substitution of RE	
• Buildings	• Energy efficiency improvement	
• Residential	• Energy efficiency improvement • Substitution of RE	
IPPU		
• Cement industry	• Substitution of clinker substance	
• Consumption of Halocarbons and Sulphur Hexafluoride	• Substitution of refrigerant substance	
Waste		
• Waste	• Waste management	
• Wastewater	• Methane recovery from industrial wastewater • Clean technology • Municipal wastewater management	

Source: Thailand's Nationally Determined Contribution Roadmap on Mitigation 2021-2030, 2017

3.1 MITIGATION POLICIES

Thailand has put effort in creating greenhouse gas mitigation policies through both top-down and bottom-up approaches at the national, sectoral, and municipality levels.

3.1.1 National Plans

The following are the national plans related to climate change in Thailand.

- **The 20-Year National Strategy framework (2017-2036)**

  The 20-Year National Strategy was put into effect during the 5-year National Economic and Social Development Plan. It commenced with the 12th Plan, which will drive Thailand's development towards security, prosperity, and sustainability. The target of the 20-year National Strategy and indicators will abide by the internationally accepted 2030 Sustainable Development Goals (SDG). The 5-year duration of the 12th National Economic and Social

Development Plan (12th NESDP) will continue to focus on the Philosophy of Sufficiency Economy as mentioned in the 11th National Economic and Social Development Plan. This is comprised of the three principles of moderation, reasonableness, and self-immunity. The related strategies in this plan, include the strengthening of Thailand's economy on a sustainable basis, which involves green growth, development of science, technology, research, and innovation, and international cooperation for development. These strategies will support the GHG emission reduction.

- **Thailand's Climate Change Master Plan (2012–2050)**

  This framework of integrated policies and action plans relates to climate change. The principles of the Master Plan are as follows. (1) Thailand places great emphasis on preparedness, solutions, coping, and adaptation to impacts of climate change, especially for the sectors that are highly at risk and exposed to biological, physical, social, and economical and livelihood vulnerabilities, such as small-scale agriculture and traditional fishing. (2) Thailand has voluntarily taken part in reducing the greenhouse gases with common, but differentiated responsibilities in operations according to the UNFCCC's principles. (3) Thailand uses the effects of climate change as an opportunity to support and sustainably develop the country according to the concept of sufficiency.

3.1.2 Sectoral Mitigation Plans

There are several sectoral plans related to climate change mitigation in Thailand in the energy, transport, industrial and waste sectors.

3.1.2.1 Energy Sector

- **The Energy Efficiency Plan 2015 (EEP2015) (2015 - 2036)**

  This plan was formulated with a target of 30% energy intensity reduction by 2036. The EEP is projected to conserve 51,700 ktoe by the end of the plan. The sectors with priority to undertake this energy conservation are the transportation sector (30,213 ktoe), the industry sector (14,515 ktoe), as well as, commercial buildings and government buildings (4,819 ktoe), and residences (2,153 ktoe). Table 3-2 presents the main features of the energy saving actions across the economic sectors of EEP2015.

Table 3-2 Efficiency Plan during 2015-2036 and the 20-year target (EEP2015)

Unit: ktoe

Mitigation \ Economic Sector	Industry	Commercial Building/ Government Building	Residence	Transportation	Total
A. FinalEnergyDemandin2036(NormalCase)					**187,142**
B. Result of Implemented Energy Efficiency so that EI in 2013 decreased, and energy can be saved					**4,442**
C. EnergyEfficiencyTargetasperEEPduring2015-2036	14,515	4,819	2,153	30,213	**51,700**
1) Enforcement of Energy Efficiency Standard in Buildings	4,388	768	-	-	**5,156**
2) Enforcement of Energy Efficiency Standard for New Buildings Construction	-	1,166	-	-	**1,166**
3) Determination of Energy Efficiency Standard and Labeling for Equipment and Material	749	1,648	1,753	-	**4,149**
4) Enforcement of Energy Efficiency Regulation for Energy Producer and Seller	202	184	114	-	**500**
5) Energy Efficiency Supporting / Contribution	8,895	629	-	-	**9,524**
6) LED Use Promotion for Energy Efficiency	281	424	286	-	**991**
7) Energy Efficiency for Transportation	-	-	-	30,213	**30,213**
8) Research and Development for Energy Efficiency Technology and Innovation	-	-	-	-	-
9) Development of Energy Efficiency's Personnel	-	-	-	-	-
10) Energy Efficiency Encouragement Campaign	-	-	-	-	-
D. Total Energy Demand Reduction (B+C)					**56,142**
E. Energy Demand in 2036 (A-D), in case EE 2015					**131,000**
F. % Energy Demand Reduction					**30**

Source: Energy Efficiency Plan B.E. 2558-2579 (2015-2036), Ministry of Energy

- **The Alternative Energy Development Plan 2015 (AEDP2015) (2015 - 2036)**

  Renewable energy has been promoted to address global warming and climate change issues. Therefore, the Thai government has been making an effort to push forward the AEDP2015 in order to become a low-carbon country. To attract renewable electricity investors, the Adder System was used to encourage renewable power generation, while Feed-in Tariff (FIT) was implemented in order to reflect the real cost of renewable power generation. In the AEDP2015, the renewable energy promotion schemes were designed to strengthen the community, lessen the dependence on fossil fuels, and address social problems such as municipal solid waste and agricultural waste. Therefore, the AEDP2015 intended to encourage waste, biomass, and biogas power generation as the top priority. The main target of the AEDP2015 is to increase the portion of renewable power generation from 8% in 2014 to 20% of the total power requirement in 2036. This accounts for 19,684.4 MW as shown in Table 3-3.

Table 3-3 Estimated installed capacity of renewable electricity in the AEDP2015

Unit: MW

Year	Solar	Wind	Hydro*	Waste	Biomass	Biogas	Energy crops	Total
2014	1,298.5	224.5	3,048.4	65.7	2,451.8	311.5	-	**7,400.4**
2036	6,000.0	3,002.0	3,282.4	550.0	5,570.0	600.0	680.0	**19,864.4**

* Including small and large Hydro power

Source: AEDP2015

- **The Power Development Plan 2015 (PDP2015)**

  This is a long-term (15-20 years) electricity generation plan. The PDP2015 was formulated in line with the Energy Efficiency Plan 2015 (EEP2015) and the Alternative Energy Development Plan 2015 (AEDP2015). The themes of the PDP2015 emphasize improving power systems reliability by reducing dependence on natural gas power generation, increasing the share of coal power generation via clean coal technology, importing power from neighboring countries, and developing renewable energy. The three frameworks used in developing PDP2015 were 1) Energy Security: dealing with an increase in power demand taking into account fuel diversification to lessen the dependency of one particular fuel; 2) Economy: maintaining an appropriate cost of power generation and implementing energy efficiency; and 3) Ecology: reducing environmental and social impacts by lessening carbon dioxide intensity of power generation. Table 3-4 shows decreased fossil requirements and increased renewable energy for electricity generation in PDP2015.

Table 3-4 Estimated fuel requirements in PDP2015

Fuel	Percentage in 2014	Percentage in 2026	Percentage in 2036
Imported hydro power	7	10-15	15-20
Clean coal including lignite	20	20-25	20-25
Renewable energy including hydro	8	10-20	15-20
Natural gas	64	45-50	30-40
Other	1	-	0-5

Source: PDP2015

3.1.2.1 Energy Sector

- **Thailand's Transport Infrastructure Development Plan (2015-2022)**

  In 2015, the Thai Government approved Thailand's Transport Infrastructure Development Plan (2015-2022). This plan aims to improve economic security, increase economic competitiveness, increase capacity building, promote life quality and equity, market green growth, and increase good governance. The concepts used in developing this plan included Green Transportation, Transport Efficiency, and Inclusive Transport. The transport strategic plan included Integrated Transport Systems, Transport Services, Regulations and Institution, Human Resource Development, and Innovation & Technology Strategies. In 2030, it is estimated that GHG reduction in the transport sector will be about 36.3% of Thailand's NDC Roadmap.

3.1.2.3 Industrial Sector

- **The Fourth National Strategic Plan on Chemical Management (2012-2021)**

  This plan was launched with the goal that "Within 2021 social and environment is safe by effective management of chemicals in accordance with national development and participation from all sectors." This goal is in line with the goal of the Strategic Approach to International Chemicals Management (SAICM). There are 3 strategies and 9 sub-strategies. One of these strategies is related to the GHG reduction by Developing "chemical databases, mechanisms and tools for fully integrated system of chemical management."

- **Eco-Industrial Strategy**

  The Ministry of Industry developed eco-industrial towns for Thailand's industries to enable them to move toward green manufacturing. This strategic plan focuses on "Green Growth" and development of environmental-friendly industries. In this regard, the Department of Industrial Works has launched a project to set up an Eco Town Center to coordinate and follow up on operations concerning eco-industries. The development of the eco-industrial towns is based on five development dimensions: physical, economic, environmental, social, and management factors.

3.1.2.4 Waste Sector

- **Waste Management Roadmap**

  Although greenhouse gas (GHG) emissions from waste sector are a small contributor (about 4%) to Thailand's total anthropogenic GHG emissions, mitigation of GHG emissions provide public health, environmental protection, and sustainable developments. According to the national GHG inventory, methane gas (CH_4) from landfills and wastewater collectively accounted for about 90% of the total GHG emitted from the waste sector emissions in 2013. Wastewater, N_2O, and CO_2 from the incineration of waste containing fossil carbon are minor sources. Mitigation options for reduction of GHGs in the waste sector, therefore, focus on CH_4 reduction from solid waste management and wastewater handling. Table 3-5 presents possible measures that will be implemented in order to reduce GHG emissions from the waste sector.

Table 3-5 Proposed measures in waste management in Thailand

Waste management	Wastewater handling
• Source separation system • Waste reuse and recovery • Composting of organic waste • Refuse derived fuel (RDF) • Landfill gas recovery • Waste-to-energy facilities • Thermal treatment facilities	• Wastewater reduction by cleaner technology • Methane recovery from wastewater treatment plants • Upgrading of wastewater treatment facilities -

3.1.3 Municipality plans

- **Bangkok Climate Change Master Plan (2013–2023)**

  The plan aims at reducing GHG or being a low carbon city. The Master Plan includes both mitigation and adaptation measures, as well as, networking to all stakeholders. It consists of 5 areas: (a) sustainable and environmental friendly public transport, including bicycle lanes; (b) energy and water efficiency in buildings, including promoting renewable energy; (c) improvements in waste-water treatment systems, especially waste from communities; (d) green urban planning; and (e) adaptation plans from disasters such as inundation, drought, coastal erosion, and intrusion of saltwater.

- **Low Carbon Municipality**

  The National Municipal League of Thailand has promoted the Promotion of Low Carbon Cities across municipalities via the project supported by the EU. This project has stimulated other municipalities to voluntarily follow this program (http://www.lcm.in.th/home.php). There are 4 campaigns: city of trees, city of waste minimization, city of energy efficiency, and city of sustainable consumption.

3.2 MITIGATION MEASURES

In the mitigation framework, the GHG emission sectors and gases were selected. The IPCC sectors were chosen along with the economic sectors. Since Thailand is a non-Annex I country in terms of national GHG reports, Thailand employed the revised 1996 IPCC guideline for both NCs and BURs. Therefore, CO_2, CH_4 and N_2O were included in the mitigation measures. For the GHG mitigation outcomes, the baseline scenario target was chosen. The target years of 2020 and 2030 were chosen for the NAMA framework and 2030 for the INDC roadmap.

3.2.1 NAMAs roadmap

Thailand's NAMAs aims at voluntarily reducing greenhouse gas emissions in the energy and transportation sectors by 7% by 2020 from the Business as Usual (BAU) levels. With sufficient international support, Thailand's NAMAs aims to lower the carbon trajectory up to 20% below the BAU level by 2020. The key mitigation actions committed and implemented in the Thailand's NAMA roadmap include:

- Development of renewable energy and alternative energy sources;
- Energy efficiency improvements in power generation, industries, buildings, and transportation;
- Substitution of bio-fuels for fossil fuels in the transport sector; and
- Thailand's Transport Infrastructure Development Plan.

3.2.2 Thailand's NDC

Thailand submitted its INDC and relevant information to the UNFCCC in 2015 to restate that GHG emissions can be reduced by 20% from the BAU levels by 2030, and up to 25% if the required support is received from international organizations. In addition to this progress, the NCCC established the Subcommittee on Climate Change Policy and Planning Integration, which is tasked with preparing and proposing mitigation mechanisms and measures that encompass the legal, economic, fiscal and social instruments that are required to translate the measures into the policies, strategies, and work plans to meet the medium-term and long-term mitigation targets. Since the submission of its first Biennial Update Report and ratification of the Paris Agreement in 2015, several climate change mitigation policies and measures have been put in place at the national level to fulfill Thailand's drive toward a low carbon and resilient society. In 2017, Thailand launched its NDC Roadmap to reduce 115.6 $MtCO_2eq$, which will account for a 20.8% reduction by 2030 when compared to the BAU level.

As mentioned, both Thailand's NAMAs and Thailand's NDC were developed on the basis of BAU (Figure 3-1). The BAU scenario was created by using the Asia-Pacific Integrated Assessment Model (AIM). The AIM model was developed in collaboration between the National Institute for Environmental Studies (NIES) Japan, Kyoto University, the Mizuho Information & Research Institute, and other Asian researchers including Thailand. The AIM model focuses on relevant policies to support low-carbon pathways.

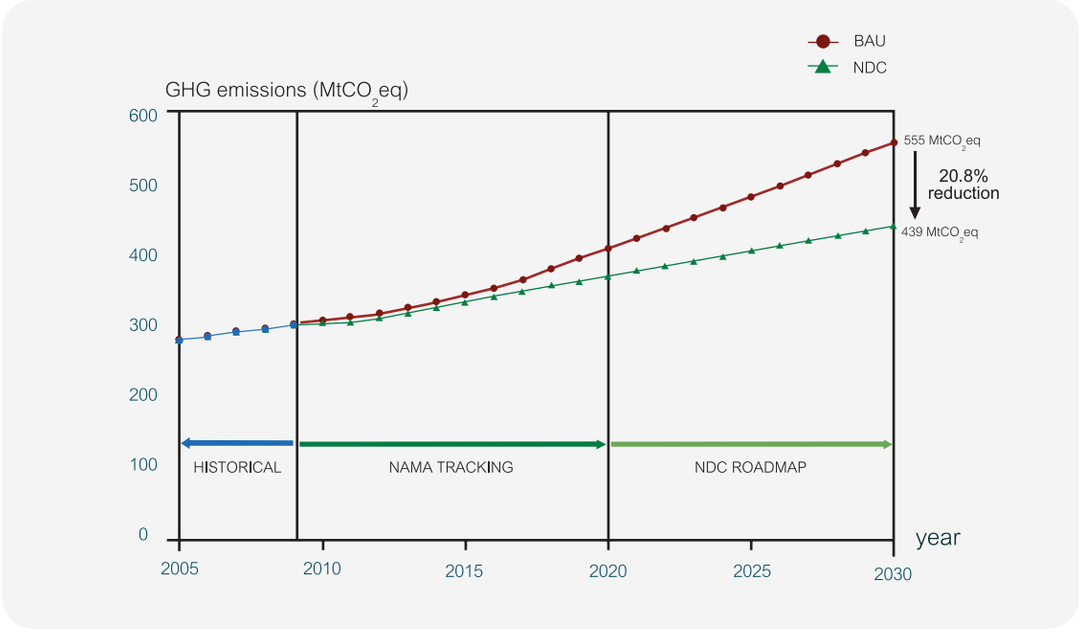


Figure 3-1: Thailand's GHG mitigation: NAMA 2020 and NDC 2030

In Thailand's NAMA roadmap and Thailand's NDC roadmap, the AIM/Enduse is used to quantify climate change assessment and relevant policies to mitigate GHG emissions. The AIM/Enduse model is the recursive dynamic model, a partial equilibrium, which can simulate policy countermeasures for near-term and long-term mitigation actions to examine the effect of energy savings and GHG emission abatement. Thailand's NAMA roadmap and Thailand's NDC roadmap were modeled in a bottom-up approach with detailed-technology information. The technological selection was based on optimization framework, which minimized the total system cost subject to various constraints (e.g. the availability of biomass used in biomass power generation, and satisfying the end-user demand within the economic sectors). In the model, CH_4 and N_2O are converted into CO_2-equivalent emissions by global warming potential (GWP) provided by the IPCC. As a result, in the BAU the economy-wide GHG emissions (excluding LULUCF) will be 555 $MtCO_2eq$ in 2030. Thailand's NDC Roadmap intends to reduce its greenhouse gas emissions by 20.8% from the projected BAU level by 2030, equivalent to 115.6 $MtCO_2eq$. The NDC roadmap identified GHG mitigation targets of 113.0 $MtCO_2eq$ (20.4%) in the energy and transport sector, 0.6 $MtCO_2eq$ (0.1%) in the industrial process sectors, and 2.0 $MtCO_2eq$ (0.3%) in the waste sector when compared to the BAU level in 2030.

3.2.3 Measures in Energy and Transport Sectors under Thailand's NDC Roadmap 2030

A number of mitigation measures are addressing emissions in the Thailand's NDC roadmap 2030, such as the energy efficiency suit of programs which contributes to improve energy efficiency across Thailand (including the energy efficiency improvement for power generation, the energy efficiency for manufacturing industries, and the energy efficiency for building and households), renewable energy, and transportation infrastructure development. The emission reduction in the energy and transport sectors of Thailand's NDC roadmap will contribute about 113 MtCO2eq by 2030, which accounts for a 20.4% emission reduction when compared to the BAU level. (Table 3-6).

Table 3-6 Mitigation measures in Thailand's NDC Roadmap in 2030

Sector	Measures	Description	GHG Reductions ($MtCO_2eq$)
Power generation	• Energy efficiency improvement • Substitution of RE	Thailand's NDC was formulated based on the following plans already approved of in the pipeline for approval by the Cabinet: - National Economic and Social Development Plans - Climate Change Master Plan B.E. 2558-2593 (2015-2050) - Thailand Power Development Plan B.E. 2558-2579 (2015-2036) - Thailand Smart Grid Development Master Plan B.E. 2558-2579 (2015-2579) - Thailand Energy Efficiency Plan B.E. 2558- 2579 (2015-2036) - Alternative Energy Development Plan B.E. 2558-2579 (2015-2036) - EnvironmentallySustainableTransport System Plan B.E. 2556-2573 (2013-2031) - National Industrial Development Master Plan B.E. 2555-2574 (2012-2031) - Waste Management Roadmap	24.0
Manufacturing industry	• Energy efficiency improvement • Substitution of RE		43.0
Transportation	• Energy efficiency improvement • Substitution of RE		41.0
Buildings	• Energy efficiency improvement		1.0
Residential	• Energy efficiency improvement • Substitution of RE		4.0
Total			113.0

Source: Thailand's National Determined Contribution Roadmap on Mitigation 2021-2030, 2017

3.2.4 Measures in Industrial Processes Sector under Thailand's NDC Roadmap 2030

The mitigation measures in industrial processes sector will be composed of substitution of raw materials in cement production which contributes about 0.3 $MtCO_2eq$, and natural refrigerants replacement which contributes about 0.3 $MtCO_2eq$. These measures account for 0.1% emission reduction when compared to the BAU level in 2030.

3.2.5 Measures in Waste Sector under Thailand's NDC Roadmap 2030

The potential of waste sector in contributing to the mitigation measures under the NDC roadmap is up to 2.0 $MtCO_2eq$ (0.3% emission reduction from BAU level in 2030). The mitigation measures under waste and wastewater management will be composed of 3R (Reduce, Reuse and Recycle) campaign, methane recovery from industrial wastewater treatment, improvement of municipal wastewater treatment, and clean technology promotion.

3.2.6 Other Mitigation Measures beyond Thailand's NAMA and NDC Roadmap

3.2.6.1 Agriculture

GHG mitigation in the agriculture sector can be done by (1) mitigating GHG emissions from livestock or croplands, and (2) enhancing carbon sequestration in plants and soil. Agricultural GHG emissions can also be mitigated by increasing production efficiency, which results in lower emission intensity. Mitigation options should be developed alongside other co-benefits, including climate change adaptation, farmer's economics, quality of life and the environment.

The agriculture sector involves the majority of Thai people. Therefore, the economics and mitigation potential in this sector is highly variable. Hence, in this report, agricultural GHG mitigation focused on the existing activities related to GHG mitigations from the relevant government agencies in particular Thailand's Ministry of Agriculture and Cooperatives. In addition, the targets from the 20-Year Agriculture and Cooperatives Strategy (2017-2036) and the 12th National Economic and Social Development Plan 2017-2021 (NESDP) were also considered in this report. Due to the sustainable development goals, most of the gathered GHG mitigations from governmental agencies were concurrent with the agencies' missions, policies and activities. Based on extensive reviews, 8 mitigation measures were grouped and classified into subcategories in this sector. Detailed information is as follows.

- **Improving animal breeding and feed quality to enhance production efficiency**

  Improvement of animal breeding and feeds are two important goals of the Department of Livestock (DLD) in Thailand. Increasing production efficiency of livestock would mitigate enteric CH_4 emission, and subsequently, reduce emission intensity. For several decades, the DLD has improved cattle breeds for higher productivity. Improving animal feed aims to reduce time of feed in the rumen and increases the feed conversion rate. The DLD has improved feed quality for livestock based on research, and then promotes it to farmers.

- **Promoting biogas production from animal waste**

  In Thailand, the Energy Policy and Planning Office (EPPO), Ministry of Energy and the DLD, Ministry of Agriculture and Cooperatives promote biogas production from animal waste. The DLD has promoted the implementation of biogas systems for swine farms on 70 farms between 2014 and 2016, and plan to expand to 170 farms between 2017-2022. From 2008 to 2012, the EPPO promoted biogas systems for treating animal waste for 819 farms and slaughters (802 farms for swine). By 2036, the 20-Year Agriculture and Cooperatives Strategy's goal is to promote wastewater treatment systems in livestock farms to an additional 500 farms, and promote biogas system to 250 cattle farms.

- **Alternative wetting and drying in paddy of rice fields**

  Water management is an efficient CH_4 mitigation for paddy rice fields. Alternative wetting and drying (AWD) is a win-win option for mitigating CH_4 emission, saving water, and potentially increasing crop yields in paddy rice fields. The Rice Department (RD) has investigated the effectiveness of AWD on CH_4 reduction in rice fields (more than 20% reduction of CH_4 emission and water usage). A pilot study on the implementation of AWD was conducted in the irrigated rice fields in the cooperation between the departments in the Ministry of Agriculture and Cooperatives (e.g., the RD and Royal Irrigation Department). Adopting AWD should be of concern to an increased N_2O emission.

- **Improving production efficiency by rice variety and agricultural zoning/Agri-Map**

  The mission of the RD is to increase rice productivity by improving rice variety and agricultural practices and management. The RD has long been investigating new rice varieties that produce higher yields and greater resistance to pest. The higher rice yields lead to the reduction of CH_4 emission intensity. During 2012-2016, the goals of the RD were to develop at least 10 new rice varieties that produce higher yields of at least 10%, and have greater resistance to insects. Growing the right crops in the right places is the concept of agricultural zoning with the objectives of reducing the cultivation area of low crop productivity and increasing crop yield per area for several economic crops, in particular of rice. The Land Development Department (LDD) aims to reduce low productivity of rice cultivation by 91,200 ha by 2021. The 20-Year Agriculture and Cooperatives Strategy targets the land conversion from low or not suitable croplands (S3 or N) to highly suitable cropland (S1) by using Agri-Map for an area of 0.96 million ha by 2036. The DOA also promotes replacing second rice with other field crops to reduce areas of rice cultivation in dry season, and consequently, leading to reduced CH_4 emissions. Converting areas from low rice production to other croplands may reduce CH_4 emission, but there should be concerns of an increased N_2O emission.

- **Improving fertilizer application according to Good Agricultural Practices and site-specific nutrient management**

  In Thailand, Good Agricultural Practices (GAPs) and site-specific nutrient management (SSNM) have been extensively promoted by the relevant government agencies and adopted by farmers. LDD develops the "Onfarm" program of SSNM. In 2016, LDD investigated SSNM for 6 economic crops (rice, maize, sugarcane, cassava, oil palm and para-rubber tree). The RD had a target to certify GAP for 320,000 ha of rice by 2016. The Department of Agriculture (DOA) promoted GAP for crop production with a target of 94,369 farms and 81,233 ha in 2015-2016. Large-scale farming has been promoted by several agencies in the Ministry of Agriculture and Cooperatives. The intention of large-scale farming is to increase crop productivity and to reduce production costs, including reducing the use of chemical fertilizer in croplands. In 2016, large-scale farming was on 600 farms covering an area of 244,800 ha, while 96,253 farmers participated. In the 20-Year Agriculture and Cooperatives Strategy, 14.4 million ha of agricultural land will adopt large-scale farming by 2036. In 2015-2016, the DOA studied the application of fertilizer based on SSNM for maize, which revealed the CO_2 reduction, by 50% of kg CO_2 per unit. In 2015, DOA developed an automatic fertilizer mixer using soil analysis for sugarcane with a reduction of fertilizer application by 3.2-4.8 kg per ha.

- **No or avoid burning of crop residues in the field**

  Stopping or avoiding crop-burning has been encouraged by Thailand's relevant government agencies. The Department of Agricultural Extension (DOAE) promotes the project of "No burning in croplands" nation-wide, with more emphasis on the Northern part of Thailand. In 2016, the DOAE educated 26,930 farmers with the best option for crop residue management to avoid burning crop residue, including monitored and prevented croplands from being burned on 77,210 ha. Based on the 2016 data from the Geo-Informatics and Space Technology Development Agency (GISTDA), the DOAE reported a 14% decrease in the number of hotspots in croplands in 2015. This led to the reduction of crop residue burning areas from 292,887 ha in 2015 to 49,272 ha in 2016, accounting for an 83% reduction. The LDD also promoted no burning of 4,456 ha croplands until 2016 and aimed to expand to an area of 856 ha in 2017. The DOA developed machines for cutting, chopping and incorporating sugarcane leaves and residues, leading to the reduction

of sugarcane residue burning fields by 160,000 ha (data from January 2017). In the 20-Year Agriculture and Cooperatives Strategy, about 78,600 farmers will be promoted to avoid burning crop residues by 2036.

- **Promoting utilization of crop residue for alternative energy purposes**

  The utilization of crop residue for alternative energy purposes has been investigated by the relevant agencies (e.g., the Department of Alternative Energy Development and Efficiency). To solve haze pollution in the northern part of Thailand, the Pollution Control Department and several agencies in the Ministry of Agriculture and Cooperatives promoted the use of crop residue for energy production with a target of 30% of crop residue in Chiang Mai in 2016.

- **Enhancing carbon sequestration in tree and soil**

  The LDD has developed microbial activator, called "LDD" microorganisms, to accelerate the decomposition of organic materials. In 2017, LDD aimed to promote the use of "LDD" microorganisms, green manure and compost for an area of 160,000 ha and 700,000 participating farmers. In addition, to increase the use of crop residue to reduce the use of synthetic fertilizers, the application of bio-extract in croplands was promoted by LDD for an area of 28,800 ha in 2016 and was targeted for 16,000 ha in 2017. The DOA, as the Ministry's responsible agency for promoting organic farming, the LDD and RD aim to promote organic farming through several projects. For example, launching 25 aerobic composting plants with a production capacity of 120 tons per plant (DOA), establishing organic fertilizer plants for 500 plants per year (LDD), and promoting organic rice fields (RD). To stop field burning in the northern part of Thailand, in 2016, the DOAE supported organic fertilizers of 76,678 tons for farmers, covering an area of 17,443 ha. The LDD also supported green manure and compost of 5,110 tons in 2017. After more than 20 years of studies, the DOA revealed that planting legumes as intercrops with several major upland crops enhanced soil carbon sequestration. The LDD enhanced the planting of vetiver grass to conserve soil and water, and consequently, leading to enhance soil carbon sequestration in croplands. Up to 2016, vetiver grass was planted on roughly 2 million ha with a target of 88,000 additional ha in 2017. Fast-growing trees were also promoted by the LDD on an area of 29,790 ha. The LDD's target in 2017 was about 1,712 ha. Incorporating crop residue in the field was promoted by the LDD to 2,531 farms covering an area of 7,299 ha until 2016. According to the 20-Year Agriculture and Cooperatives Strategy, conserving and restoring agricultural lands will be implemented with a target of 2 million ha and sustainable agricultural lands will be promoted to 1.6 million ha in 2036.

3.2.6.2 Land used, Land-used Change and Forestry

According to national GHG inventory, LULUCF sector is sink of GHG in Thailand and showed increasing trends. GHG removal from forest plantations exceeded GHG emissions from deforestation and wood harvested. LULUCF sector is therefore not the target in the Intended Nationally Determined Contribution (INDC) commitment. Mitigation approaches in the LULUCF sector are suggested to assist the reduction of GHG, within the framework of sustainable forest management.

- **Reducing emission from deforestation**

Forest conversion is generally associated with carbon emission. In Thailand, conversion of forests into agricultural land and other uses have reduced the total forest cover significantly in the last 50 years. The current forest area was estimated at 16 million hectares, which accounted for 31.6%. Deforestation used to be the major source of GHG emission in the LULUCF sector in 1990 (the first inventory report) with decreasing trends due to decreasing rate of deforestation. The Thailand National Forest Policy has set targets of total forest area to be 40% of the land area, of which 25% serves as conservation forest and 15% is retain as production forest. Reducing deforestation not only benefits GHG emissions, but also leads to water and soil conservation, coastal erosion protection, as well as, increasing biodiversity. Therefore, reducing deforestation is considered to be positive to sustainable development and a high priority mitigation option. REDD+ is an international mitigation measure to reduce greenhouse gas emissions from deforestation and forest degradation, and foster conservation, sustainable management of forests, and enhancement of forest carbon stocks. Thailand has been actively participating in the REDD+ readiness preparation program supported by the Forest Carbon Partnership Facility (FCPF). The program was granted in 2016 and has begun implementation. Policy related to REDD+ implementation was also acknowledged in the 11th National Economic and Social Development Plan (2012-2016). Reducing emissions from deforestation is considered to be a cost-effective mitigation measure, but there is no single cost-value for the REDD+ supply. Deerai (2011) estimated total costs for REDD+ implementation in Thailand including operating costs, transaction costs and opportunity costs. The results showed that the total costs in reducing emission by forest protection equivalent was 8.44 US$/t$CO_2$. The Department of National Parks, Wildlife and Plant Conservation is the key organization implementing REDD+. The four-year action plan (2012-2015) included several programs that support REDD+ measures. For example, the Forest Conservation Program in the Yom - Nan Watershed which covers 1.74 million hectares, and the Sustainable Forest and Wildlife Resources Conservation, Protection and Rehabilitation Program, with the participation of all sectors, covers an area of 12 million hectares. All these activities are in accordance with the Strategic Plan of the Ministry of Natural Resources and Environment (2013–2018) which aimed to stop deforestation, rehabilitate degraded forest and increase forest area to be more than 17 million hectares in 2016.

- **Afforestation/ Reforestation (A/R)**

Establishing new forest plantations are one of the simplest methods to mitigate emissions. This is done by generating new carbon stocks. Expanding forest plantations may affect agricultural land, as well as, communities' traditional way of living. Decreasing biodiversity is referred as another disadvantage of reforestation. Therefore, A/R for GHG emission must be implemented with special attention. Indirect benefits to the environment must be considered. The agroforestry system is another alternative to extenuate afforestation/ reforestation disadvantages. Agroforestry provides economic, social and environment benefits to local communities. Planted trees can store carbon while farmers can benefit from intercrops. A/R under clean development mechanism aims to enhance CO_2 removal from the atmosphere. There was no A/R project activity developed in Thailand. This is probably due to the difficulty and complexity of methodologies and procedures. To promote domestic A/R projects, the Thailand Greenhouse Gas Management Organization (Public Organization) has developed a scheme on a voluntary basis (T-VER) in line with clean development mechanisms. Moreover, the Strategic Plan of the Ministry of Natural Resources and Environment (2013–2018) indicated that A/R was the Flagship Project and forest area must

increase 0.5 million hectares by 2018. Cost estimates for A/R projects varied among regions. The cost is in the range of 0.5 USD to 7 USD/tCO_2 for A/R projects in developing countries, compared to 1.4 USD to 22 USD/tCO_2 for A/R projects in industrialized countries (Nabuurs, 2007). The cost of A/R projects for GHG reduction has not been studied in Thailand. However, it is comparable to the cost for the establishment of teak plantations reported by FIO (2014). For 30-year rotations, the cost of teak plantations is 2,842.85 USD/ha, with the ability to sequester carbon of 322.5 tCO_2/ha (Faculty of Forestry, 2011). The value of the carbon of teak plantations is equivalent to 8.81 USD/tCO_2 which is higher than that of developing countries, and similar to the cost for REDD+ projects.

- Improved forest management

Improved forest management can enhance mitigation options in the LULUCF sector. Various forest management activities can be changed to increase carbon stocks and/or reduce GHG emissions. Improved forest management includes the enhancement site preparation, planting, thinning, fire protection, pest and diseases prevention, as well as, harvesting. Activities related to forest management can be categorized into two groups: natural forest management and plantation management. Since logging from natural forests is prohibited in Thailand, activities related to forest management in natural forests are less of an issue. Improved forest management is mainly concentrated under plantations.

Rotation management

Typically, trees are harvested at the economic or optimal rotation age. Extending the age at which the trees are cut increases the average carbon stock on the land, in addition to, the value of timber. Large logs generally have higher prices than small logs. There is no fixed period of years over which the extension should occur, but generally the longer the period (on average 5-20 years), the more carbon stock increases. However, demand of wood and the economic returns often drive the growers to cut down trees instead of extending the rotation cycle. The government may have to provide incentives for growers to keep their trees, such as tree bank projects. Extending wood products' life cycle can also decrease wood consumption, and thus, extend rotation cycles. This is how the Forest Industry Organization (FIO) operates today.

Conversion of low productive forests to productive forest

This is one way to increase carbon stored in an area. To increase the forest productivity, several activities can be done such as introducing other tree species with higher timber value or improving varieties with high growth rate, mitigating disturbing events (forest fire, pest and diseases), adopting enriched planting to increase the density of trees, as well as, using other forest management techniques (weeding and fertilization). In Thailand, activities under the Golden Jubilee Forest Restoration Project are categorized as converting low productive forests to productive forests.

Increase urban green area

Urban areas are low carbon stock land. Attempts are currently being made to promote tree planting and increase urban green space to improve the urban environment. The World Health Organization has recommended the minimum green space per capita to be 9 m^2 (Deloya, 1993). Urban areas that can be considered to increase carbon stock include public parks, roadsides, riversides, vacant spaces, government offices and temples. Strategies to promote tree planting in home garden should also be considered. Intensive urban tree care will extend trees life cycle reduce GHG emission from death.

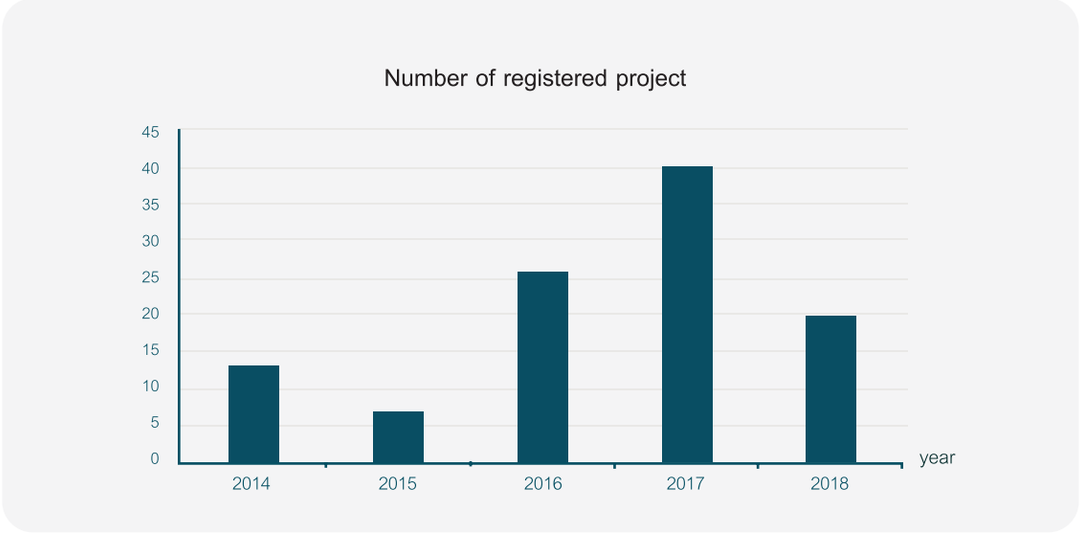
- **Promoting wood products utilization**

  Wood products are an important part of the carbon cycle. They play an important role in the carbon reservoir. Wood can be used as a direct source of energy, such as fuel wood and charcoal, as well as substitution energy, such as bio-energy. Wood products contribute to GHG emissions when decomposed or burned. However, carbon can remain stored for the entire lifetime of products. It is the continuation of carbon storage after harvesting. IPCC (2006) recognized harvested wood products as one carbon pool in the GHG inventory. Care must be taken when promoting the use of other wood substitution materials instead of wood. This is because the production of wood substitution materials generally produces more GHG emissions than wood. Moreover, wood is a renewable natural resource. Trees regrow after harvest.

3.2.6.3 Voluntary Action to Achieve Thailand's Mitigation Target

- **Thailand Voluntary Emission Reduction Program**

  Thailand Greenhouse Gas Management Organization (Public Organization) (TGO) has developed Thailand Voluntary Emission Reduction Program or T-VER to promote participation for domestic voluntary GHG mitigation in Thailand. As of 30 June 2018, 106 projects have been registered as T-VER projects with TGO (Figure 3-2). The expected GHG emission reductions are 2,892,692 tCO_2eq per year. Thailand Verified Emission Reductions (TVERs) have been issued to 60 projects with a capacity to reduce 1,909,220 tCO_2eq.



Source: Thailand Greenhouse Gas Management Organization (public organization)

Figure 3-2: Number of T-VER project registered with TGO

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

  TGO developed the GHG mitigation scheme via a social incentive in order to promote and support the government sector, private sector, and people to mitigate GHG. LESS's project development is to raise awareness of the GHG mitigation using an evaluation of GHG reduction via analysis and technical methods. In addition, it integrates a "Support approach", which the supporter, meaning the private sector or the business, gives both knowledge and funds for the GHG mitigation to social or community recipients. The Letter of Recognition (LoR) has been issued to the GHG mitigation by oneself, supporter for GHG mitigation, and recipient for GHG mitigation support.

- **Carbon Footprint Reduction Label**

  To promote and support activities related to climate change mitigation, TGO has initiated and implemented the "Carbon Footprint Reduction (CFR)" or "Global Warming Reduction" label for products as innovative solutions to mitigate GHG emissions in Thailand. The CFR label aims to encourage Thai manufacturers to participate in climate change mitigation by reducing GHG emissions throughout the life cycle of their products. A CFR label assessment is based on the concept of a product's life cycle. This includes, but not limit to, raw material acquisition, transportation and distribution, production, usage and end of life disposal. To further the process of obtaining a 'CFR' label, these stages of the products' lifecycle are accounted and compared with their base year Carbon Footprint and present year Carbon Footprint. On doing so, TGO will be able to determine and evaluate the amount of GHG emissions reduction against its requirements. As of June 2017, 254 products from 52 companies have been approved to use the CFR label, including ceramic tiles, wall and floor tiles, dish cleaner, textiles, cement, cooking oil, drinking water, beverage and others, with a total emission reduction capacity of 1,549,812 tCO_2eq/year.

- **Partnership for Market Readiness (PMR)**

  The Partnership for Market Readiness (PMR) is a forum for collective innovation and funding to support countries to prepare and implement carbon-pricing instruments, in order to scale-up mitigation efforts. Thailand PMR comprises of 3 technical components including:

  1. Preparation of key market components of Energy Performance Certificate scheme (EPC)

  2. Development of Local Greenhouse Gas Abatement Plans and a study on pricing mechanism for Low Carbon City (LCC) program

  3. Policy recommendation on legal framework to establish the Emission Trading Scheme (ETS)

- **Achieving Low Carbon Growth in Cities through Sustainable Urban Systems Management in Thailand**

  From 2017 to 2021, this project aims at promoting sustainable low carbon development in 4 pilot cities. These cities include Nakhon Ratchasima Municipality, Khon Kaen Municipality, Koh Samui Municipality and Chiang Mai Municipality. This will be accomplished through capacity enhancement, as well as, the integrated framework at the local level while being supported and funded by Global Environment Facility (GEF) and TGO.

- **Capacity Development on Climate Change Mitigation/Adaptation in the Southeast Asia Region (2013–2016)**

  The Japan International Cooperation Agency (JICA) and TGO supported this project. There are two main activities of this project were training programs and establishing a climate change network.

1. Training programs that were implemented;

Domestic courses;

- Climate Change Management and Sustainable Development

International courses;

- Greenhouse Gas Inventory
- Climate Change Management and Sustainable Development
- Mitigation Mechanism
- Climate Finance

2. A climate change network was established by organizing an annual conference in order to share the latest trends of international and regional climate issues, with special focus on capacity building. This was a key driving force to accelerate climate actions throughout the region.

- **Project for Capacity Development to accelerate Low Carbon and Resilient Society realization in the Southeast Asia Region (2017-2020)**

  The Japan International Cooperation Agency (JICA) & TGO supported this project. The Project consists of 3 elements;

  1. Developing training programs for specific target groups (i.e. Mitigation Mechanism/MRV training program and Climate Finance training program).

  2. Establishing a network of academia and technical experts at the regional level with international organization (ASEAN Secretariat, UNFCCC and GCF).

  3. Enhancing knowledge related to climate change for stakeholders (government, private sector, eucation, public and journalists) in Thailand and ASEAN members.

- **The GREEN and CLEAN Hospitals in Thailand**

  The GREEN and CLEAN Hospitals project was implemented nationwide in 2010, with an objective to promote healthy hospital environments and reduce greenhouse gas emissions from hospitals through an economy approach and sustainable sanitation. Presently, more than 4,500 hospitals and sub-district health promoting hospitals are implementing this initiative, with more than 190 hospitals becoming GREEN and CLEAN models hospitals. These models have completed all the recommended activities including recorded carbon footprints for evaluating the effectiveness of their activities.

  The G-R-E-E-N activities cover five areas: G stands for Garbage reduction and management, R for Restroom improvement and management, E for optimizing use of Energy, E for Environmental protection, and N for Nutrition from locally grown food produced by community.

  The C-L-E-A-N strategies include C for Communication: raising awareness and responsibility for the actions to health professions and nearby communities, L for Leader: plays active roles in practicing reduction of greenhouse gases, E for Effectiveness: implementing program activities which were recommended as good models and practices by the Carbon Footprint, A for Activity: creating various activities for sharing experiences in order to reduce greenhouse gases emissions, N for Networking: collaborating to reduce global warming and extend activities to other sectors.

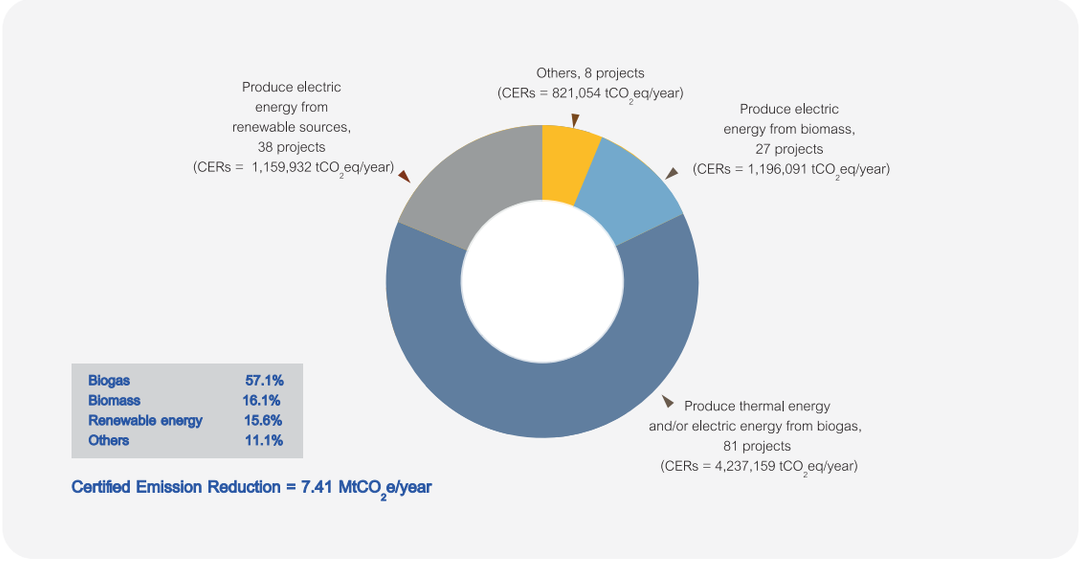
  This initiative raises concern and awareness of climate change among health workers. We also gain knowledge and “know-how” in reducing greenhouse gases among health personnel, as well

as, budget saving from alternate energy sources and waste reduction. This project has spillover effect on awareness to the communities for sustainability to create healthy environments.

3.2.7 Kyoto Protocol Implementation

Clean Development Mechanism

Clean Development Mechanism (CDM) has contributed to GHG mitigation, following Thailand's ratification of Kyoto Protocol. TGO acts as Designated National Authorities (DNA) for CDM projects. As of 1 June 2018, Thailand had approved Letter of Approval (LoA) for 219 projects with the capacity to reduce GHG emissions of 12.09 $MtCO_2eq$/year. At present, 154 projects with a CO_2 reduction capacity of about 7.41 Mt/year have been registered with the CDM Executive Board. Of these, about 57% are biogas projects and 16% are biomass projects (Figure 3-3). Certified Emission Reductions (CERs) have been issued to 65 CDM projects with a capacity to reduce 13.35 $MtCO_2eq$.



Source: Thailand Greenhouse Gas Management Organization (public organization)

Figure 3-3: CDM projects registered with the CDM Executive Board, by type

3.3 THAILAND'S NAMAs IMPLEMENTATION

3.3.1 The Progress toward NAMAs Roadmap

Details of progress toward NAMAs roadmap and current achievements for the energy sector and transport sector are already presented in Thailand's Second Biennial Update Report. In summary, the domestic Measurement, Reporting and Verification (MRV) scheme presented the achievement of GHG reductions of 14.34 $MtCO_2eq$ in 2013, 37.47 $MtCO_2eq$ in 2014, and 40.14 $MtCO_2eq$ in 2015.

3.3.2 Information on Domestic MRV

To monitor the implementation progress of the NAMA Roadmap, Thailand has developed a domestic MRV system for the sectors. Included in the NAMA Roadmap, as mentioned in the first BUR, currently Thailand has improved its domestic MRV system as the revised structure in the Figure 3-4.

- Measuring activity data is carried out according to specific GHG emission reduction methodology by responsible installations (e.g., power plants and liquid fuel production plants);
- Reporting of the activity data by responsible installations to corresponding authorities (e.g., Energy Regulatory Commission, Department of Energy Business, and EGAT); and
- Verification by the authorized agencies such as the Department of Alternative Energy Development and Efficiency.

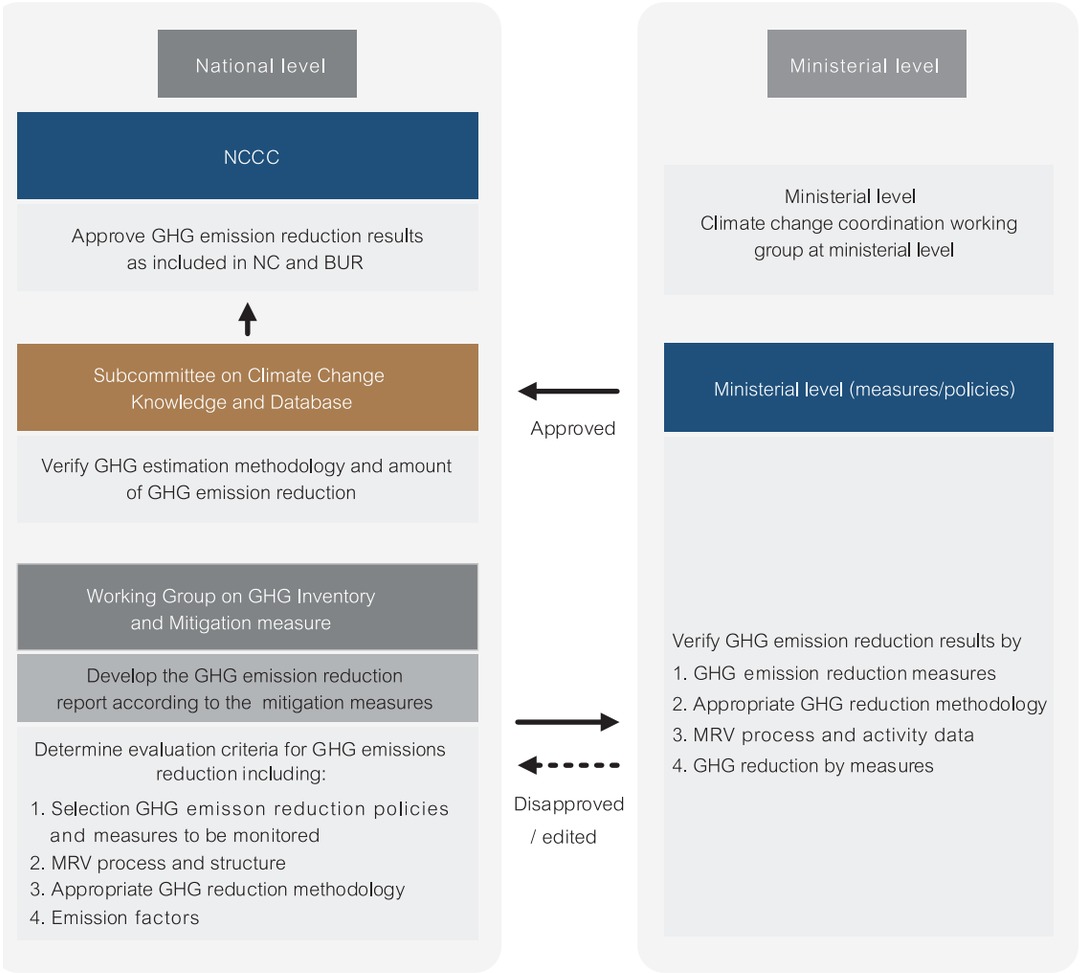


Figure 3-4: The revised structure of the domestic MRV system

Chapter 4:

VULNERABILITY AND ADAPTATION

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VULNERABILITY AND ADAPTATION

4.1 CONCEPTUAL FRAMEWORK

4.1.1 Introduction

After reviewing documents related to vulnerability and adaptation in Thailand, this chapter aimed to present the work on the climate change projections used for impact assessment, vulnerability assessment results in each sector under the climate change impact, risk assessment results with examples of adaptation to respond to future uncertainty, and the status of adaptation related activities in the country. A scenario approach is used to assess future uncertainty from both climate change and socio-economic development. The study area covers Thailand and the analysis is until 2030. The four main sectors that are based on Thailand's Climate Change Master Plan include water resources, agriculture, human security, and health. Risk assessment and management were reviewed to present the future risk in which Thailand needs to mitigate and adapt.

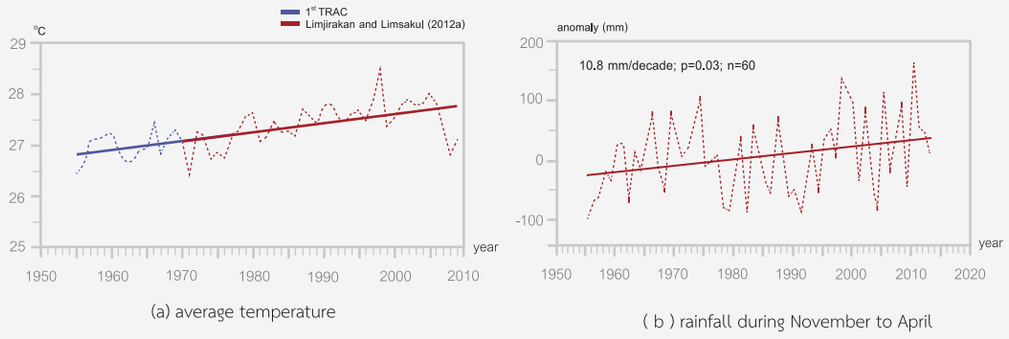
4.1.2 Climate Change Scenarios

4.1.2.1 Climate Change in the Past

Surface observation-based evidence of climate change in Thailand was reported in Thailand's Second Assessment Report on Climate Change 2016 (2nd TARC) (TRF, 2016). There was significant progress in the study and analysis of near surface temperature in Thailand, mainly based on the observed data from the Thai Meteorological Department. The confidence level of change in near surface temperature in Thailand is high. The studies after the 1st TARC showed a consistent trend of increasing temperature in Thailand for the period of 1970 – 2009. The maximum, minimum and average temperatures increased 0.96, 0.92, and 1.04 ^{o}C, respectively. The time series of Thailand's average temperature is shown in Figure 4-1(a). The results showed consistent trend between studies during the 1st TARC and Limjirakan and Limsakul (2012), even though the time period and the number of stations used were different. However, the rising trend in temperature could be a result from the increased greenhouse gas emission or local factors that are not related to climate, such as an urban heat island. This requires further studies to confirm the results.

The 2nd TARC reports that there is no significant long-term change in the annual rainfall in Thailand. However short-term variation is correlated with the El Niño–Southern Oscillation (ENSO) and the Pacific Decadal Oscillation (PDO), which contributes to changes in annual rainfall. The study showed that the accumulated rainfall during the southeast monsoon (May to October) did not show significant change in long term. The accumulated rainfall during November to April over Thailand did show significant change especially in the East-Coast Gulf. The accumulated rainfall during November to April increased 10.8 mm/decade or 64.8 mm over the past 60 years (1955 – 2014) as shown in Figure 4-1(b). The study also showed that to study long term change of the annual rainfall in Thailand, which is located in a tropical zone, the analysis should be carried out based on the hydrological

regime and season. In addition, understanding the causes and trends of rainfall change on a local scale is very important for adaptation and needs further studies.



Source: (a) 2nd TARC, (b) Limsakul and Singhruck (2016)

Figure 4-1: Past trends of the average temperature and change of rainfall during November to April in Thailand

4.1.2.2 Climate Change in the Future

To assess vulnerability to climate change, climate change projections are required along with socio-economic scenarios. The three General Circulation Models (GCMs) under Coupled Model Intercomparison Project Phase 5 (CMIP5) were selected base on the smallest bias in relation to the Thailand's observed rainfall data. The three RCPs (RCP2.6, RCP4.5, and RCP8.5) were selected from three GCMs, IPSL-CM5A-MR, GFDL-CM3 and MRI-CGCM3, which represent uncertainty in climate modeling and scenarios (Ruangrassamee et al., 2015). The outputs from GCMs need to be downscaled before assessing the vulnerability. There are several studies regarding climate model. Chinvanno and Snidvongs (2005) used PRECIS (Providing Regional Climate for Impact Studies) to downscale outputs from ECHAM5 (CMIP3) under SRES A2 and B2. The recent work by Santisirisomboon et al. (2015) used the dynamic downscaling to downscale MPI-ESM-MR and EC-Earth (CMIP5) with RegCM4 in the Southeast Asia Coordinated Regional Climate Downscaling Experiment (CORDEX-SEA) domain under RCP4.5 and RCP8.5. This on-going work is in cooperation between five countries under the Southeast Asia Regional Climate Downscaling (SEACLID)/CORDEX Southeast Asia Project.

In this report, the climate projections were obtained from the statistical downscaling and bias correction of the three GCMs IPSL-CM5A-MR, GFDL-CM3 and MRI-CGCM3 (CMIP5), since the downscaling products from SEACLID were not completely available. The daily precipitation, maximum temperature, and minimum temperature in Thailand from the three GCMs were statistically downscaled and bias corrected using the method proposed by Watanabe et al. (2014) during the two future periods , 2016 – 2045 and 2071 – 2100. They represent medium and long-term projections under the three RCPs. The results showed that the maximum temperature in Thailand is projected to increase around 0.9 – 1.8 °C, 1.3 – 2.3 °C, and 2.0 – 3.1 °C under RCP2.6, RCP4.5, and RCP8.5, respectively, as shown in Figure 4-2. The minimum temperature in Thailand is projected to increase around 1.2 – 2.2 °C, 1.6 – 2.4 °C, and 2.2 – 3.4 °C under RCP2.6, RCP4.5, and RCP8.5, respectively, as shown in Figure 4-3.

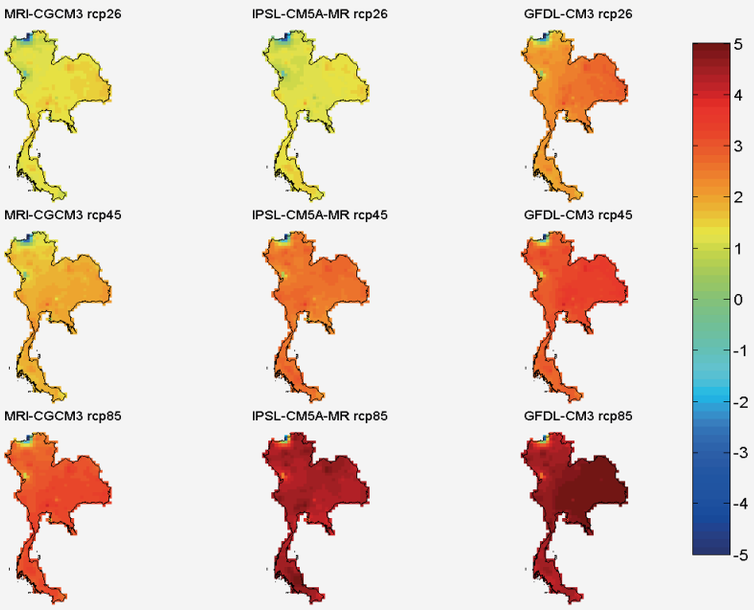


Figure 4-2: Changes in daily maximum temperature in 2071-2100 from the referenced period 1976-2005

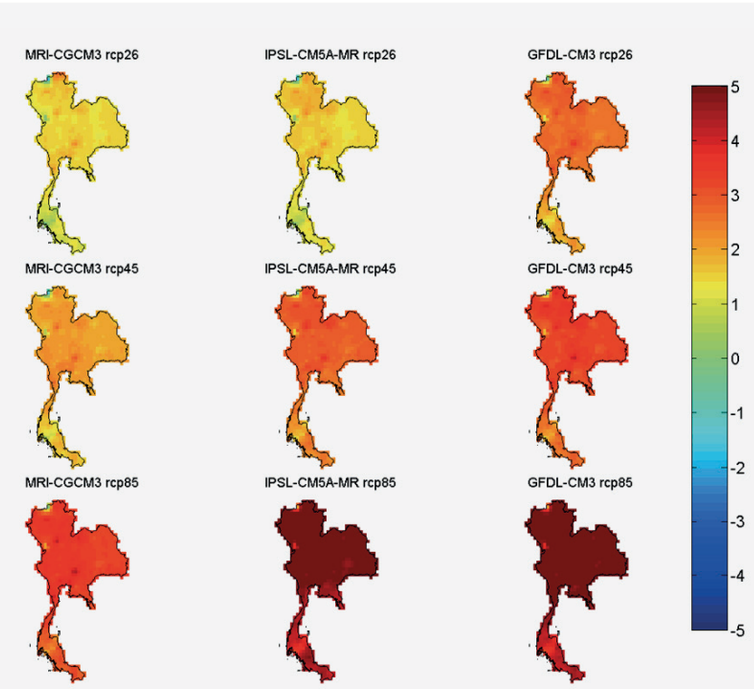


Figure 4-3: Changes in daily minimum temperature in 2071-2100 from the referenced period 1976-2005

The change in the annual precipitation from the three GCMs in certain regions is different as shown in Figure 4-4. Overall, the projected annual precipitation showed decreasing trends for both time periods. The decrease in annual precipitation ranges between 66 – 193, 46 – 229, and 19 – 191 mm/year under RCP2.6, RCP4.5, and RCP8.5.

For changes in extreme weather, the downscaled and bias corrected results from the three GCMs showed that on average, the number of days with the maximum temperature greater than 40 °C is projected to increase in the lower part of Northern Thailand and the upper part of Central Thailand. The number of days with the minimum temperature lower than 25 °C is projected to decrease significantly under RCP8.5 for the period of 2071-2100. The consecutive dry days in Northern, Western, and Northeastern Thailand is projected to be around 100 days. The consecutive wet days in Northern, Central, Western, and Northeastern Thailand is projected to be 10-20 days, while it is projected to be 30-40 days for Eastern and Southern Thailand. The number of days with daily rainfall greater than 35 mm is projected to be 15-20 days for Eastern and Southwestern Thailand. The number of days with daily rainfall greater than 90 mm is projected to be 3-5 days for Eastern and Southern Thailand.

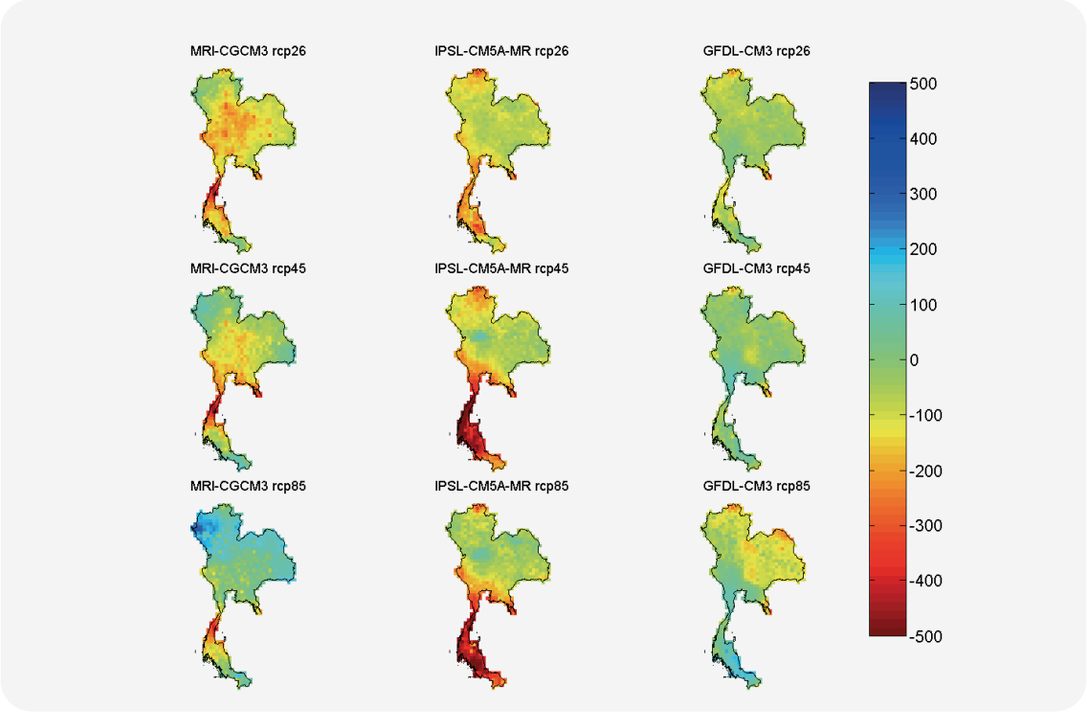


Figure 4-4: Changes in annual precipitation in 2071-2100 from the referenced period 1976-2005

4.1.3 Baseline Socio-Economic Scenarios

4.1.3.1 Socio-economic Development from the Past

Based on information from the Office of the National Economic and Social Development Board (NESDB), Thailand has experienced three major economic crises in its modern history:

(1) the Asian Financial Crisis in 1997; (2) the Subprime Mortgage Crisis in 2009; and (3) the Thailand Flood in 2011. The third crisis was a flood, which is one of the climate-related disasters that affects all economic sectors.

The impacts of climate change on future socio-economic development, and how to mitigate or adapt with that uncertainty in order to minimize negative effects, are important for decision makers. In the future, climate change may produce more severe flooding, which causes greater damage to the national account. To answer these questions, however, the direction of Thailand's future socio-economic development is analyzed via a scenario approach.

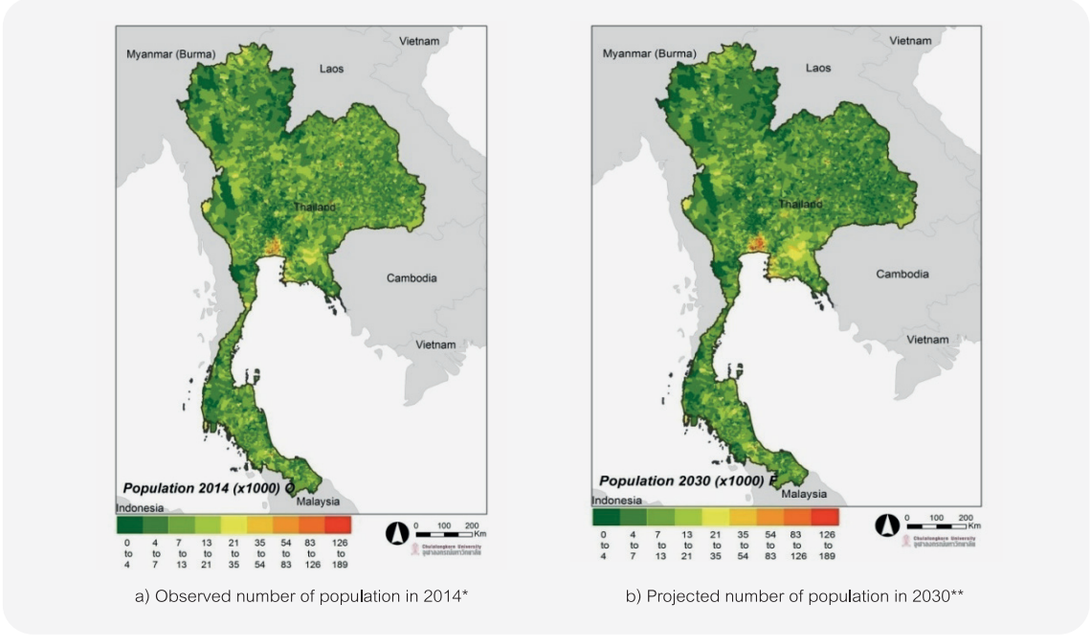
4.1.3.2 Socio-economic Development in the Future

The drivers that develop uncertainty of socio-economic developments in the future were analyzed from both international and national strategies. For international issues, Sustainable Development Goals (SDGs) and Water-Energy-Food NEXUS were the key drivers. In Thailand, the 20-year National Strategy, linked with the 12th National Economic and Social Development Plan (NESDP), Thailand 4.0 policy, and Thailand's Eastern Economic Corridor (EEC) were considered the key driving forces. Those strategies caused increased risk in development under future climate change impacts. For example, if a specific area is developed in a high climate change impact zone, such as of flooding or drought, the risk of socio-economic damages in that area is much higher.

All strategies showed that Thailand's government has made an effort to develop infrastructure, such as energy, water, and transportation. This development is the main factor in increasing competitiveness of economic development and upgrading the quality of life of Thai citizens. The "Philosophy of Stability, Prosperity and Sustainability" is adopted as the guideline for future socio-economic development in Thailand. This concentrates security before prosperity, long-term sustainability before short-term popularity under social, economic, natural resources and environment aspects with spatial aspect, the development of communities, areas and regions. The brief results are summarized as follows.

a) Social Issues

The social issues are analyzed via the number and distribution of Thailand's population in the future. The results presented that the country's maximum population will be approximately 66.4 million in 2025 (Figure 4-5).



a) Observed number of population in 2014*

b) Projected number of population in 2030**

Source: *Department of Provincial Administration, **Office of the National Economic and Social Development Board

Figure 4-5: Change of population in each sub-district level of Thailand

After 2025, Thailand's population will decrease but the urbanization rate will increase. This is because Thai people have longer life expectancies with low rates of birth. Thailand's population structure is changing towards an ageing society, which will affect provisions of social services in all aspects. For social aspects, Thailand will face more of rural-urban transformation that occurs with the urbanization process. Each group in urban-rural areas and an aging society should be carefully considered with climate change vulnerability and adaptation.

b) Economic Issues

NESDB concluded past and present situations, including trends on national development, that "the Thai economic has gradually continuously grown until presently. Thailand is grouped in the medium-level countries in terms of income earners and could position itself possessing the important role in international trade in the fierce competition in the world scenario". Based on the Philosophy of Stability, Prosperity and Sustainability, escaping from the middle-income trap is one of the main targets. Innovation is defined to ensure sustainable long-term economic growth. Figure 4-6 shows GDP per capita in each scenario. The main difference between these scenarios is labor-intensive products in the 1st scenario and high technology in the 2nd scenario.

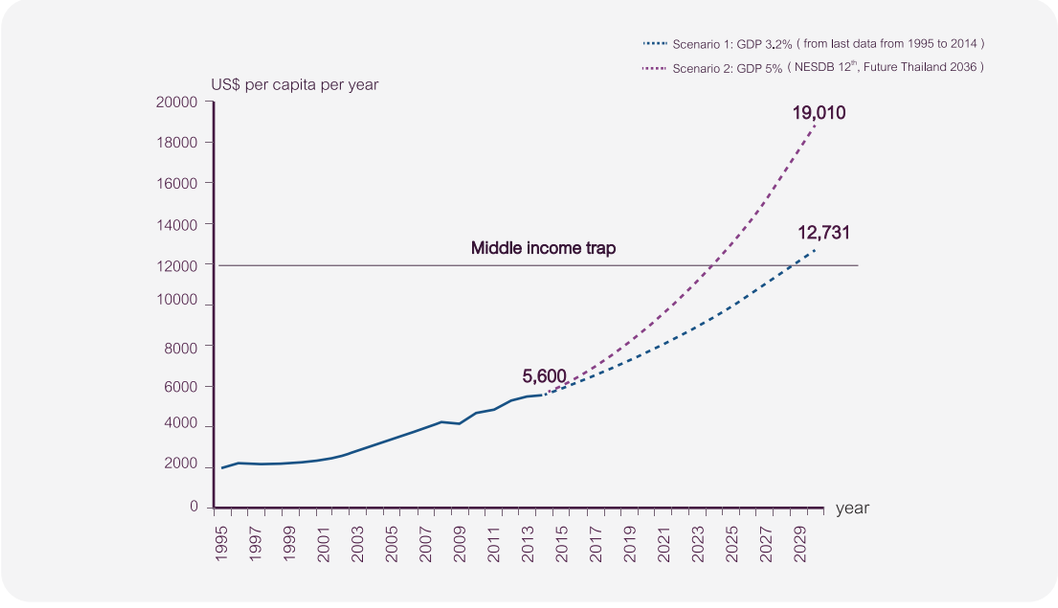


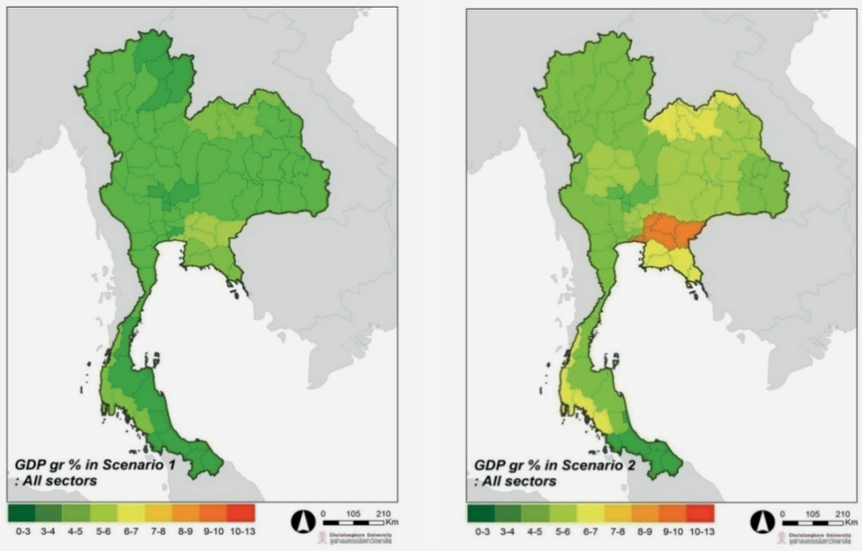
Figure 4-6: GDP per capita in each scenario (NESDB)

c) Spatial Development Issues

Figure 4-7 shows GDP growth rate in each provincial cluster under two scenarios. This represents one main difference in term of spatial development. The 2nd scenario concentrates on the development of new economic areas to increase the competitiveness of the country. As can be seen in Figure 4-7, Thailand's EEC plan in the eastern part of the country will be the main development area in the future with greater GDP growth compared with the rest of Thailand.

d) Key results

The risk of future development under climate change impacts was analyzed by using the results of climate change scenario and socio-economic scenario. The uncertainty from both scenarios is important for understanding and making decisions on mitigation and adaptation measures.



a) 1st Scenario, GDP gr for all sector = 3.2 %

b) 2nd Scenario, GDP gr for all sector = 5.0 %

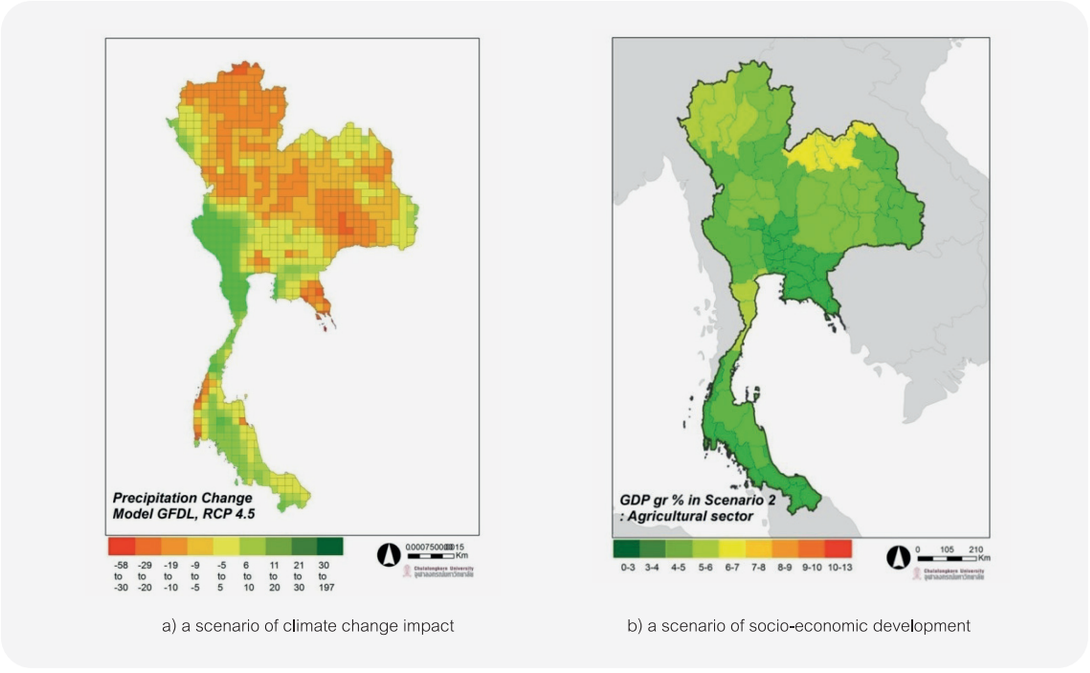
Source: edit from Office of the National Economic and Social Development Board

Figure 4-7: GDP growth rate (gr) in each provincial cluster and scenario

For example, Figure 4-8 shows an example of a combination of climate change and socio-economic scenarios. This means some targeted areas of agricultural production, especially in the northern part of the country will be affected from less precipitation caused by climate change. The target of escaping the middle-income trap in some agricultural communities may not be met because of this water shortage. Vulnerability of each sector and area include risk management with adaptation will be shown in the next section.

4.2 VULNERABILITY ASSESSMENT

This section presents information on the regional areas with vulnerability assessment to climate change impacts in Thailand. This is assessed by overlaying exposure maps, sensitivity maps, and adaptive capacity maps following the vulnerability assessment framework of IPCC. This assessment required data of the spatial distribution of four sectors (water resources, agriculture, human settlement and health).



a) a scenario of climate change impact

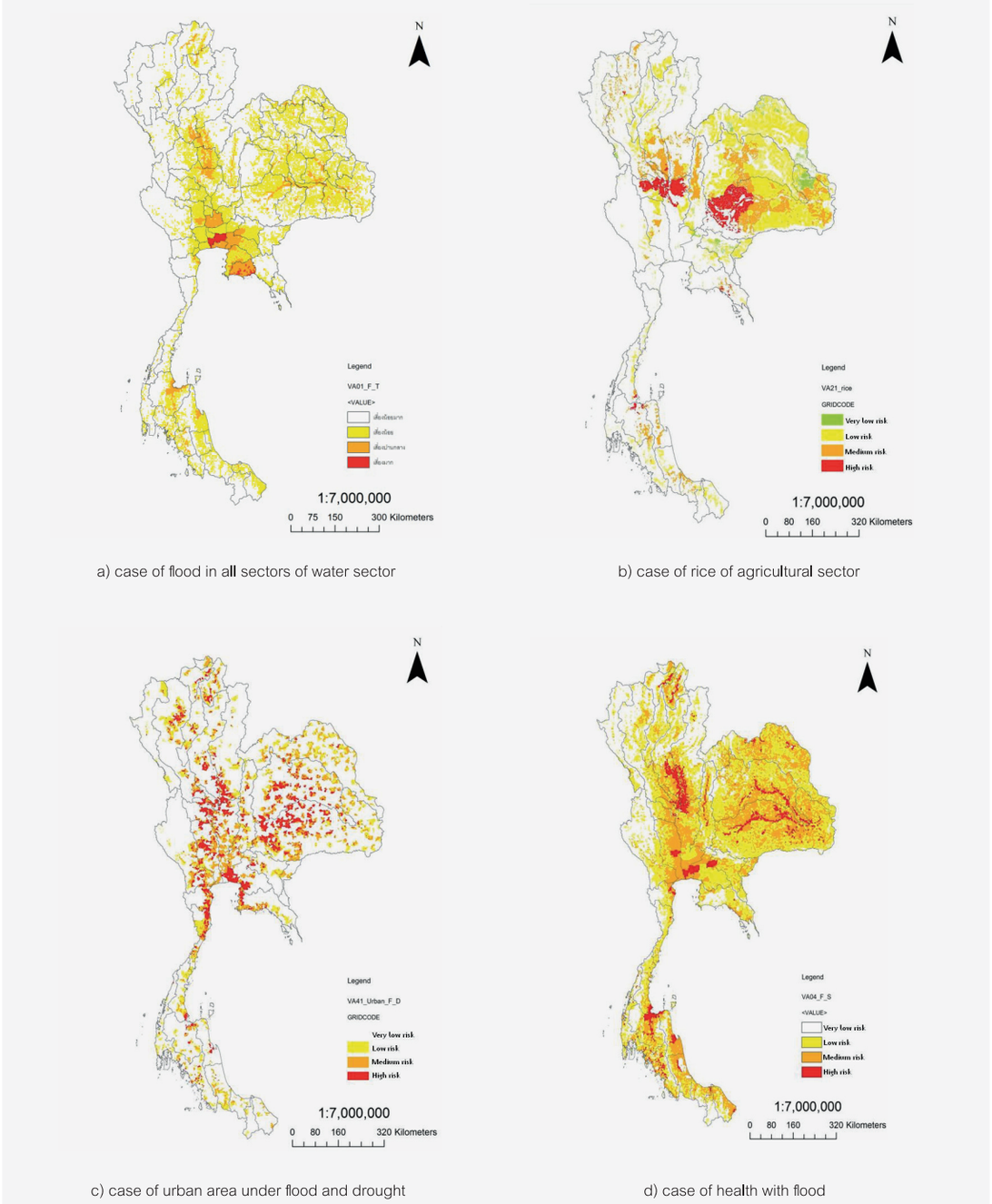
b) a scenario of socio-economic development

Figure 4-8: Example of a combination of scenarios of climate change and socio-economic matrix in 2030

4.2.1 Vulnerability Maps

Vulnerability maps were divided into 4 sectors: (1) water resources; (2) agriculture; (3) human settlement; and (4) health are shown in Figure 4-9. In conclusion, vulnerability levels are mainly based on sector (water resources, agriculture, human settlement and health), area (region and province) and time (past, present and future).

The option for mitigation and adaptation to climate change may be different based on dimensions of sector, area and time. The next section will show some examples of risk management and adaptation options to deal with this issue. Table 4-1 to Table 4-4 concluded the vulnerability hotspots of water resources, agricultural, human settlement and health sectors.



a) case of flood in all sectors of water sector

b) case of rice of agricultural sector

c) case of urban area under flood and drought

d) case of health with flood

(red means high, orange means medium, yellow means low level of vulnerability)

Figure 4-9: Vulnerability map in case of flood and drought in each economic sector

Table 4-1 Vulnerability hotspots, economic sector and dominant hazard

Economic sector	Dominant hazard	Vulnerability hotspots	Note
Agriculture	Flood	- Upper Chao Phraya river basin - Upper Mun river basin - Chantaburi province	- Major and second Rice producing area - Rain-fed area for major rice - Fruit
	Drought	- Same area as flood including - Chiang Mai province - Surat Thani and Nakon Si Thammarat provinces	- Fruit - Rubber tree
Manufacturing	Flood	- Large eastern industrial estate	- Especially in Rayong province
	Drought	- Large eastern industrial estate and factory in northeastern region	
Service	Flood	- Upper Chao Phraya river basin - Lower Mun river basin	
	Drought	- Northeastern region	

Table 4-2 Crop types and vulnerability hotspots in the agriculture sector

Crop type	Vulnerability hotspots	Note
Rice	- Upper Chao Phraya river basin - Upper Mun river basin	- White rice in irrigation area - Jasmine rice in rain-fed area
Sugarcane	- Upper Chao Phraya river basin - Upper Mun river basin	-Rrain-fed area
Cassava	- Upper Mun river basin	- Rain-fed area
Maize	- Upper Chao Phraya River Basin - Upper Mun river basin	- Rain-fed area
Rubber tree	- Surat Thani and Nakorn Si Thammarat Provinces	- Rain-fed area

Table 4-3 Urban/Rural area and vulnerability hotspots in the human settlement sector

Crop type	Vulnerability hotspots
Urban	- Bangkok and vicinities - Upper Chao Phraya river basin - Northeastern region not connected with Mekong river
Rural	- Upper Chao Phraya river basin - Northeastern region not connected with Mekong river - Eastern region

Table 4-4 Water-related disaster and vulnerability hotspots in the health sector

Crop type	Vulnerability hotspots
Flood	- Bangkok and vicinities - Upper Chao Phraya River Basin - The area along Chi and Mun Rivers
Drought	- The central part of northern region - Northeastern region not connected with Mekong River

4.3 ADAPTATION OPPORTUNITIES IN KEY SECTORS

4.3.1 Disaster Risk Management and Adaptation

From the risk assessment analysis results conducted from the impacts of the uncertainty analysis of climate change and the development of the area, counter measures can be prioritized in each sector by the severity of climate change and the level of economic development. The management approach can be divided into four parts. First, in case there is high intensity of climate change and high economic development level, this area should be selected as the top priority by taking urgent measures, such as structural measures, which requires investment. Second, structural measures that focus on protection, such as reservoirs or retention ponds, should be used. This requires planning in case of high levels of economic development with low impact of climate change. Third, in case of high impact of climate change and low economic development, this area should be managed by non-structural measures, such as system alarms and insurance systems. Finally, fourth, in case of low impact of climate change and low economic development level, non-structural measures, such as database preparation, education, which requires monitoring system, should be used. All details are shown in Figure 4-10. The measures of each part should be streamlined with the disaster risk management cycle for planning and implementing at the national, regional, local and community levels.

4.3.2 Adaptation Measures Implemented

Office of Natural Resources and Environmental Policy and Planning (ONEP), as the national focal point, is in the process of preparing the National Adaptation Plan (NAP). In Phase 1 (2015), the study and assessment of vulnerability from climate change in six sectors (as in Thailand's Climate Change Master Plan) in Thailand at the regional and provincial levels shown in vulnerability/risk was conducted. In Phase 2 (2016), the database of best practices in adaptation from climate change impact at both local and national levels was collected. Currently, ONEP is implementing the NAP draft into regional and provincial pilot areas. The results will be used to improve the NAP draft for practical local base implementation.

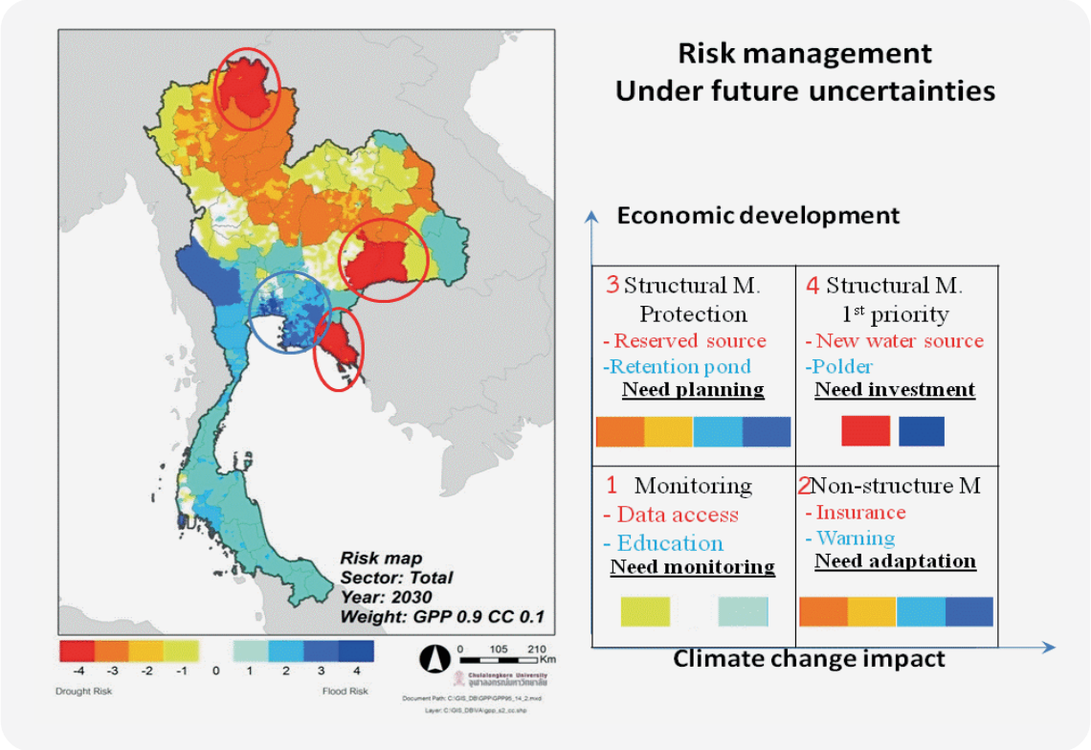


Figure 4-10: Risk management under uncertainty in the future

Nowadays, a number of government agencies in Thailand have taken responsibility and collaborate on climate change adaptation projects in each sector. For the agricultural sector, the Rice Department presented measures of risk management and climate change adaptation to increase building capacity of farmers in rain-fed areas of the northeastern part of Thailand. The Japanese Institute of Irrigation and Drainage (JIID), the Royal Irrigation Department, and Chulalongkorn University also showed climate change adaptation cases of farmers within the irrigation area in the Chao-Phraya river basin in Thailand. For the water sector, the Department of Disaster Prevention and Mitigation proposed the flood and drought risk map related to the risk of future climate change. They have also implemented projects on disaster risk assessment, exposure vulnerability, capacity building and an early warning system. For the health sector, the Ministry of Public Health declared Thailand's Climate Change Adaptation Plan on Health Sector (2018 – 2030) is prepared to mitigate and adapt the impacts of climate change in the health sector. For the human settlement sector, the Bangkok Metropolitan Administration presented the Bangkok Master Plan on Climate Change (2015-2050) with numerous risk management plans and pilot projects. The Thailand Research Fund (TRF) and

National Research Council of Thailand (NRCT) supported the research activities related to climate change impact and adaptation. For international cooperation on climate change, the United Nations Development Programme (UNDP) showed Climate Change Benefit Analysis (CCBA) Guidelines to support the government of Thailand to ensure that the investments are properly implemented to respond to climate change and receive appropriate additional funding. This funding can be from either the national or international climate fund. The Japan International Cooperation Agency (JICA) supports ADAP-T Project to Thailand (2016-2021) to develop resilient and sustainable solutions for climate change in coastal, forestry, water, urban, rural and sediment sectors. "Risk-based National Adaptation Plan" (Risk-NAP) , in collaboration between ONEP and the German International Cooperation (GIZ), is set to analyze climate risks in Thailand and implement activities aimed at integrating the NAP into sectorial and subnational planning processes, coupled with adequate budgeting. The UNDP: NAP-GCF project, which will be implemented in 2018, concentrates on climate change adaptation in marine and coastal sectors. JICA and the Thailand Greenhouse Gas Management Organization (TGO) cooperated for the human resource development aspect of the climate change training. European Union and Good Governance for Social Development and the Environment Foundation (EU-GSEI) projects were generated for training activities in local communities for climate change adaptation plans at the community level.

4.3.3 Samples of Adaptation Cases

a) Planned Cases

Sample of planned adaptation cases can be introduced via the project "Improved Management of Extreme Events through Ecosystem-based Adaption in Watersheds" (ECOSWAT), in cooperation between the Department of Water Resources and German International Cooperation (GIZ). They studied vulnerability and adaptation measures. Studies were conducted in three pilot areas: Lum Pha Chi, Huay Sai Bat and Tha Di Subriver Basins. The results of the Ecosystem-based adaptation are as follows. (1) Lum Pha Chi Subriver Basin: the adaptation measures were bank stabilization, forested buffer strip, and forest riparian buffers, terracing and Infiltration Basin (Figure 4-11). (2) Huay Sai Bat Subriver Basin: the adaptation measures were wetland restoration and sedimentation trap, water management, sedimentation trap at confluence of tributaries, riparian zone development and flood plain (Figure 4-12). (3) Tha Di Subriver Basin: the adaptation measures are bank erosion control, riparian zone development, river bed enhancement, constructed wetland and flood control with wetland, water spreading weir with connected wetland development (Figure 4-13).

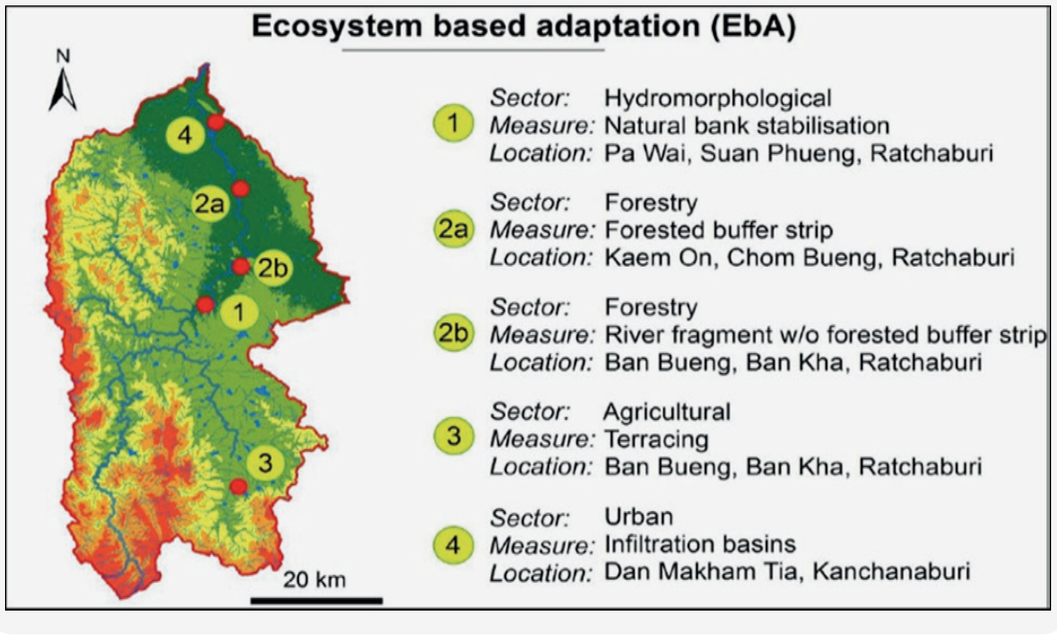


Figure 4-11: Ecosystem-based adaptation of Lum Pha Chi Subriver Basin (Hubert Lohr, 2015)

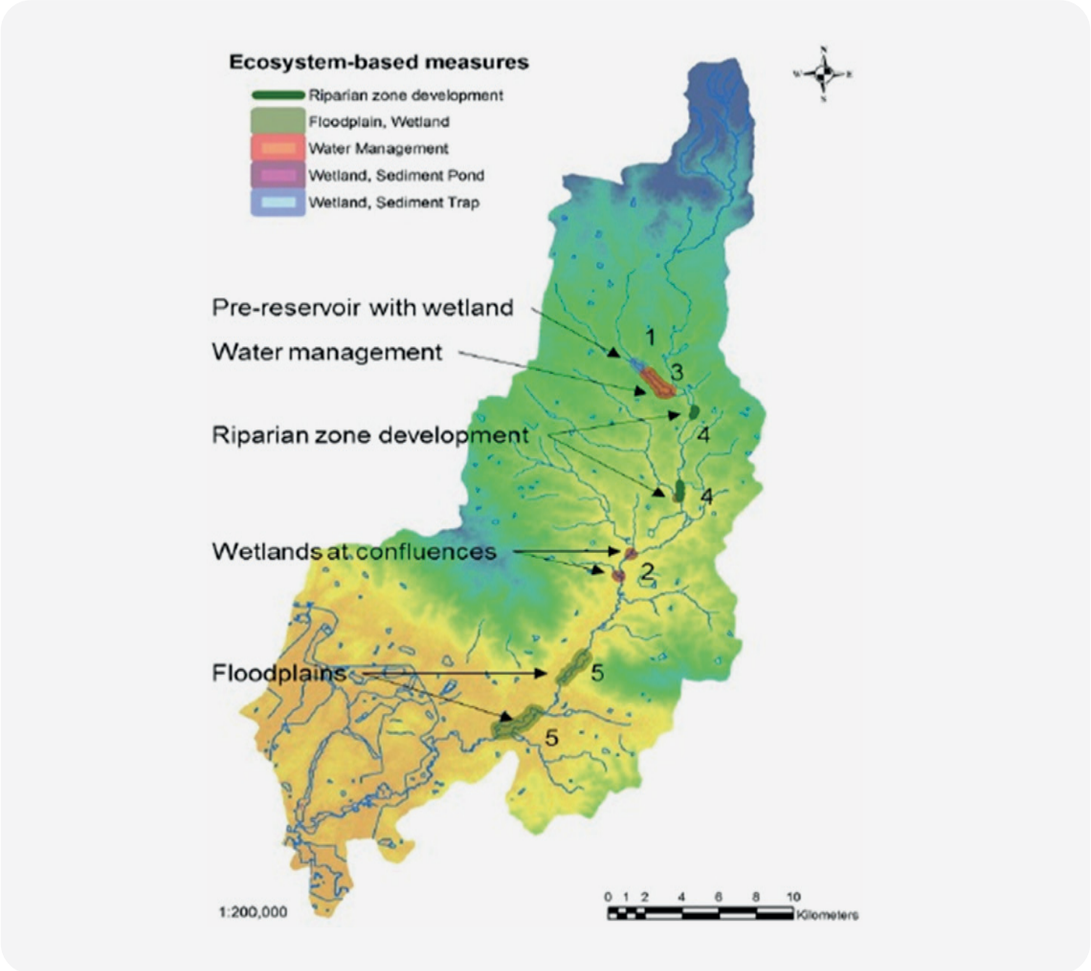


Figure 4-12: Ecosystem-based adaptation of Huay Sai Bat Subriver Basin (Hubert Lohr, 2015)

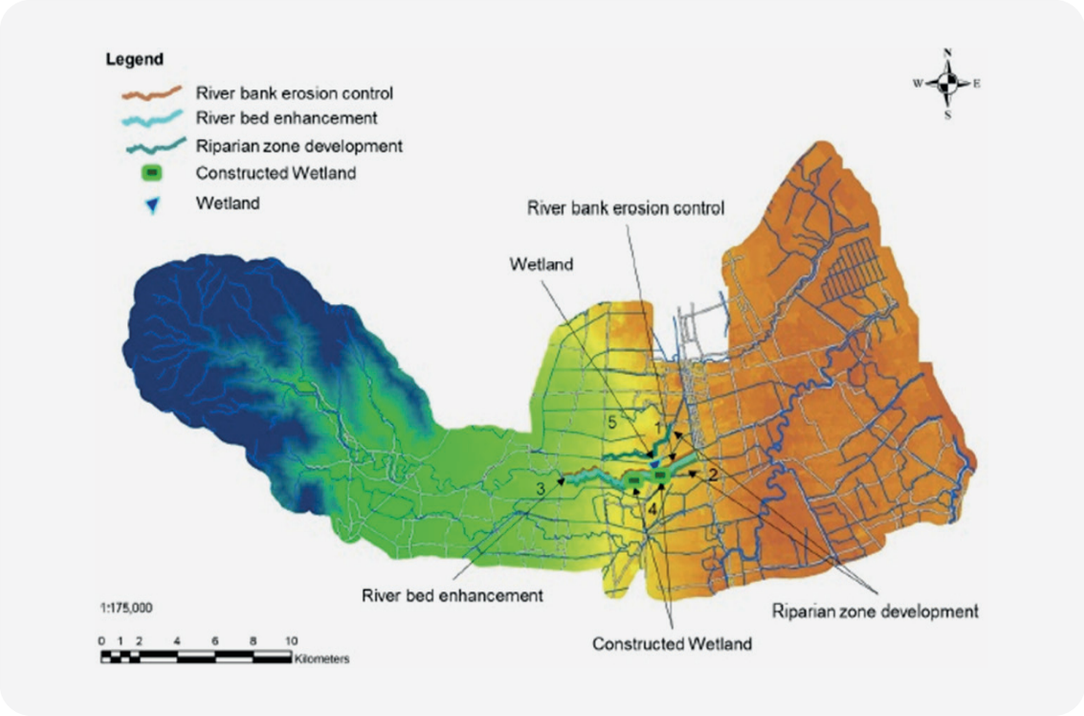


Figure 4-13: Ecosystem-based adaptation of Tha Di Subriver Basin (Hubert Lohr, 2015)

b) Unplanned Cases (Community Survey on Drought)

To explore the unplanned adaptation for rice cultivation at the farm level, field surveys were conducted in the Plaichumpol Irrigation Project (in the central area as a wet case) and the Lam Pao Irrigation Project (in the northeast area as a dry case) during July 2016, which was at the end of critical drought period. The results showed that the farmers in the central plain in the irrigation area were impacted from severe droughts in the years 2015-2016. The impacts were from damages of agricultural products and worse product quality. Farmers in the rain fed areas were impacted from water shortage and product damage. The farmers in the northeast area were mainly affected from water shortage in both irrigation and rain fed areas while the farmers in the rain fed area in the northeast were effected more from insects due to the drought.

Farmers in irrigation areas in the central plains adapted themselves by reducing their cultivation area, growing less water crops, using shallow groundwater wells, and using loans to solve their problems. Farmers in the rain fed areas changed to crops that used less water and reduced their cultivation area as counter measures. Farmers in the northeast area in the irrigation area adapted themselves by decreasing their cultivation area and growing drought tolerant crops. Farmers in the northeast and rain fed areas adapted by growing less water consuming crops and reducing their cultivation area. At the farm levels, farmers prepared two choices of adaptation measures, either stop farming and find other jobs or farm with supplementary water, such as pumping water from drainage canals, farm ponds, tube wells, and shallow groundwater, including selected plants.

4.3.4 Key Results of Risk Management and Adaptation

The key results of risk management and adaptation measures for each sector and each risk level related to Figure 4-8 can be shown in Table 4-5.

Table 4-5 The risk management and adaptation for each sector

Issue	Measure
Water resources (Note: LH = Low economic development and High climate change impact)	
1 Need monitoring: (LL)*	– Technology development (warning system and dredging) – Improve timely weather forecasts and response options – Drought / floods urveillance system – Community communication – Water saving measures 3R (Reduce, Reuse and Recycle) – Study of technology for water resources development
2 Need adaptation; (LH)*	– Water saving measures 3R (Reduce, Reuse and Recycle) – Build social immunity by providing the right knowledge and information – Local wisdom such as mining, stepping and digging ponds – Preparation for evacuation – Crop insurance – Modification of crop and cropping behavior of farmers by focusing on quality rather than quantity – Tax incentives
3 Need Planning; (HL)*	– Water diversion across the watershed – Zoning – Warning system – Water act – Community communication – Disaster response planning – Study of technology for water resources development – Water resources development plans
4 Need investment; (HH)*	– Restoration of forest areas – Investment in water retention structures to reduce the severity of severe climate impacts – Flexibility in structural design responds to predicted changes in precipitation rainfall, maximum rainfall – Preparation or improvement of flood protection structures to minimize contamination of water – Provide retention area to reduce the problem due to the intensity of rain and the length of time – Water act – Community communication – Private-public investment in water resources

Table 4-5 The risk management and adaptation for each sector (continued)

Issue	Measure
Agricultural Sector (Note: LH = Low economic development and High climate change impact)	
1 Need monitoring: (LL)*	– Technology development (warning system and dredging) – Improvement of timely weather forecasts and response options – Promotion of the drip irrigation system using innovations to warn – Disaster warning on disease and insect prediction
2 Need adaptation; (LH)*	– Finding measures for risk management and adaptation by researching and enhancing farmers to adapt to climate change in sustainable rice crop production systems – Modifying of crop and cropping behavior of farmers by focusing on quality rather than quantity – Increasing the effective of water resources and water use in various activities by integrating in all sectors – Enhancing knowledge and promote participation in watershed management – Improving old or damaged irrigation systems – Using water saving technology (Alternative Wetting and Drying) – Building knowledge, such as smart farming
3 Need Planning; (HL)*	– Modification of planting systems – Changing crop calendar – Changing plant type – Budgeting and prioritizing – Zoning – Marketing management of crops and livestock – Promoting sufficient farming to reduce greenhouse gas emissions
4 Need investment; (HH)*	– Investment in water retention structures to reduce the severity of severe climate impacts – Soil improvement – Adding organic matter to soil to increase plant moisture – Breeding for heat stress tolerance in plants – Knowledge transfer – Crop insurance

Table 4-5 The risk management and adaptation for each sector (continued)

Issue	Measure
Human settlement sector	
1 Need monitoring: (LL)*	– Improving of timely weather forecasts and response options – Technology development (warning system and dredging) – Education for the people to prepare for disaster – Mapping risk at the provincial level
2 Need adaptation; (LH)*	– Building social immunity by providing the right knowledge and information – Preparing for evacuation – Changing water use behavior / savewater / reducewaterloss / reusewater – Disaster preparedness with anticipation of disruption of water supply and sanitation – Plan to career change of people in the area – Payments for ecological services
3 Need Planning; (HL)*	– Establishing the risk map which shows the details of the house location – Integrated flood risk management into spatial planning to protect ground water and water areas – Land management and landuse planning – Developing a map of areas that allow for damage and compensation
4 Need investment; (HH)*	– Flexibility in structural design responds to predicted changes in precipitation rainfall, maximum rainfall – Improving flood protection structures to minimize contamination of water – Coastal erosion protection and management project – Reducing urban heat island effect by increasing green space – Developing additional drainage or new design to mitigate the effects of increased rainfall – Long-term investment the areas to prevent new risks and reduce the original risk such as increased water retention

Table 4-5 The risk management and adaptation for each sector (continued)

Issue	Measure
Health Sector (Note: LH = Low economic development and High climate change impact)	
1 Need monitoring: (LL)*	– Development of effective epidemiological surveillance system – Communication/awareness – Heath education
2 Need adaptation; (LH)*	– Development of acommunity for adaptation to reduce health risks and contribute to reducing greenhouse gas emissions – Evaluation of the risk of disasters in the hospital periodically to know the risks in the hospital area and provide equipment, tools and other support systems – Avoiding construction of a nursing home in risky areas – Arrangement of medical equipment and medical supplies in appropriate areas, taking into account the safety and usability – Improvement of review of relevant legislation to suppor treadiness and strictly enforce safety standards in hospitals – Lead Development / impact warning system – Health insurance system
3 Need Planning; (HL)*	– Defining health care infrastructure outside the disaster area – Mapping and surveillance – Capacity building
4 Need investment; (HH)*	– Construction of a nursing home building with strong structure and strictly defined measures – Prevention of health care from flooding – EMS / Emergency Plan – Call center / Hotline – Warning system – Surveillance system – GPS patient location – Standard hospital – Park / greenarea

*Note: LL = Low economic development and Low climate change impact
LH = Low economic development and High climate change impact
HL = High economic development and Low climate change impact
HH = High economic development and High climate change impact

4.3.5 Research and Cooperation Activities

Study and research activities

TRF issued the report on Thailand's assessment on climate change in 2015 and 2017 to demonstrate the existing research and knowledge on climate data, mitigation and adaptation in various sectors. There is research in community-based adaptation carried out by the Center for People and Forests (RECOFTC), the International Union for Conservation of Nature (IUCN), Raks Thai Foundation, Maejo University and Chiang Mai University, under funding support from the ASEAN Social Forestry Network (ASFN).The Department of Mineral Resources studied the rising sea level over the past 60 years to forecast future patterns. The results showed that historically, the sea levels rose approximately 0.4 mm per year. Based on these results, Bangkok and vicinities have the greater risk from (1) rising sea levels affected by climate change and (2) land subsidence. This caused the government of Thailand to declare rising sea levels to be an issue in the 20-year National Strategy.

Regional cooperation

The ASEAN academic network for water, disaster management and climate change was established in 2015 under the United Nations Educational, Scientific and Cultural Organization (UNESCO) support. There were two international conferences on "Climate Change and Water & Environment Management in Monsoon Asia" organized in 2015 and 2017 in Bangkok. These conferences facilitated collaboration among academics in ASEAN for water, disaster management and climate change and to provide platform for networking among academics and government executives to coordinate disaster management, policies and technologies.The Mekong River Commission (MRC) is currently developing a "Mekong Adaptation Strategy and Action Plan" (MASAP), which promotes adaptation to climate change in the Mekong Basin.

4.4 CONCLUSIONS AND RECOMMENDATIONS

4.4.1 Conclusions

The study was conducted under three scenarios of the national socio-economical development, i.e., SSP1, SSP2 and SSP3. The analysis of climate change was based on daily maximum and minimum temperature and precipitation during 2016 - 2100 from three GCMs (IPSL-CM5A-MR, GFDL-CM3, and MRI-CGCM3) under RCP2.6 RCP4.5 and RCP8.5. The risk assessment was conducted from the dominant factors, i.e. present and future climate change and socio-economic development scenarios. The disaster risk management was proposed based on the impact and risk assessment results with proposed measures to adapt the climate change impact and possible measures in each sector based on structural and nonstructural measures of the functions and community coping capacity. The coping capacity assessment used the spatial analysis techniques and expert views from four selected sectors, i.e., water, agriculture, human settlement and health. The vulnerability assessment was conducted in the selected sectors using Geographic Information System (GIS) and overlapping techniques from three main parameters, i.e., damage, vulnerability and coping capacity.

4.4.2 Recommendations

There are constraints and gaps to cope with full assessment in vulnerability to properly cope and adapt with climate change. Thailand still needs more data monitoring, research and training for young scholars, as well as, additional international/regional collaboration to find joint and co-benefit measures. The main issue is to address gaps and constraints by streamlining the climate change planning into the normal budget planning. This is especially important in the extreme events, hotspot areas and prioritized sectors as water resources, agriculture, human settlement, and health as shown in previous vulnerability map. Data monitoring systems for rising sea levels, water and other related sectors are required to prepare for appropriate counter measures. The climate change management tools related to financial, technical and capacity building are still be needed.

Chapter 5:

OTHER INFORMATION AND RELEVANT ACTIVITIES

CHAPTER 5:
OTHER INFORMATION AND RELEVANT ACTIVITIES

5.1 TECHNOLOGY TRANSFER

Technology development and transfer is a key factor to enhance mitigation and adaptation of climate change. Energy efficiency, renewable energy and adaptation technologies for agriculture, water resources and coastal ecological system requires substantial and continuous financial and technical support and, in many cases, international cooperation. Thailand has been systematically promoting its technological development since the National Science and Technology Development Act 1991. The Act established the National Science and Technology Development Board and the National Science and Technology Development Agency (NSTDA). It also adopted the First 5-year strategic plan (1992-1996). Later, the Vision and National Strategy on Scientific and Technology (2000-2020) was introduced. The Fourth 5-year Scientific and Technological Strategic Plan (2007-2011) recognized the importance of the country's economic and social foundation in so far as food and agriculture, energy and the environment are concerned. It also emphasizes the transfer of appropriate technologies to rural communities. The First Science, Technology and Innovation (STI) Policy and Plan (2012 – 2021) identified priorities and aimed at balancing economic and social development and context for Thailand. One of the STI strategies was to develop STI to deal with climate change that would provide adverse impact to Thailand.

The technology development and transfer related to climate change, particularly mitigation and adaptation, have been concentrated in the following issues: (a) local emission factors for agriculture (rice, livestock, and agricultural soil), forestry, and waste management; (b) technologies for mitigation, especially technologies and know-how on improving energy efficiency, biomass, biogas and solar energy; (c) technologies and know-how on impact, vulnerability, and adaptation. Technology that has been developed and transferred include 1) technologies and analytical techniques related to climate change at sub-regional scales, particularly on the development of climate scenarios, 2) development of capacity to assess impact on and vulnerability of the agricultural sector, particularly cash crops in different regions, 3) research capacity to analyze impact on water resources, surface water, and water storage, 4) analytical techniques to analyze impact on coastal areas, especially impacts on the ecological system and land use, and 5) analytical techniques to analyze impact on health, especially airborne diseases.

5.1.1 Technology Needs Assessments and Technology Action Plans

According to the Poznan Strategic Program (PSP), with financial support from the Global Environment Facility (GEF) and the technical support from the United Nations Environment Programme (UNEP) through the UNEP DTU Partnership (formerly UNEP Risoe Centre), Thailand conducted the research project entitled "Technology Needs Assessments (TNAs) and Technology Action Plans (TAPs) for Climate Change Mitigation/Adaptation in Thailand." Thailand was one of the first fifteen countries from Africa, Asia, Latin America, Caribbean, and Europe in 2010 to conduct this research. As one of the six countries in Asia, the Thai government assigned the National Science Technology and Innovation Policy Office (STI), Ministry of Science and Technology, as the Technology Needs Assessments (TNAs) coordinator.

The Thailand Technology Needs Assessment focused on 3 aspects for adaptation including agriculture sector, water resource management, and the modeling, along with one aspect in the energy sector for mitigation. The National Science and Technology Development Agency (NSTDA), the Hydro and Agro Informatics Institute (HAII), Chulalongkorn University (CU), and Chiang Mai University (CMU) conducted the assessment in these sectors. The TNA was completed and endorsed by the National Climate Change Committee in 2012 and also the results of TNA were adopted in the major national plans, for example, Thailand's Climate Change Master Plan (2014-2050), Thailand's Intended Nationally Determined Contribution (INDC) etc. The prioritized technologies are shown in the Figure 5-1.

Source: National Science Technology and Innovation Policy Office (STI), Ministry of Science and Technology, Thailand

Figure 5-1: Prioritized technologies in Thailand Technology Needs Assessment

With reference to the resolution of the National Climate Change Committee meeting in 2012, the STI formulated the Technology Action Plan (TAP) for the agriculture sector and the energy sector in collaboration with the National Science and Technology Development Agency (NSTDA) and King Mongkut's University of Technology Thonburi (KMUTT). Consequently, STI developed the policy recommendation for the TAP implementation in the agriculture sector. The National Climate Change Committee adopted the recommendation in 2016.

5.1.2 Technology

The national strategic plan on climate change has also given top priority to technology development related to GHG mitigation as follows: (a) development plan for renewable energy, especially biomass and solar energy; (b) plan for the improvement of a technology foundation for clean technology development; (c) energy efficiency plan. These prioritized technologies were one of the missions of National Climate Change Master Plan 2015 – 2050.

The National Science Technology and Innovation Policy Office (STI) within the Ministry of Science and Technology has been appointed as the National Designated Entity (NDE) of Thailand. This resulted from the cabinet resolution in November 2014. In Thailand, technology development in mitigation and adaptation still share common barriers in all priority sectors as shown in Table 5-1.

Table 5-1 Technology Development and Implementation Barriers in Thailand

Technology	Types of Action	Barriers	Short-term Actions
Mitigation Technology	Requiring International Actions	Technology Capacity	Provide guidance/share knowledge on standardizing data formats, data collection procedures, and data interpretation.
		Capacity Building	Provide guidance/share knowledge on technology e.g. smart grid, CCS.
		Policy & Regulation	Collaborate with international institutes in term of technology or researchers or expert exchange
		Economy	Provide financial aid for an initial phase such as, researcher exchange programs and training courses
Mitigation Technology	Domestic Actions	Technology Capacity	Provide guidance/sharing knowledge on standardizing data formats, data collection procedures, and data interpretation
		Capacity Building	Allocate budget for development and maintenance infrastructure
		Policy & Regulation	Promote policies on enhancing research collaboration, R&D budget, MOU with developed country on technology transfer or research collaboration
		Economy	Increase R&D budget
Adaptation Technology	Requiring International Actions	Technology Capacity	Provide guidance/share knowledge on standardizing data formats, data collection procedures, and data interpretation
		Infrastructure	Provide guidance/share knowledge on water resource management planning, seed banks, biosafety house, and networking system.
		Policy & Regulation	Address Intellectual Property Rights' issues
		Economy	Provide financial aid for national data center establishment, researcher exchange programs, and training courses
Adaptation Technology	Domestic Actions	Technology Capacity	Provide cross-sectoral training courses or multidisciplinary exchanged researchers
		Infrastructure	Allocate budget for development and maintenance water infrastructure
		Policy & Regulation	Promote policies on enhancing research collaboration, and GM field experiments.
		Economy	Increase R&D budget

Source: National Science Technology and Innovation Policy Office (STI), Ministry of Science and Technology, Thailand

Thailand has also provided technical assistance to Bhutan in support of their efforts to reform the Bhutanese transport sector. This could be the world's first case of South-South collaboration under the Climate Technology Centre and Network (CTCN) and the UNFCCC Technology Mechanism, facilitating climate technology transfer between Thailand and Bhutan NDEs.

5.1.3 Enabling Environments

Not only does the Ministry of Natural Resources and Environment promote climate-friendly technology, the Ministry of Science and Technology and the Energy Conservation Plan of the Ministry of Energy also take responsible to improve with global warming and climate change by using science and technology developed domestically and imported from developed countries.

The 12th National Economic and Social Development Plan (2017–2021), with support from the Thailand 4.0 Plan, aims at achieving sustainable development, reducing income gaps and poverty, as well as, developing innovation and technology. Meanwhile, the government is also prepared to reduce greenhouse gas emission by 7% by 2020 compared with business as usual according to NAMAs (Nationally Appropriate Mitigation Actions) Roadmap. Thus, to ensure a sustainable environment, the government has some action plans, for instance, the Eastern Economic Corridor of Innovation (EECi), promoting research and development of advanced technology and innovation in large, medium and small enterprises, including climate technology.

5.1.4 Capacity Building for Technology Transfer

The Talent Mobility Program (TMP) facilitates the mobility of researchers in governmental agencies and higher education institutions to work with the industrial sector. It aims to increase talent mobility in the private sector and create knowledge exchange mechanics between personnel, entrepreneurs, designers, and educational institutes. It recognizes the crucial issues on climate change and established the Climate Change International Technical and Training Center (CITC) under Thailand Greenhouse Gas Management Organization (Public Organization) (TGO). The main activities of the CITC are to provide training services in areas of climate change mitigation and adaptation, establish networking platforms for ASEAN countries, disseminate knowledge on climate change mitigation and adaptation, and be a learning resource center on climate change mitigation and adaptation.

5.1.5 Mechanism for Technology Transfer

Responding to the cabinet resolution in January 2017, the National Science Technology and Innovation Policy Office (STI), Ministry of Science and Technology, was appointed to formulate the Climate Technology Database and Roadmap for Thailand. Its goal is to develop a database and technology roadmap for selected mitigation sectors corresponded with the INDC. There are few mechanisms for technology transfer in Thailand via several channels as followings: (a) tax deduction for research, development, and innovation; (b) tax exemption for SMEs and Start-up Businesses (commonly called "Start-up"); and (c) technology and innovation enterprise development (TED) fund for encouraging young talented people.

5.2 CLIMATE CHANGE RESEARCH AND SYSTEMATIC

Research and systematic observations are instrumental in successful implementation of the Convention. Article 5 of the Convention called on all Parties to support international efforts to strengthen systematic observation and national scientific and technical research capacities and capabilities. The Global Climate Observing System (GCOS) was established to coordinate the international undertaking in observation of Essential Climate Variables (ECVs) in atmospheric, oceanic and terrestrial domains. Several platforms exist to coordinate climate change research such as the World Climate Research Programme (WCRP). Thailand continually contributes observations through GCOS and actively collaborates with international communities in climate change research programs. At the same time, Thailand also strives to increase its capacity in environmental surveillance and research on climate variability and change, impact and adaptation, and climate change mitigation in response to the country's specific needs. This is consistent with Article 7, paragraph 7(c) of the Paris Agreement, which called on Parties to strengthen scientific knowledge on climate, including research, systematic observation of the climate system and early warning systems. It needs to be in a manner that informs climate services and supports decision-making. The GCOS 2016 Implementation Plan broadens the scope of observations for adaptation and mitigation. This section provides Thailand's new development on research and systematic observation since the Second National Communication (SNC) identified remaining constraints and gaps.

5.2.1 Status of National Program on Climate Change Research

Thailand's overarching strategies were envisioned in the 5-year National Economic and Social Development Plan. The 11th Plan (2012-2016) placed science and technology, research, and innovation as driving forces for achieving Thailand's food and energy security, while transitioning development toward a low-carbon economy and climate resilient society. These directions were reflected in the National Research Policy and Strategy (2012-2016) formulated by the National Research Council of Thailand (NRCT), the governing body which oversees research proposals submitted by government agencies for annual budget allocation. Similarly, the Thailand Research Fund (TRF), one of the leading government research funding agencies, put climate change, water, food security, and alternative energy as its top strategic research issues. These collective efforts resulted in an increase in the number of research carried out by government agencies, research institutions and universities, which greatly supports government strategies and policies relevant to climate change. For example, in Thailand's 2nd Assessment Report on Climate Change 2016 sponsored by the TRF, the numbers of peer-reviewed publications increased from the 1st Assessment Report in 2011. There were 45 publications on climate change science, 44 publications on climate change impact and adaptation in various sectors, and 17 publications on mitigation. The TRF also funded universities to establish several international research networks leading to more collaboration between Thai and overseas researchers (e.g., Southeast Asia Climate Change Network, Food Security Research Network, Energy Research Network).

The current 12th National Economic and Social Development Plan (2017-2021), in keeping with the 20-year National Strategy (2017-2036) and the Thailand 4.0 economic model, emphasizes the role of science and technology, research, and innovation in transforming the country's economy toward a high income country, as well as, achieving the UN Sustainable Development Goals. The government plans to increase expenditure on research to 1% of the GDP in 2021. The Thailand

Research Organizations Network (TRON), a consortium of 7 research funding agencies (NRCT, TRF, Agricultural Research Development Agency (ARDA), National Science and Technology Development Agency (NSTDA), National Science Technology and Innovation Policy Office (STI), Health Systems Research Institute (HSRI), and Office of Higher Education Commission (OHEC) was formed in order to achieve more synergy in research directions and more effective utilization of resources. Among areas of research priorities detailed in the National Research Policy and Strategy (2017-2021) are sustainable green economic growth, food-water-energy security, and enhancing the capacity to adapt to climate change. These priorities are in line with capacity building targets set by the National Climate Change Master Plan (2015 -2050) designed to propel Thailand toward sustainable low carbon growth and climate change resilience by 2050.

5.2.2 Systematic Observation

The Thai Meteorological Department (TMD), according to the World Meteorological Organization (WMO), operate meteorological observations. Currently there are 123 surface stations participating in the Global Observing System (GOS). These stations provide meteorological parameters, such as atmospheric pressure, air temperature, relative humidity, wind speed and direction for synoptic purposes at least every 3 hours (Table 5-2). Approximately 40 stations have existed for more than 60 years providing long-term high-quality data for climate change analyses. A subset of GOS stations are selected to be part of the Regional Basic Synoptic Network (RBSN) and Regional Basic Climatological Network (RBCN). There are 5 upper-air stations which launch radiosondes attached to free-rising balloons making measurements of pressure, wind velocity, temperature and humidity up to 30 km above the ground. Although a global network of upper-air stations make observations at 0000 UTC and 1200 UTC daily, limited resources constraint observations to once per day at 0000 UTC for all upper-air stations in Thailand. There are 2 stations which monitor vertical ozone profiles, aerosol, UV and solar radiation as part of the Global Atmosphere Watch (GAW). In addition to surface and upper-air stations, TMD also operates 23 weather RADARs and a network of automatic weather stations in supporting of its missions to provide weather forecasts and disaster early warning for public safety.

Table 5-2 Meteorological and atmospheric observing stations in Thailand

Network or System	Numbers of Stations
Global Observing System (GOS)	123
Regional Basic Synoptic Network (RBSN) surface station	80
Regional Basic Synoptic Network (RBSN) surface and upper air station (radiosonde)	5
Regional Basic Climatological Network (RBCN)	14
CLIMAT: Report of monthly means and total from WWW (WMO/World Weather Watch) land station to GCOS archive centers	13
GCOS Surface Network (GSN)	6
GCOS Upper Air Network (GUAN)	2
Global Atmosphere Watch (GAW): Background atmospheric pollution monitoring station	2

Source: https://www.wmo.int/cpdp/thailand (accessed on 25 May 2017)

Many different government agencies also observe climate-related variables in relation to their mandates The Royal Irrigation Department (RID) operates stations in the irrigated areas to monitor and provide early warning to river discharge, while the Department of Water Resources operates hydrology network in many non-irrigated watersheds. The Hydro and Agro Informatics Institute (HAII) serves as the national central weather and water data repository and dissemination. Although currently there are too many government agencies responsible for different aspects of water resources and early-warning systems in Thailand, thus there have been trying to reorganize water resources institutions for more efficiency and more effective utilization of resources.

The Hydrographic Department within the Royal Thai Navy observes sea levels. There are 24 coastal tide gauges. Six of them are available to the international community via Permanent Service for Mean Sea Level (PSMSL). Recently, Thailand enhanced its capacity in coastal surveillance by installing coastal high frequency RADAR networks; one network is operated by TMD, while the other network is operated by the Geo-Informatics and Space Technology Development Agency (Public Organization) (GISTDA). The high frequency RADAR networks monitor sea state and coastal currents, which provide essential information for marine safety, as well as, coastal resources management.

In addition to in situ observations, satellite remote sensing observations have been extensively used in various government activities, including policy planning and monitoring of natural resources, as well as, disaster responses and recovery. GISTDA is the national agency overseeing satellite operations and applications. Thailand owns one earth observing satellite called Thailand Earth Observation Satellite THEOS (Thaichote). Products from THEOS and other satellites, such as land use/land cover maps, floods and droughts maps, forest fire hot spot maps are supplied to various government agencies to support their respective missions. Currently, Thailand is working on Thailand Earth Observation System Phase 2 (THEOS-2) which is not a satellite procurement project but a complete system covering the whole value chain from upstream to downstream. The upstream consists of satellites and external data from satellite constellations, air-based and ground-based

sensors and other related in-situ data. The midstream consists of an efficient and timely processing and data dissemination system. The downstream consists of solutions and applications and an integrated area-based decision support system with multi-level user access from policy level to local level and public to private.

5.2.3 Participation in the Global Research and Observation Systems

Thailand is actively involved in global observation systems. Several stations are part of GCOS ECVs observation. Thai Meteorological Department (TMD) is the national focal point for GCOS related activities. A subset of TMD stations are selected to be part of GCOS Surface Network (GSN), GCOS Upper Air Network (GUAN) and GAW Regional Network (Table 5-3). Through existing platforms of WMO and the Intergovernmental Oceanographic Commission (IOC) Joint Technical Commission for Oceanography and Marine Meteorology (JCOMM), 2 coastal tide gauges operated by the Hydrographic Department within the Royal Thai Navy are part of the global Sea Level Observing System (GLOSS) GLOSS Core Network (GCN). Apart from observing systems operated by government agencies, a number of climate-related observations are being carried out by research institutions and universities. The data are often freely available to public and GCOS-related networks (e.g. AERONET, FLUXNET) (Table 5-3). While integration of Thailand's observation network with GCOS is already achieved, integration with the Global Ocean Observing System (GOOS) is limited, except via GLOSS due to non-existing ocean observation capabilities. Currently, the extensive river discharge stations in Thailand are not yet integrated with the Global Terrestrial Observing System (GTOS), possibly due to a lack of coordination mechanisms.

Table 5-3 Thailand observing stations of Global Climate Observing System (GCOS) Essential Climate Variables (ECVs)

Network or System	Essential Climate Variable (ECV)	Numbers of stations (ECV)
GCOS Surface Network (GSN)	Surface-air temperature, surface-wind speed and direction, surface-water vapor, surface pressure, precipitation	6
GCOS Upper Air Network (GUAN)	Upper-air temperature, upper-air wind speed and direction, upper-air water vapor.	2
GAW Regional Network	Aerosol properties, ozone	2
GAW Affiliated Aerosol optical depth (AOD) network: Aerosol Robotic Network (AERONET)	Aerosol optical depth	8
FLUXNET	Exchanges of carbon dioxide, water vapor, and energy between terrestrial ecosystems and the atmosphere	7
Permanent Service for Mean Sea Level (PSMSL)	Sea level	6
Global Sea Level Observing System (GLOSS) Core Network (GCN)	Sea level	2

Notable developments on climate change research have become apparent from Thailand's close collaboration with international research communities. In the Second National Communication, uncertainty of climate change scenarios was raised as constraints limiting adaptation planning. Traditional adaptation planning relies on information from climate and impact models to identify adaptation options, which are intrinsically sensitive to future uncertainty. Recently, the approach to consider robust adaptation options across plausible climate change scenarios have gained more acceptance and can enable adaptation planning during uncertainty. In this regard, emerging research on climate change adaptation in Thailand has also adopted the robust adaptation framework. Notwithstanding this new direction, research on climate change scenarios is still needed in order to be able to quantify uncertainty, especially at regional and local scales. However, the task of carrying out climate change downscaling across plausible scenarios requires enormous resources, which are not feasible within one institution or one country. Since 2013, Thai researchers have closely collaborated with researchers from other ASEAN countries, under the Southeast Asia Regional Climate Downscaling (SEACLID) project funded by the Asia Pacific Network of Global Change Research (APN). The project was subsequently integrated with the World Climate Research Programme (WCRP) Coordinated Regional Climate Downscaling Experiment (CORDEX) for Southeast Asia and involves, not only researchers from Southeast Asian countries, but also wider international communities. The results from the project are expected to provide climate change scenarios enabling more robust assessment on climate change impact and adaptation. In addition, in 2017, Ramkamhaeng University Center of Regional Climate Change and Renewable Energy (RU-CORE), partially funded by TRF and NRCT, was established as a regional data center to archive and

disseminate climate downscaling output from the project under the Earth System Grid Federation (ESGF) framework. Apart from that, Thai researchers have contributed to UNFCCC activities as the technical expert team for reviewing the reports submitted by both Annex I and non-Annex I Parties, including IPCC activities.

5.2.4 Needs, Constraints and Gaps in Climate Change Research and Systematic Observation

While notable developments have been observed since the 2nd National Communication, constraints and gaps in climate change research and systematic observations still remain due to inadequate resources and expertise. Thus, support from developed country Parties, and international communities are necessary in the following areas:

1. Strengthening the capacity and ability for operational and long-term sustainability of existing observation sites, especially those in GCOS networks;
2. Developing the capacity and ability to monitor other climate-related variables, especially those in oceanic, terrestrial, and ecological domains; and
3. Enhancing bilateral, multilateral and international collaborations, as well as, technical assistance in all aspects of climate change research, especially in climate change impact and adaptation.

5.3 INFORMATION ON EDUCATION, TRAINING AND PUBLIC AWARENESS

5.3.1 Policy and Institution Framework for the Implementation of Article 6 of the Convention

Education, training and public awareness play a fundamental role for the effective development and implementation of climate change policies and actions. In recognition of this, Article 6 of the United Nations Framework Convention on Climate Change (UNFCCC) and Article 10 (e) of the Kyoto Protocol call for all Parties and relevant organizations to cooperate and promote the development and implementation of climate change education, training, public awareness, public participation, and public access to information at the national, sub-regional and regional levels. The implementation plan for Article 6 of the Convention and all its elements to enhance climate actions under the Paris Agreement will be further explored and considered in the Conference of the Parties serving as the meeting of the Parties to the Paris Agreement (CMA). Action for Climate Empowerment (ACE) is a new term adopted by the UNFCCC in 2015 as an appropriate way to refer to Article 6 of the Convention so that everyone can better understand.

As part of the national implementation plan within the scope of the Doha Work Programme (DWP), the Department of Environmental Quality Promotion (DEQP) within the Ministry of Natural Resources, and Environment (MONRE) was appointed as an ACE national focal point in 2014 in order to systematically coordinate, foster and enhance the ACE activity implementation in Thailand. Some elements of the ACE were incorporated into Thailand's Climate Change Master Plan 2015-2050, the first National Adaptation Plan (NAP) and other relevant national, sectoral and local government climate change plans and programs. Stakeholder consultations and engagements are an important process that were established during formulation of the 11th and 12th National Economic and Social Development

Plans, the National Sustainable Development Strategy 2007-2036, and Thailand's UNFCCC National Communication and Thailand's UNFCCC Biennial Updated Report. This emphasized the importance of engaging the public in the process of developing national strategy and plan, as well as, drafting the national reports as a means of building national capacity and raising awareness of climate change related issues. Moreover, some of six ACE elements were mentioned in Thailand's Intended Nationally Determined Contribution (INDC). Civil society, the private sector, academia, NGOs, multilateral organizations and other relevant stakeholders have involved in the design of Thailand's INDC, and their participation is a key success of Thailand's INDC implementation. More recently, the cabinet, during its meeting on 24 January 2017, assigned DEQP, in collaboration with Office of National Resources and Environmental Policy and Planning (ONEP) and Thailand Greenhouse Gas Management Organization (Public Organization) (TGO) to prepare the ACE action plan to support the enhancement of ACE's efforts under the Paris Agreement implementation and development of climate change curriculum with Ministry of Education.

5.3.2 Level of Awareness and Understanding of Climate Change Issues

Over the last decade, Thailand has made substantial progress in planning, coordinating and implementing climate change education, training, public awareness, public participation and public access to information, as well as, international cooperation on these matters. A broad range of ACE activities with multi-sectoral, multi-stakeholder and participatory approaches fall under both the amended New Delhi work programme and the DWP, which are carried out at national, sub-national and local levels. As a result of continued implementation of these activities, the current situation of public understanding and awareness of climate change issues and stakeholder engagement in the development and implementation of climate change policies and actions in Thailand has been improved progressively.

5.3.3 Implemented Initiatives and Programs for the Elements of Article 6 of the Convention

5.3.3.1 Education

It is widely accepted that a combination of formal, non-formal and informal education is the most powerful tool to initiate change, empower the community, and support climate change mitigation and adaptation actions. The United Nations Decade of Education for Sustainable Development (UNDESD; 2005–2014), and the 5-year Association of Southeast Asian Nations (ASEAN) Environmental Education Action Plan (AEEAP; 2000 – 2005, 2008 – 2012 and 2014 -2018) provided valuable global and regional frameworks for educational activities in Thailand, both in schools and in a wider context. The Thailand National Education Act of B.E. 2542 underscored the importance of a learning process that promotes environmental awareness and instills environmental ethics. The Basic Education Curricular of B.E. 2544 specified Environmental Education for Sustainable Development (EESD) content and standards in various fields of education. Climate change and the individual and societal actions needed to address its challenges are an integral part of the UNDESD and AEEAP and are increasingly recognized as life-long learning. In Thailand, environmental education was integrated into the school curriculum in 1997.In the past, the Thai government and civil society organizations carried out a significant number of programs and activities to promote environmental education. For instance, since 2007, more than 146 Eco-schools have been set up across the

country through the initiative project of the DEQP. Together with the development of environmental education curricula and learning processes, an emphasis was placed on community-based and problem-based learning. Nowadays, one of the priority goals of the basic education level is the promotion of environmental sustainability. It has been incorporated into educational policies with the aim of contributing to Thai citizens being better prepared and involved in the construction of desirable futures.

Climate change issues are included in Thailand's basic education policies and higher-level education policies as part of EESD. The Basic Education Core Curriculum (BECC) developed by Thailand's Office of Basic Education Commission (OBEC) under the Ministry of Education addresses climate change in the science curricula. The BECC prescribes climate change in the Standard Science 6.1 (Change Processes of the Earth) under Strand 6 (Science) of eight standard learning areas. It aims to increase primary and secondary students' understanding of various processes on the Earth's surface and interior, the relationship between various casing processes in climate change, topography and form of the Earth, the investigative process for seeking knowledge and scientific reasoning, and communicating acquired knowledge to apply to useful purposes. The detailed content of learning standards related to climate change in the Standard Science 6.1 (Change Processes of the Earth) under Strand 6 (Science) of the BECC for primary and secondary schools is shown in Table 5-4. In addition, global warming was selected as an elective subject for some non-formal and informal education curricula. To integrate Earth System Science principles and approaches into school curriculum based on the National Science Education Standard (NSES), the Institute for the Promotion of Teaching Science and Technology (IPST) within the Ministry of Education developed the Earth System Science Student's Guide and Teacher's Guide. This guide aimed to develop students' understanding of Earth System Science including climate change through authentic science learning experience in natural setting. The English version of the Earth System Science Student's Guide and Teacher's Guide was introduced in the schools that offer English programs in Thailand. Moreover, the IPST developed 'Science Kids: Greenhouse effect' which is an animation aimed to motivate young kids to learn and understand climate change easily.

Climate change-related subjects and topics are also addressed by universities in Thailand. At Kasetsart University, for example, new undergraduate students take a general education course on climate change. Students from the social science, business administration and communications disciplines at Chiang Mai University must register for a climate change course. The University of Phayao, situated in the northern Thailand, provides climate change courses for bachelor, master and doctoral degrees. Climate change issues are an important element in the Earth System Environment Program in the Faculty of Environmental Management, Prince of Songkhla University, in the Environment, Development and Sustainability Program of Graduate School, Chulalongkorn University, and in the Environmental Technology and Management of the Joint Graduate School of Energy and Environment (JGSEE), the King Mongkut's University of Technology Thonburi. The School of Environment, Resources and Development, Asian Institute of Technology also provides a master's course of climate change and sustainable development. It seeks to develop professionals who can contribute to addressing issues of the climate change impact and sustainable management of resources. This is done through a curriculum and research program that exposes students to a wide range of contemporary topics.

Table 5-4 Content of learning standard related to climate change in the Standard Science 6.1 (Change Processes of the Earth) under the Strand 6 (Science) of the BECC for primary and secondary schools

Grade level content									
G1	G2	G3	G4	G5	G6	G7	G8	G9	G10-G12
		-Search for data and discuss the components of air and the importance of air. -Experiment and explain the motion of air resulting from differences in temperature.		-Explore, experiment and explain formation of clouds, mist, dew, rain and hail. -Design and make simple instruments for measuring temperature, humidity and air pressure.		-Observe, analyze and discuss formation of climate phenomena affecting human beings. -Search for relevant information, analyze and interpret meanings of data from weather forecasts. -Search for, analyze and explain effects of climate on the lives of living things and the environment. -Search for relevant information, analyze and explain natural factors and man-mode actions affecting changes of the Earth's temperature, ozone holes and acid rain. Search for relevant information, analyze and explain effects of global warming, ozone holes and acid rain on living things and the environment.			

5.3.3.2 Public Awareness

In recent years, a number of awareness-raising activities on climate change-related issues have been increasingly carried out across Thailand by various stakeholders. There is a continuing development in the scopes and patterns of such activities, expanding from simply informing others about the causes and consequences of climate change to encouraging the public and stakeholders to contribute and participate in mitigation and adaptation actions. The DEQP, as an ACE national focal point, is the main governmental agency responsible for regularly launching public awareness campaigns and activities on climate change and other related issues at different levels, from national, sub-national and local levels. These campaigns and activities are primarily aimed at building public support and participation for a variety of actions on climate change. In addition, other agencies, specifically those under the MONRE and Ministry of Energy, local governments, non-governmental organizations, private sectors, academia and civil society, frequently conduct public awareness campaigns and activities on climate change, energy saving and other related issues.

In recent years, the media has played an increasing larger role in helping to raise public awareness of climate change problems and solutions in Thailand. A wide range of tools, such as websites, radio and television programmes, newsletters, social media, web blogs, movies, video games, advertisements, posters, exhibition, conferences, seminars, awards and days, weeks and months of actions and campaigns are used for the public awareness activities. The DEQP and its networks usually launch country-wide awareness-raising campaigns and activities on climate change as part of international environment-related events, such as World Environment Day, Earth Day and '60+ Earth Hour Campaign'.

Promoting environmentally friendly production and consumption of green-label and carbon-label products and services, including green leaf certification for hotels, saving energy labels on electric applicants, and up-cycle carbon footprint, is another market-based instrument (Figure 5-2) to raise public awareness to enhance climate change mitigation actions in Thailand. Green public procurement has been introduced and database of sustainable consumption, service and production in Thailand is provided.

Figure 5-2: Green Labels and Carbon Labels in Thailand

In addition, awareness has been promoted at the organization level, such as low carbon footprint for organizations, green industry certification for firm, and low carbon municipality certification (Figure 5-3).

5.3.3.3 Public Participation

In Thailand, multi-stakeholder engagement and broad public participation are key elements in good governance and decision-making in order to encourage support of policies and actions. This is particularly true for climate change issues, which public fora and platforms have been set up to discuss strategies, plans and projects at national, subnational and local levels. Public participation and consultation are also an essential step when drafting Thailand's UNFCCC-related report and preparing Thailand's INDC and National Adaptation Plan. Therefore, public participation and engagement in developing and implementing climate change related policies, plans, and actions in Thailand have been improving steadily over time. Public participation is an integral part of climate change activities and projects.

Figure 5-3: Carbon and Green Labels for organizations in Thailand

The DEQP, in collaboration with multi-organizations including central and local governmental organization, NGOs and civil society, has continued to promote public participation in climate actions through a variety of projects and initiatives. Zero-waste communities, green offices, eco-schools, sustainable urban environments, and sustainable consumption and production are among recent DEQP-led projects and initiatives which emphasized public participation on environmental, climate change and other cross-cutting issues. The Natural Resource and Environmental Protection Volunteer Network, which is a large civil society network of the MONRE, plays a crucial role in participating in a number of climate change actions covering broad vertical spectrums from national to community levels. Participation of multi-stakeholders is as a core component in a number of climate change projects implemented by other agencies as well. For example, 84 municipalities from 5 regions in Thailand participated in the EU-funded initiative project. This was conducted by the Municipality League of Thailand to reduce carbon emissions to create low carbon cities under four frameworks.

5.3.3.4 Public Access to Information

The Official Information Act B.E. 2540 (1997) is a Thai act which guarantees the people's right to have full access to government information and ensures transparency and good governance in the administration of the public sector. The Official Information Act created more trust between officials and the general public. In compliance with the Official Information Act, Thailand has made progress to use various channels and mechanisms to actively disseminate and increase availability of climate change-related information. Being the most important mass source of public information on matters of climate change, the media, such as radio, press, television and internet, have played a dominant role in providing access to information in Thailand. For example, the UNFCCC's Conference of the Parties (COP) has been regularly reported on by 3 Miti News of Channel 3. A large number of copyright-free and translated Thai language climate change materials were prepared and disseminated by the government, NGOs, civil society, and academia have been increasingly available to the public via different channels.

Over the last decade, the Thailand Research Fund (TRF) has continually produced easy-to-understand books related to climate change issues based on research findings. Climate change materials for local people have been made by the DEQP as part of awareness-rising campaign and activities.

Web-based platforms and social media have become a more important communication mechanism by providing easy access to up-to-date climate change information, facilitating exchange of views and showcasing success stories. For example, the websites of Thailand Climate Change Network, Environment, DEQP, ONEP, TGO, MEAs Think Tank, Thailand Environment Institute, Thailand adaptation, THAI-GLOB, Sustainable Development Foundation and Raks Thai Foundation, provide a wide range of information related to climate change issues.

5.3.3.5 Training

A variety of training programs on climate change-related issues have been conducted in Thailand in order to develop skills, empower citizens as agents of change and mobilize solutions to climate change. The targeted training groups include central and local governments, academia, teachers, private sectors, civil society, and other relevant stakeholders with specific role in addressing climate change. Since 2008, the Institute for Environmental Technology Development and Transfer, DEQP has provided more than 10 training courses on climate change-related issues. Trainees from multi-agencies participated. A training topics including greenhouse gas (GHG) management, Clean Development Mechanism (CDM), CDM-program of activities, GHG protocols, carbon footprints, Nationally Appropriate Mitigation Action (NAMA) and Measurment Reporting and Verification (MRV), have been provided under the GHG Management Program of TGO. More than 3,000 trainees attended these training courses during 2009-2012. In addition, universities such as Faculty of Environment and Resource Studies, Mahidol University, Joint Graduate School of Energy and Environment, the King Mongkut's University of Technology Thonburi and Asian Institute of Technology have sometimes organized training courses on particular topics related to climate change.

5.3.4 Regional and International Cooperation to Promote Education, Training and Public Awareness

As part of the international, the United States Agency for International Development Lowering Emissions in Asia's Forests (USAID LEAF) program and the U.S. Forest Service (USFS), in collaboration with a group of 12 leading professors from eight universities in Southeast Asia, designed a climate change curriculum and developed university-level teaching materials. Collaboratively, the network of educators developed a series of four modules: Basic Climate Change; Social and Environmental Soundness; Low Emission Land Use Planning; and Carbon Measurement and Monitoring. Each comprised of presentations, associated lecturer notes, and complementary case studies, role plays and extensive online resources. The curriculum is now adapted to specific country context and is already being used in classrooms to teach more than 30,000 undergraduate and 700 graduate students. The network has grown to 700 professors from 63 universities across the SEA region.

The curriculum also works well at Thai universities, such as Chiang Mai University, and the University of Phayao participating in this network.

Under the EU-funded Switch Asia Programme on 'Sustainable Consumption and Production: Policy Support Component Thailand', a number of awareness activities related to promoting use of environmentally friendly green-label and carbon-label products have been carried out by the DEQP and other central and local agencies. The European Union has supported 84 municipalities in Thailand to participate in the project entitled 'The promotion of low carbon city across municipalities.

Hat Yai, Chiang Rai, Udon Thani and Phuket participated in the Asian Cities Climate Change Resilience Network (ACCCRN) Program and Mekong-Building Climate Resillient in Asian Cities (M-BRACE) coordinated by the Thailand Environment Institute to build climate change resilience in the context of big cities through multi-sector engagement.

More than 6 local communities from all regions of Thailand actively engaged in the on-going EU-funded project entitled 'strengthening good governance and democratic process in national climate change adaptation planning.' They will take an important role in conducting vulnerability, risk assessment, and adaptation implementation.

With support from the Swedish International Development Cooperation Agency (Sida) and the Asian Development Bank (ADB), the Asia-Pacific Media Alliance organized regional campaigns in Philippines, Thailand, Vietnam, and Bangladesh during 2010-2014. These campaigns utilized both traditional and online media to raise public awareness of climate change under the tagline 'Redraw the Line'. Moreover, in 2014, the Asia-Pacific Media Alliance organized a 2 day training workshop on opportunities and challenges in reporting climate change and food security for Thai journalists, newsreaders and broadcasters.

1. Strengthening the role of the ACE national focal point through international, regional and national activities,
2. Improving cooperation and collaboration among ministries, especially those dealing with climate change and those responsible for education and international cooperation,
3. Establishing reporting and monitoring system for the ACE activities,
4. Strengthening international cooperation to scale up action in relation to all elements covered by the ACE,
5. ncluding all elements of the ACE activities in the nationally determined contributions,
6. Seeking financial support from developed country Parties in the priority areas, so as to enhance actions under the Paris Agreement. Some examples include: 1) climate change curriculum and teaching material development at the primary, secondary and higher-education levels, 2) focused training on particular issues related to NDC for teachers and other key stakeholders, and 3) youth and local empowerment to enhance the implementation of climate actions.

5.4 INFORMATION ON CAPACITY BUILDING AT THE NATIONAL AND SUB-REGIONAL LEVELS

5.4.1 Policy Framework, Needs and Priorities for Capacity Building

Capacity building is fundamental to enable the full, effective and sustained implementation of the United Nations Framework Convention on Climate Change (UNFCCC) and Kyoto Protocol. Since 2001, the implementation of capacity-building efforts in developing countries has been guided by the Framework for Capacity Building in Developing Countries. The frameworks provide a set of principles, scope and guidance for implementation and actors involved in building the capacity of developing countries to implement the Framework Convention. The framework identifies 15 priority areas for capacity building in developing countries. Article 11 of the Paris Agreement further reaffirms the importance of enhancing the capacity and ability of developing country Parties to take effective climate actions.

This Article outlaid the goals, guiding principles, and procedural obligations of all Parties to the Agreement with regard to capacity building.

In Thailand, capacity building is given a high priority in the policy agenda. The Thailand Climate Change Master Plan (TCCMP) 2015 -2050 defines the higher-ranking national goal for capacity development. To achieve climate resilience and low carbon growth in accordance with sustainable development, as set out in TCCMP 2015 – 2050, capacity, as well as, awareness of developing partners and stakeholders at all levels needs to be built and enhanced. In addition, effective engagement and implementation of climate change policies and plans also need to be developed and implemented. Moreover, capacity building was incorporated in the 12th National Economic and Social Development Plan, the first National Adaptation Plan, (NAP) and other relevant national, sectoral and local government climate change plans and programs.

Capacity building has been identified as a key success in implementing Thailand's Intended Nationally Determined Contribution (INDC). Enhancement of capacity building along with adequate access to technology development and transfer of financial resources through a balanced and ambitious global agreement under the UNFCCC. This will increase the level of Thailand's contributions from 20% to 25%. The development and enactment of these climate change strategies and plans enable a more systematic integration of climate change actions into national policies and regulatory frameworks that support national priorities to move toward a low-carbon, climate-resilient future. As mentioned earlier, the cabinet meeting on 24 January 2017 assigned the Department of Environmental Quality Promotion (DEQP) in collaboration with Office of National Resources and Environmental Policy and Planning (ONEP), and Thailand Greenhouse Gas Management Organization (Public Organization) (TGO) to prepare strategies and action plans to support the enhancement and scaling-up of capacity building efforts under the Paris Agreement implementation.

5.4.2 Status of Capacity Building Activities and Level of Participation in and Promotion of South-south Cooperation with Other Institutions in Developing Countries

Most of the capacity building activities undertaken in Thailand are integral to other climate change projects and programs. Capacity-building activities aim primarily at strengthening the institutional, systematic and individual capacities of the country to enable the formulation, coordination and implementation of diverse mitigation and adaptation related actions. They covered all of the 15 needs and priority areas identified in the capacity-building framework.

In recent years, particular attention has been devoted to programs and activities relating to the preparation of Nationally Appropriate Mitigation Action (NAMA), INDCs, Thailand's UNFCCC Biennial Update Report (BUR), and other capacity-building areas emerging as a result of the evolving nature of climate science and policy.

Recent examples of capacity building activities carried out in Thailand as part of global/regional international-supported programs include the Green Climate Fund (GCF) Readiness Support to Strengthen the National Designated Authority (NDA), United Nations Development Programme (UNDP), Low Emission Capacity Building (LECB) Programme, Thailand's Second BUR to the UNFCCC, Achieving Low Carbon Growth in Cities through Sustainable Urban Systems Management in Thailand, and Low Emission Capacity-building Programme: A Global Initiative to Support NAMA, Low Emission Development Strategies (LEDS) and Measuring, Reporting and Verification (MRV).

Since 2009, the ONEP, as the UNFCCC National Focal Point, has strengthened through the climate change policy collaboration between the German Federal Ministry for the Environment, Nature Conservation, Building, Nuclear Safety (BMUB), and Thai Ministry of Natural Resources and Environment (MONRE).

In addition, other UNFCCC dedicated authorities, such as the National Designated Entity (NDE) for the Climate Technology Center and Network (CTCN), NDA for GCF and National Focal Point of the Article 6 of the Convention, have been appointed or established as permanent governmental bodies responsible for either proving policy guidance on particular issues of climate change or coordinating and implementing programs and projects. This domestic institutional arrangement has resulted in higher national capacities to implement climate actions.

To extend national projects on capacity development and institutional strengthening for greenhouse gas mitigation in Thailand, TGO, as Designated National Authority (DNA) for Clean Develop Mechanism (CDM), established the Climate Change International Technical and Training Center (CITC) in 2014. This was accomplished through technical and financial support from Japan International Cooperation Agency (JICA). The CITC is aimed to be a one-stop technical and training center and networking platform for Thailand, Association of Southeast Asia Nations (ASEAN) countries, and other developing countries to address climate change. Since its official launch, the CITC has implemented several capacity development activities including workshops, trainings, knowledge exchange, and experience sharing for Thailand and other Southeast Asian countries.

The Institute for Environmental Technology Development and Transfer (IETDT) within the DEQP was also involved in building multi-stakeholder capacities on climate change related issues. This was done by providing training courses, workshops, seminars and e-learning to various agencies and organizations, specially to local governments. Since 2008, IETDT has organized more than 10 training courses on climate change-related issues. Two of them were international training courses with 14 countries participating in the Asia-Pacific region.

There are others governmental and non-governmental agencies involved in climate change capacity development at national, sub-national and local levels. For example, Thailand Research Fund (TRF) and National Research Council of Thailand have built the capacity of young researchers and students through supporting a variety of research projects and activities.

At the regional level, the Asia-Pacific Network for Global Change Research (APN) is an active intergovernmental network, regularly supporting and implementing research, capacity building and science-policy interaction in the Asia-Pacific region.

Thailand places high importance on the role of South-South Cooperation to achieve climate change goals and sustainable development goals. Thailand supports the initiatives of Southern Climate Partnership Incubator to accelerate efforts to create and finance climate partnerships among developing countries. The role of South-South Cooperation is to step up and extend the development cooperation from neighboring countries to countries in other regions, such as South Asia and the Pacific Islands. The examples of Thailand's South-South cooperation on climate change include the CITC supporting for sharing technical knowledge and lessons learned with Bhutan on the implementation of the Intelligent Transport System (ITS). Another example is a pilot project in ethanol production among ASEAN partners including Vietnam, Laos, Myanmar, and Thailand. The project aims at promoting technological innovation in ethanol production in which Thailand is willing to share technical know-how and assist other countries in ethanol production from cassava.

5.4.3 Promotion and Level of Involvement of a Wide Range of Stakeholders

Climate actions are increasingly recognized as part of sustainable development. Mitigation and adaptation activities, with a wide range of stakeholder engagements, are being integrated into national development strategies. As climate change is a multi-industry issue that requires action and support at different levels, Thailand places particular attention on empowering local governments, municipalities and communities. and the goal is to enhance their capacities to better cope with climate change impacts and extreme weather events, as well as, to participate in sub-national and national efforts to reduce greenhouse gas emissions.

Nowadays, adaptation and mitigation policies and programs are being decentralized into sectoral line agencies, and provincial, municipal and local levels. For example, guidelines for national and sub-national climate change policy development and development-oriented adaptation and mitigation strategies have been developed, and training on sub-national policy development for 16 provinces and 32 municipalities have been carried out under the Support to the Development and Implementation of the Thai Climate Change Policy Project supported by the BMUB.

Capacity in local communities from all regions of Thailand to carry out vulnerability and risk assessment and adaptation actions is being developed through the on-going EU-funded project entitled 'Strengthening Good Governance and Democratic Process in National Climate Change Adaptation Planning'. In addition, the promotion of public participation and capacity development of multi-stakeholders have been included as a main element in a number of climate change related projects and initiatives carried out by different central and local organizations. For instance, capacity building and stakeholder engagement have been embedded in the activities of the Article 6 of the Convention.

5.4.4 Status of Activities Related to Coordination and Sustainability of Capacity Building Activities

In recent years, efforts have been made to improve coordination among key ministries involved in sectoral climate change plans and between central and local governmental agencies, as well as, non-state actors. The establishment of national UNFCCC-related institutions, committees and ministry-level mechanisms laid the foundation for improving and strengthening coordination among relevant agencies.

The Natural Resource and Environmental Protection Volunteer Network, as a large number of the MONRE civil society network covering all provinces, is another coordinating channel to facilitate climate change related activities at national, provincial and local levels.

Coordination platforms have been also created to enable greater participation of stakeholders at various levels. For example, the Asia Pacific Adaptation Network (APAN) is a regional platform for coordinating and managing adaptation knowledge and enhancing capacity in the region.

5.4.5 Dissemination and Sharing of Information on Capacity Building Activities

Thailand has made efforts to improve dissemination and sharing of climate change information, including capacity-building activities. The establishment of sub-national, national and regional networks has contributed to enhanced cooperation and research in the areas related to climate change, facilitating the transfer of knowledge and information-sharing on climate change mitigation and adaptation, including the dissemination of success stories, good practices and lessons learned. The PAN, APAN, CITC, the Southeast Regional Climate Downscaling (SEACLID), Thaicity climate, Thailand Climate Change Network (TCCN) are examples of those networks. The networks also provide other necessary climate change information, such as capacity building needs and targeted training in managing and operating new technologies.

The creation of data and information sharing centers and hubs, such as SEACLID, TRF's Research Development and Coordination Center for Global Warming and Climate Change (THAI-GLOB), Southeast Asia (SEA) Global Change System for Analysis, Research and Training (START) Regional Center, has also contributed to enhanced knowledge of the scientific aspects of climate change.

With growing public access to the internet, online information websites and portals on climate change are frequent tools used to disseminate and share knowledge, information and networking. The use of online services and the creation of dedicated websites are significantly contributing to the dissemination of information on climate change. A number of websites such as TCCN, DEQP, Environment, TGO, MEAs Think Tank, and Thailand adaptation provide lots of climate change information.

5.4.6 Capacity-building Activities Aimed at Integrating Adaptation to Climate Change into Medium- and Long- Term Planning

Thailand has carried out programs and activities related to building capacity to enhance the resilience of communities and sectors vulnerable to long-term climate change impact. Most of these programs and activities undertaken across related areas, such as vulnerability assessment, disaster risk reduction, the development and transfer of adaptation technologies and education, and training and public awareness especially for grass root communities.

The Thailand Climate Change Master Plan (TCCMP) 2015-2050 identifies adaptation as one of the higher-ranking national goals. The Climate Change Action Plan, however, focuses only on the implementation of short-term adaptation goals of the TCCMP. In order to address the growing challenges and strengthen the adaptation into strategies and development plans of sectoral ministries and those at sub-national level, Thailand has developed the National Adaptation Plan (NAP). Through the NAP, Thailand aims to integrate development-oriented adaptation measures into sectoral and sub-national adaptation planning.

Other adaptation-related capacity-building activities include workshops and training in the assessment of climate change impacts, vulnerability, risk and technical assistance to local planners in using climate-related data and information.

5.4.7 Gaps, Needs and Priorities in Capacity Building

There is a need for more integrated training in order to strengthen the technical capacity of a broader range of staff who need to carry out specific tasks. More targeted training of national experts is also needed, especially in the areas emerging as a result of the evolving nature of climate science and policy and in the context of Paris Agreement. This is due to the fact that the development and implementation of climate change policies and plans are usually hindered by limited technical expertise in climate change related domains.

Other priorities are the measurement, reporting and verification (MRV) of the implementation of mitigation and adaptation activities.

Another emerging area of concern is transparency of climate finances and how to hold institutions accountable. There is a need for mechanisms and systems that can track and monitor the use of climate funds and manage allocate domestic financial resources.

5.5 EFFORTS TO PROMOTE INFORMATION SHARING AND NETWORK

5.5.1 Efforts to Promote Information Sharing Among and Within Countries and Regions

The Office of Natural Resources and Environmental Policy and Planning (ONEP) within the Climate Change Management and Coordination Division (CCMCD) has been assigned to act as a national focal point of the UNFCCC since 2004. The office has formulated policies, plans, measures, instruments, and mechanisms to support the implementation of actions in response to climate change in Thailand. This includes both climate change adaptation and mitigation. As global warming and climate change relate to nearly all sectors of the economy, the national focal point plays an important role as the coordinating body for climate change activities, including information and networking.

Networking on climate change has continuously developed. Initially, climate change networks were related to research activities and were informal among researchers working in projects supported by the Thailand Research Fund (TRF) or among technical experts on different climate change committees. In addition, the Environmental Research and Training Center (ERTC), under Department of Environmental Quality Promotion (DEQP) initiated a network called the Thailand Climate Change Network.

5.5.2 Access to, and Use of, Information Technology for Information Exchange

As mentioned in previous sections, there are several international collaborations via UNDP, USAID, UK, EU, which provide access to information, advice and guidance in the preparation of national communication reports. In addition, the UK Department of Energy and Climate Change (DECC),the UK Foreign and Commonwealth Office and the UK Department for International Development funded TGO in collaboration with EPPO and DEDE (Department of Alternative Energy Development and Efficiency). The goal was to develop an energy-GHG model for “2050 Pathways Calculator” in order to write policies and capacity-building in the academia sector. The World Bank has supported TGO the program of “Partnership for Market Readiness (PMR)” to promote GHG

mitigation activities and facilities. Initiated by TGO, the Climate Change International Technical and Training Center (CITC) aims to be a “one-stop technical training center” and networking platform on mitigation and adaptation for ASEAN countries and other developing countries. The main activities of CITC are to provide training service in the area of climate change mitigation and adaptation, disseminate knowledge on climate change mitigation and adaptation, and to be a learning resource center on climate change mitigation and adaptation. The target groups of CITC are governmental agencies, academic institutions, private companies related to mitigation and adaptation, and the general public.

Chapter 6:

CONSTRAINTS AND GAPS, AND SUPPORT RECEIVED

CHAPTER 6:

CONSTRAINTS AND GAPS, AND SUPPORT RECEIVED

6.1 CLIMATE CHANGE MITIGATION AND ADAPTATION CONSTRAINTS AND NEEDS

The National Science Technology and Innovation Policy Office (STI) prepared Technology Needs Assessments for Climate Change Mitigation and Adaptation of Thailand, which was completed in 2012. The report concluded that mitigation technology was needed for energy efficiency and the renewable energy sector. Information on constraints, gaps and support need for climate change implementation of Thailand are shown in Table 6-1.

In addition, the National Science Technology and Innovation Policy Office (STI) within the Ministry of Science and Technology has already submitted six requests, as shown in Table 6-2.

Table 6-1 Information on the constraints, gaps, and support needs for implementation of climate change actions in Thailand

Need Area	Gaps/ Barriers/ Constraints	Needs	Rationales
Technology Transfer	The Technology Needs in the energy sector have been prioritized: into 2 main sectors: (a) Energy Supply, including • Smart Grid • Waste-to-Energy • Advanced Biofuels (b) Energy Efficiency Improvements such as • High Efficiency Boilers (c) Other Energy Sector, such as • Carbon Capture and Storage (CCS) One of constraints is these technologies require high investments, which Thailand also has limited fiscal budgets, in both central and local government levels.	Smart Grid: A modernized electricity generation and delivery system, which integrate information and communication technologies (ICT). Waste-to-Energy: To be promoted to reduce fossil-fuel power generation Advanced Biofuels: Biofuel is produced from non-food feedstock to avoid affecting the human food supply chain. High Efficiency Boiler: Designed technology to control the burner output to match the boiler's variable load requirements and a special type of water-tube boiler composed of tubes. Carbon Capture and Storage (CCS): Technology and process for capturing CO_2 from large point sources, such as fossil fuel power plants, transporting it to a storage site depositing it where it will not enter the atmosphere.	Smart grids can provide the right information to consumers (including the public and private sectors) to increase the share of renewable energy. Recently, many local governments faced difficulty in reducing waste correctly. Waste-to-energy can reduce waste, as well as, increase non- fossil fuel power generation at local levels. Due to limited land for agriculture, avoiding conflict of land uses for food and non-food cultivation is crucial. Advanced biofuel should be promoted in Thailand, both efficiency boilers and CCS are needed supports as a technology transfer.

Table 6-1 Information on the constraints, gaps, and support needs for implementation of climate change actions in Thailand (continued)

Need Area	Gaps/ Barriers/ Constraints	Needs	Rationales
Technology Transfer	Priority should be put to maintain observation sites, especially those in AERONET and FLUXNET, which are not the responsible for other operational agencies. Research institutions and universities maintain these sites. Thus, they are reliant on available funding. Support should be strategically focused on those sites that already provide long, non- disrupted, high-quality records. In addition, support for the development of an in- situ ocean observation network, such as oceanographic buoys are urgently needed.	Development of in-situ ocean observations, such as oceano-graphic buoys.	To focus on sites that already provide long non- disrupted high- quality records.
Capacity Building	Capacity building for personnel to operate and maintain the observation sites for meteorological, atmospheric, and oceanic variables should be continually supported. Moreover, capacity building is required on new issues emerging from the Paris Agreement, green growth education and business models for renewable energy. Research on adaptation to climate change in high-risk and vulnerable areas has shown that financial support is needed, especially in low- income communities. In addition, capacity building in areas of understanding impact to ecosystem services from policies and business.	Formulate long-term climate-economic models for use by policy-makers to forecast economic impacts from climate policies or measures, as well as, impact to ecosystem services.	To evaluate GHG emission mitigation capacity by a sectoral approach and macro-economic approach. Also, to evaluate policies on climate change on impacts to ecosystem services.
		Training programs for staff (who work on research and systematic observations) to operate and maintain the sites that gather data on meteorological, atmospheric and oceanic variables, and ecosystem services.	To set up continual data collection and coordination among related agencies.
		Integrated training for staff to carry out specific jobs or holistic tasks and emerging issues (in context of the Paris Agreement).	To strengthen the technical capacity of a broader range of staff.

Table 6-1 Information on the constraints, gaps, and support needs for implementation of climate change actions in Thailand (continued)

Need Area	Gaps/ Barriers/ Constraints	Needs	Rationales
Capacity Building	As mentioned above	Establishing reporting and monitoring systems for the ACE, in particular those in the nationally determined contributions.	To strengthen the technical capacity for a broader range of cooperation among related ministries and agencies.
Mitigation	• High investmentand operation costs for technologies and infrastructures to implement measures according to NDC roadmap. • Lack of methodologies and technologies for tracking the progress of NAMAs and NDCs.	• Financial support for investment and operation. • Capacity building and technological support for tracking NAMAs and NDCs.	-
Adaptation	• Community and urban planning to avoid inundation and impact during high-tides in the mouth of the rivers or during flooding season. This includes investments in housing, walkways and streets. • Investments in hard structures to protect rising sea levels along coastlines or shorelines. • Expenses for promoting soft structures (e.g. regulations and public services) to protect vulnerable land and coastal areas from immigrants or settlements, and to raise awareness, as well as, adaptive capacity for health problems relating to climate change.	Research and development (R&D) in hard structures to avoid rising sea levels along coastlines or shorelines, to reduce damages from floods, and to prevent agricultural damage from droughts.	To avoid and prevent huge damage and irreversible losses.
		Expenses relating to promoting soft structure (e.g. regulations and public services), as well as, raising awareness and adaptive capacity for health problems relating to climate change.	To protect vulnerable lands or coastal areas from immigrants or settlements.

Table 6-1 Information on the constraints, gaps, and support needs for implementation of climate change actions in Thailand (continued)

Need Area	Gaps/ Barriers/ Constraints	Needs	Rationales
Adaptation	The Technology Needs Assessments for Climate Change Adaptation in Thailand are categorized into three sectors: (a) Agriculture (b) Water Resource Management (c) Modeling	Three groups of technology needs for adaptation in the agricultural sector are identified: (i) forecasting and early warning systems; (ii) crop improvement for climate–resilience [Marker Assisted Selection (MAS) and genetic engineering]; (iii) precision farming technologies	(i) To reduce the risk of damage from extreme climate events and pest/ disease outbreaks, as well as, to increase the ability to select the right crops based on specific planting time and crop cycle; (ii) To reduce the risk of yield loss while increasing resource efficiency; (iii) To enable farmers to make informed decisions concerning their farming operations, as well as, to reduce inputs while maintaining maximum productivity and minimizing the effects on the environment.
	As mentioned above	The high-impact technologies that have been prioritized as technological needs in water resource management include: (i) networking (via pipes or canals) and management of infrastructures (including zoning); (ii) seasonal climate predictions as a part of weather and hydrological modeling; (iii) sensor webs using observation and/or modeling data as a part of an early warning.	(i) To increase the efficiency in water resources allocation among users in both urban and remote areas; (ii) To reduce risk and poverty of the farmers who make up the majority of Thailand's population.

Table 6-1 Information on the constraints, gaps, and support needs for implementation of climate change actions in Thailand (continued)

Need Area	Gaps/ Barriers/ Constraints	Needs	Rationales
Adaptation	As mentioned above	The expert groups and other stakeholder have identified the following technologies as high priority for the modeling: (i) the national data center; (ii) national data collection, transfer, and management process; (iii) integrated modeling i.e., Weather Research and Forecasting (WRF) and Advanced Research WRF (ARW).	To empower both public and private sectors, as well as, civil society for adapting to climate change. -

Table 6-2 Summary of gaps, barriers, constraints and needs for mitigation and adaptation to the CTCN

Gaps/ Barriers/ Constraints	Needs	Status (as of July 2017)
Agricultural Sector Thailand's agricultural production depends on natural cycles. Therefore, climate change has several effects on agriculture. Existing technologies will not be good enough to accommodate the changes expected.	• Increase the capacity for technological development. • Supporting Thai stakeholders to make more efficient use of resources in the agriculture sector. • Improve knowledge of agricultural technologies to help better manage the resource allocations needed for optimal resilience to climate change related impact on productivity.	Project Title Capacity Building on technological development for efficient use of resources in the Agriculture Sector Project Proponent The National Science and Technology Development Agency (NSTDA) Status Implementation/Asian Institute of Technology (AIT)
Early Warning and Environmental. Assessment Lack of adequate regional climate models, collection, and distribution of spatial and temporal meteorological and hydrological data.	Enhance climate information for adaptation decision making in Thailand with high-resolution climate modeling.	Project Proponent Faculty of Social Sciences, Chiang Mai University Status Design
Early Warning Lack of capacity in management of urban environmental issues such as rising sea levels and increased frequency of extreme weather events.	Strengthen Bangkok's early warning system to respond to climate induced flooding.	Project Proponent Bangkok Metropolitan Administration (BMA) Status Implementation/ UNEP and Danish Hydraulic Institute (DHI)
Building Energy Efficiency Sector Lack of knowledge and capacity for green building designs, as well as, evaluation, construction, technology implementation, retrofits, operation and maintenance	Foster green buildings in Thailand to create a low carbon society.	Project Proponent King Mongkut's University of Technology Thonburi (KMUTT) Status Design

Table 6-2 Summary of gaps, barriers, constraints and needs for mitigation and adaptation to the CTCN (continued)

Gaps/ Barriers/ Constraints	Needs	Status (as of July 2017)
Industry Sector The iron and steel industry is the one of large energy consuming industry, and one of the greatest sources of GHGs emissions. Thailand would like to study the baseline of energy consumption and GHG emissions of each process within the country to provide a benchmark to support Thailand's NAMA implementation.	Benchmark Energy Consumption and GHGs emission of the iron and steel industries of Thailand.	Project Proponent Iron and Steel Institute of Thailand (ISIT) Status Implementation of New Energy and Industrial Technology Development Organization (NEDO)
Energy Use Sector Implementation of energy efficient street lighting technologies has been very slow at the municipal level. The key barriers that contribute to the slow uptake are the lack of confidence when investing in these new technologies on a large scale and limited access to investment financing.	Assess energy efficient street lighting technologies and financing models for Thai municipalities.	Project Proponent Provincial Electricity Authority of Thailand (PEA) Status Implementation via The Energy and Resources Institute (TERI) and International Institute for Energy Conservation (IIEC)

Source: National Science Technology and Innovation Policy Office (STI), Ministry of Science and Technology, Thailand

Chapter 2 mentioned gaps and constraints on National GHG inventory for all sectors, namely the energy sector, the industrial sector, the agricultural sector, the waste sector, and the LULUCF sector. The followings are needed for better data collection to improve GHG inventory quality: (a) capacity building and enhancement of local experts in GHG inventory; (b) research to obtain country-specific emission factors in many sub-sectors of the agricultural sector, and accurate estimation on activity data of solid waste disposal; and (c) developing a MRV system for the LULUCF sector.

In addition, as mentioned in Chapter 3, the GHG emissions mitigation capacity should be understood as the ability of individuals, groups, organizations, and institutions concerned to solve the problems associated with climate change. This mitigation capacity is considered an integral part of a series of efforts towards a low carbon society and sustainable development. Thailand still needs support for improving GHG emission mitigation capacity covering three dimensions. These dimensions include (a) carrying out climate science studies, research and assessments, in all related industrial and energy sectors; (b) zero-burning in agricultural practices in rural areas are needed to be promoted, as well as, innovations in climate-friendly cultivation practices; and (c) formulating long-term climate-economic models in order for policy-makers to forecast economic impact from climate policies or measures.

Support needed for adaptation includes three areas, as stated in Chapter 4. These include : (a) community and urban planning to avoid inundation and impact during high-tides in the mouths of the rivers or during flooding season, including investments in housing, walkways and streets; (b) investment in hard structures to protect rising sea levels along coastlines or shoreline to reduce damages from floods and to preventing agricultural damage from droughts; and (c) expenses related to the promotion of soft structures (e.g. regulations and public services) to protect vulnerable lands and coastal areas from immigrants or settlements, as well as, raising awareness and adaptive capacity for health problems related to climate change.

In the issue of research and systematic observation, as mentioned in Chapter 5, there are few constraints. Priority should be put to maintain observation sites especially those in AERONET and FLUXNET. These sites are not the responsibility of other operational agencies. These sites are maintained by research institutions and universities, thus are reliant on funding availability. Support can strategically be focused on those sites, which already provide long, non-disrupting, high quality records. In addition, support for the development of an in-situ ocean observation network, such as oceanographic buoys are urgently needed.

Capacity building for personnel to operate and maintain the observation sites for meteorological atmospheric and oceanic variables should be continually supported. Moreover, capacity building is required on new issues emerging from the Paris Agreement, such as green growth education and business models for renewable energy. Research on adaptation to climate change in serval high-risk and vulnerable areas have shown that financial support is needed, especially in low-income communities.

One of the key elements in implementing adaptation capacity is promoting Actions for Climate Empowerment (ACE). Despite the progress made in implementing ACE activities, some important gaps and barriers remain, especially weak cooperation among related ministries and a lack of reporting and monitoring systems. Thus, establishing a reporting and monitoring system for ACE activities, in particular, those related to the Nationally Determined Contributions (NDCs), is a top priority that requires financial and technical support from international agencies.

6.2 SUPPORT RECEIVED

Thailand has received, and expects to receive, financial support, capacity building support and technical assistances from a number of international government and organizations. GEF provided grant funding, through UNDP, to assist Thailand in the preparation of its National Communication and Biennial Update Report. The four-year project, entitled Thailand's Third National Communication and Biennial Update Report to the UNFCCC, was initiated in April 2014. It was supported by GEF funding of USD 852,000 for Third National Communication (TNC) and First Biennial Update Report (FBUR). In addition, Thailand received an additional grant from GEF through UNDP with the amount of USD 352,000 for the preparation of its Second Biennial Update Report (SBUR). ONEP was the implementing agency, under the oversight of Thailand's Subcommittee on Climate Change Knowledge and Database under the National Committee on Climate Change Policy (NCCC).

The Greenhouse Gas Inventory Office of Japan has organized capacity building through a workshop series entitled Workshop on Greenhouse Gas Inventories in Asia (WGIA). The goal is to improve the accuracy of GHG inventories in Asia including Thailand. The Global Green Growth Institute (GGGI) assisted the implementation of Thailand's Climate Change Master Plan by developing a clear

roadmap for GHG reduction in three selected industrial sub-sectors of the Thai economy, including palm oil production, frozen foods, and automotive parts. The project was financially supported by the German Government. GGGI contributed to the development of the NDC Action Plan for the Thai industrial sector, focusing on GHG reduction from the energy sector, which offers high potential in terms of cost-effective GHG reduction measures and enhanced industrial competitiveness. Regarding capacity building in the area of climate finances, the UNDP supported ONEP on "Strengthening Thailand's Capacity to link Climate Policy and Public Finance (2013-2017)", with partial financial support by the Swedish International Development Agency (SIDA). "Thailand's Domestic Preparation for Post-2020 Contributions (2014–2016)" and "Achieving Low Carbon Growth in Cities through Sustainable Urban Systems Management in Thailand (LCC) 2015-2018" were funded by GEF through the UNDP. The "Low Emission Capacity Building (LECB)," by the European Commission, the German Federal Ministry for the Environment, Nature, Conservation, and Nuclear Safety, and the Australian government, is currently being implemented in Thailand with the UNDP support.

The information in Table 6-3 summarizes the sources of funding from international organizations and agencies related to climate change activities in Thailand. These include technology transfers, capacity building, mitigation and adaptation.

From 2010 through 2017, international financial support in technology transfers include regional support (UNEP), bilateral support (JICA), multilateral support (Japan Fund for Poverty Reduction, ADB), and global support (GEF, UNEP). These projects are related to preparing the master plan, the flood & drought management system, and data facilities for climate consortium for Asia and the Pacific region.

In the capacity building, international financial support, from 2013 to 2018, are bilateral supports (Australian Government, UK government, German government, and Forest Carbon Partnership Fund), multilateral support (UNDP, SIDA, EU), and global support (GEF). Besides preparing SBUR and TNC reports, LECB, and TGEIS projects, these capacity building projects include MRV, strengthening capacity to link climate policies and public finances, preparing for post-2020 contributions, measuring SCP, and preparing proposals on REDD+.

Between 2009 and 2021, mitigation projects mostly received global support (BMUB-IKI, GEF, World Bank) and bilateral support (BMUB-IKI, EU, JICA, NAMA Facility), while some projects were supported by regional types (by BMUB-IKI) and multilateral types (GEF, OECD). These projects are related to (a) bio-energy and renewable energy, (b) energy efficiency in the industrial sector and in the building sector, (c) water and wastewater management, (d) carbon market readiness, (e) climate fiancé, and (f) measuring mitigation performance at national policy and municipalities.

From 2012 – 2021, the adaptation projects are mostly supported by bilateral types (EU, Rockefeller Foundation, BMUB-IKI, IAED, CAAS, JICA, Deltares), global (GEF, BMUB-IKI, UNEP, FAO, WHO), regional (BMUB-IKI) types. The projects deal with (1) local coastal management, (2) community based adaptation, (3) sustainable forest and catchment management, (4) SCP awareness, (5) ethanol from agricultural products, (6) enhanced food security for small farmers, (7) biodiversity finances, (8) ecosystems protection, (9) agricultural zoning for major crops, (10) water management in watershed areas, (11) adaptive flood risk management and disaster risk reduction, (12) health vulnerability, and risk of heat stress, and (13) forest landscape restoration.

Table 6-3 Sources of Funding from international organizations for climate change activities regarding technology transfer, capacity building, mitigation and adaptation

Project Name	Project Period	Project Description	Donor Agency / Government	Types of Support
Technology transfern				
Technology Needs Assessment – Asia (Adaptation and Mitigation)	2010-2013	The research project entitled "Technology Needs Assessments and Technology Action Plans Report for Climate Change Mitigation/Adaptation in Thailand" allowed Thailand to be among one of the first fifteen countries from Africa, Asia, Latin America, Caribbean, and Europe to conduct the project funded by the UNEP Division of Technology, Industry and Economics (DTIE) in collaboration with the UNEP Risoe Centre.	UNEP	Regional
Project on Technical Collaboration for Preparing Bangkok Master Plan on Climate Change (2013 – 2023)	Since 2012	The scope includes environmentally-friendly and sustainable transport systems; energy efficiency and alternative sources of energy; efficiency in waste and wastewater management; green urban planning; and strategies for adaptation to climate change, especially flooding, coastal erosion, drought, and salt water intrusion. Each of these strategies raises measures for relevant agencies to implement and MRV.	JICA	Bilateral
Flood & Drought Management Tools, which include a decision support system (DSS)	2014-2018	The project outcome will enable stakeholders to compile information, with models, indicators and existing planning methods to develop future planning scenarios that are robust and resilient. The developed methodologies will be applied, both on the regional basin scale through IWRM, as well as, on a local scale for urban and industrial areas. Three pilot basins used in the developing and testing of the methodologies are Chao Phraya Basin (HAII), Lake Victoria Basin (The Lake Victoria Basin Commission) and Volta Basin (The Volta Basin Authority).	GEF (source of fund) UNEP, IWA and DHI	Global

Table 6-3 Sources of Funding from international organizations for climate change activities regarding technology transfer, capacity building, mitigation and adaptation (continued)

Project Name	Project Period	Project Description	Donor Agency / Government	Types of Support
Technology transfern				
Project TA-8359 REG – Regional Climate Projections Consortium Data Facility in Asia and the Pacific (RCCDF)	2015-2017	This was a technical assistance (TA) initiated by the Asian Development Bank (ADB) with grants from the Australian CSIRO to operate the project. Objectives included building networks in Asia and Pacific countries, in accordance with climate change issues; enhancing access to climate data; and strengthening capacity building for regional adaptation to climate change impacts.	Japan Fund for Poverty Reduction (JFPR) and ADB	Multilateral
Regional Climate Consortium for Asia and the Pacific (RCCAP) under RCCDF	2015-2017	This was developed under the Asian Development Bank (ADB) Technical Assistance for Regional Climate Projections Consortium and Data Facility in Asia and the Pacific (RCCDF) in order to gauge climate information products and services for pilot countries and to enhance technical capacity for developing and applying climate information products and services.	Japan Fund for Poverty Reduction (JFPR) and ADB	Multilateral
Capacity Building				
Low Emissions Asian Development Program's Winter Institute on the 2006 IPCC Guidelines for National Greenhouse Gas Inventories	2016	This project provided training to Thai government officer on the 2006 IPCC Guidelines for National Greenhouse Gas Inventories.	The United States of America through the USAID	Multilateral

Table 6-3 Sources of Funding from international organizations for climate change activities regarding technology transfer, capacity building, mitigation and adaptation (continued)

Project Name	Project Period	Project Description	Donor Agency / Government	Types of Support
Capacity Building				
Strengthening Thailand's Capacity to Link Climate Policy and Public Finance	2013-2015	The project aimed to support Thailand in strengthening its institutional capacity to link a coordinated and coherent green growth and climate change policy with its budgetary allocations. In addition, it aimed to report and measure over time the effectiveness of those policies and expenditures. This work further promoted sharing of knowledge across countries to help identify and support innovation at the regional level by linking climate policies, public finance and accessing international climate finance.	UNDP/SIDA	Multilateral
Thailand's Domestic Preparation for Post-2020 Contributions	2014-2016	To identify Thailand's contributions to the post-2020 global climate agreement (called 'Intended Nationally Determined Contributions' or 'INDC') and to strengthen Thailand's engagement in the UNFCCC negotiation process leading to the post-2020 agreement. The need to submit INDC followed a decision adopted by UNFCCC COP 19 in November 2013.	GEF	Global
Third National Communication and Biennial Update Report	2014-2018	The project aims to enable Thailand to prepare its Third National Communication (TNC) under Decision 17/CP7 and the first Biennial Update Report (BUR) under Decision 2/CP17 to the UNFCCC. ONEP is the host.	GEF	Bilateral

Table 6-3 Sources of Funding from international organizations for climate change activities regarding technology transfer, capacity building, mitigation and adaptation (continued)

Project Name	Project Period	Project Description	Donor Agency / Government	Types of Support
Capacity Building				
Thailand's Second Biennial Update Report (SBUR) to the UNFCCC	2017-2018	Thailand's Second Biennial Update to the UNFCCC Project involves the preparation of the SBUR for submission to UNFCCC, in accordance with its commitment as a Party to the Convention as per Decision 2/CP.17 taken at COP 17.	GEF	Bilateral
Thailand's Greenhouse Gas Emissions Inventory System (TGEIS)	2017-2018	ONEP and the Australian Government by Department of the Environment and Energy have signed an MOU for Australia – Thailand Cooperation on National Greenhouse Gas Inventories (June 2016) to support the Greenhouse Emission Inventory in Thailand by applying the Australian Greenhouse Emissions Information System (AGEIS) and establishing the Thailand's Greenhouse Gas Emissions Inventory System (TGEIS). The TGEIS will contribute to a more efficient inventory system to support the Thailand National Communication (NC) and Biennial Update Report (BUR).	Government of Australia	Bilateral
2050 Thailand - UK Pathways Calculator	2013-2014	The project was designed to calculate the energy balance and GHG emissions from the energy sector in Thailand, as well as, to collaborate in technology and knowledge transfer. TGO is the national focal point for developing the model. The project was supported by the Department of Energy and Climate Change (DECC), the Foreign and Commonwealth Office, and the Department for International Development	UK	Bilateral

Table 6-3 Sources of Funding from international organizations for climate change activities regarding technology transfer, capacity building, mitigation and adaptation (continued)

Project Name	Project Period	Project Description	Donor Agency / Government	Types of Support
Capacity Building				
Low Emission Capacity Building (LECB) Project in Thailand	2013-2018	The goal of this project is to build capacities for the development of Nationally Appropriate Mitigation Actions (NAMAs) in selected industrial sectors and to systematize the GHG inventory in the sectors of Transport and Waste, with four outcomes: 1. Strengthened institutional & procedural system for the National GHG Inventory System for the transport and waste sectors; 2. Create a portfolio of NAMA proposals and their built-in MRV systems developed for selected industrial sector(s); 3. Formulate multiple source Finance and Technology Transfer Framework to support the implementation of NAMAs and policies/programs in selected industrial sectors; 4. Establish knowledge platforms to ensure the flow of expertise among key stakeholders of NAMAs in selected industrial sectors.	The European Commission, The German Federal Ministry for the Environment, Nature, Conservation and Nuclear Safety, and the Australian government	Multilateral
Advancing and Measuring Sustainable Consumption and Production (SCP) for a Low-Carbon Economy in Middle-Income and Newly Industrialized Countries (Advance SCP)	2015-2018	This project is funded by Germany (Ministry of Environment) and organized by GIZ and agencies in 4 ASEAN countries (Thailand, Indonesia, Malaysia, and the Philippines). The Pollution Control Department (PCD) is the supported agency.	Government of Germany	Bilateral
Readiness Preparation Proposal (R-PP) on REDD+	2016-2019	This was a grant from the Forest Carbon Partnership Facility (FCPF). The focal point of this project is the Department of National Parks, Wildlife and Plant Conservation (DNP).	FCPF	Bilateral

Table 6-3 Sources of Funding from international organizations for climate change activities regarding technology transfer, capacity building, mitigation and adaptation (continued)

Project Name	Project Period	Project Description	Donor Agency / Government	Types of Support
Mitigation				
Sustainable Palm Oil Production for Bioenergy	2009-2012	The project supported the introduction of international sustainability standards for Thailand's palm oil production, as well as, certification of its cultivation and processing. The impact of the cultivation and increasing use of palm oil for energy generation have been investigated in order to identify and prevent any adverse effects. The project also provided advisory support on the issues of sustainability standards and promoted dialogue among the various political and economic actors within the palm oil sector.	BMUB/IKI	Regional
Improve the Energy Efficiency of Small and Medium-Sized Businesses	2009-2012	The project improved advisory services and funding instruments to increase energy efficiency in Thailand. It fostered the sharing of experiences between the Thai institutions (ministries, associations, private consulting companies, etc.), German organizations and model enterprises. The project partners implemented specific energy efficiency measures in selected enterprises in order to create examples of good practice and demonstrate the potential for cost savings and reductions in greenhouse gas emissions.	BMUB/IKI	Regional
Sectoral Study on Climate and Refrigeration Technology in Developing Countries and the Development of Methods and Instruments for Identifying Reduction Potential and Implementing NAMA	2010-2014	The project enabled decision-makers in developing countries to estimate their fluorinated greenhouse gas emissions and the potential reductions to be achieved by using alternative technologies, such as natural refrigerants. The project advised the partner governments on formulating regulations for individual industry sectors and on nationally appropriate mitigation actions (NAMAs). The project developed and tested a method for recording the sector-specific use of halogenated hydrofluorocarbons (HFCs), which are harmful to the climate. A handbook was also produced containing guidelines on preparing NAMAs. The project was piloted in four partner countries (India, Mexico, Colombia, South Africa), which then acted as models for other countries in their regions.	BMUB/IKI	Regional

Table 6-3 Sources of Funding from international organizations for climate change activities regarding technology transfer, capacity building, mitigation and adaptation (continued)

Project Name	Project Period	Project Description	Donor Agency / Government	Types of Support
Mitigation				
Enhance low-carbon development by greening the economy: policy dialogue, advisory services, benchmarkingy	2011-2014	The project provided content-related support in the preparatory and follow- up processes surrounding the UN conference 'Rio+20' and developed a concrete roadmap towards a green economy that led to reductions in greenhouse gases and more efficient use of resources. It developed macroeconomic guidelines in the form of tax reforms and trade regulations, as well as, progress indicators related to investments and employment. For example, help to measure progress towards poverty reduction and the development of a green economy. In addition, the project partnered with governments in six developing and emerging countries (China, Ghana, India, Morocco, Thailand, and Uruguay) in different regions on low-carbon development. This involved both the formulation of operative strategies and their practical implementation.	BMUB/IKI	Global
Measurement and Performance Tracking (MAPT) of Climate Change Mitigation Activities	2011-2016	The project worked with five partnering countries, assessing existing monitoring systems, greenhouse gas (GHG) inventories and institutional capacities in the areas of the measurement, reporting and verification (MRV) of GHG emissions, in the context of each country's specific needs and further developed. The project supported the development of MRV systems at the national, sub-national, sectoral and international levels through workshops, training events, and case studies. The project incorporated decision-makers, private sector, and civil society in all phases. With the support of all relevant stakeholders, this top-down/bottom-up approach helped to establish guidelines and standards at the national level and also prepared the ground for uniform international MRV standards. The experience gained is analyzed and made available internationally to replicate successes and influence the development of international MRV regulations.	BMUB/IKI	Global

Table 6-3 Sources of Funding from international organizations for climate change activities regarding technology transfer, capacity building, mitigation and adaptation (continued)

Project Name	Project Period	Project Description	Donor Agency / Government	Types of Support
Mitigation				
GEF: 3786 Industrial Energy Efficiency (IEE) Project	2011-2017	The project intended to improve in energy efficiency through the components on policy, capacity building and demonstration projecs. Stakeholders included industrial enterprises, equipment suppliers, distributors, engineering / energy service companies and government planners to develop services focused on capturing system level efficiencies. With the introduction of national energy management standards, energy efficieny was integrated into management systems of industrial enterprises to accelerate the adoption of energy efficient best practices on a continuous basis. In addition, the competitive position of companies was enhanced through their eventual incorporation of energy efficient-operation into the national certification process. The project also contributed to reducing energy intensity and energy elasticity. There were four components: national program to implement energy management standard and recognition programs; technical assistance to build capacity through tools and training on energy management, including industrial systems optimization to enable industries comply with national standards; financial capacity development to support energy efficiency projects in industries; and industrial energy efficiency projects including biomass boilers.	GEF	Global

Table 6-3 Sources of Funding from international organizations for climate change activities regarding technology transfer, capacity building, mitigation and adaptation (continued)

Project Name	Project Period	Project Description	Donor Agency / Government	Types of Support
Mitigation				
Partnership for Market Readiness	2011-2021	Launched in 2010, the Partnership for Market Readiness (PMR) helps to establish carbon markets in developing, emerging and transition countries. Guided by the needs of the partner countries, the PMR is pursuing various approaches, such as the development of national emissions trading systems or new market instruments (new market mechanisms, CO_2 taxes and national certification standards). The PMR functions both as a dialogue forum for technical exchange and as a trust fund for developing, piloting and implementing new carbon market instruments. Its work also helps to create systems for the measurement, reporting and verification (MRV) of emission reductions, as well as, expanding resources and expertise.	BMUB/IKI	Global
Thai-German Programme on Energy Efficiency Development Plan (TGP-EEDP)	2012-2015	The project aimed at implementing Thailand's National Energy Efficiency Plan in the industrial and building sectors. The data pool in particular was being improved in terms of sector-specific energy consumption and potential of reductions. This data was helpful in calculating potential efficiency gains, creating new incentive systems, strengthening energy management, and establishing optimized standards and designations. The policy advice was supplemented by concrete pilot measures for improving energy efficiency among small and medium-sized enterprises (SMEs) in the automotive supply industry. The experience gained in using the instruments in the energy efficiency plan contributed decisively to further policy making in this area.	BMUB/IKI	Bilateral

Table 6-3 Sources of Funding from international organizations for climate change activities regarding technology transfer, capacity building, mitigation and adaptation (continued)

Project Name	Project Period	Project Description	Donor Agency / Government	Types of Support
Mitigation				
The Promotion of Low Carbon City across Municipalities in Celebration of His Majesty the King's 84th Birthday	2012-2015	To promote climate mitigation awareness among municipalities and to create Low Carbon City at the local level, under 4 frameworks: City of Trees; City of Waste Minimization; City of Energy Efficiency, and City of Sustainable Consumption concepts. The project covered 5 regional areas of Thailand: North, Northeast, Central, East and South.	EU	Bilateral
Green Growth Project in Bangkok	Since 2013	Promoting green growth in Bangkok includes the transport sector, infrastructure, adaptation to climate change, resource consumption, environmentally friendly production, and contribution of community or public participation. There are four areas of work shared with other agencies and neighboring provinces: land use and transport, waste and water resources management, greener energy, and flood protection and rehabitation.	OECD	Multilateral
GEF: 4184 Promoting Small Scale Biomass Power Plants in Rural Areas of Thailand for Sustainable Renewable Energy Management and Community Involvement	2012-2015	The project aimed at promoting an on-grid small biomass-based power plant as a means of sustainable management and use of biomass in rural Thailand. There were 3 components: installation and sustainable operation of on-grid small biomass power plants; capacity building for communities to replicate and adopt a community-based wood-fired power plant; and policy change to promote community-based biomass power plant.	GEF	Global

Table 6-3 Sources of Funding from international organizations for climate change activities regarding technology transfer, capacity building, mitigation and adaptation (continued)

Project Name	Project Period	Project Description	Donor Agency / Government	Types of Support
Mitigation				
GEF: 3937 Promoting Energy Efficiency in Commercial Buildings (PEECB) in Thailand	2013-2017	The project aimed at the reduction in the annual growth rates of GHG emissions from the operation of commercial buildings through the application of EE technologies and practices. This project aimed to increase the demand for EE equipment and practices, so that manufacturing costs of EE equipment gradually decreased to create business feasibility for banks and commercial buildings by focusing on existing and new commercial buildings. There were 3 components: awareness enhancement on building EE technologies and ractices; EE building policy frameworks; and EE building technology application demonstrations.	GEF	Multilateral
NAMA-Programme for the construction sector in Asia	2013-2017	The project supported countries to develop Nationally Appropriate Mitigation Actions (NAMA) for the building sector. The NAMAs applied common Measurement, Reporting and Verification (MRV) methodologies for buildings that were developed in the frames of this project and in line with work by the Clean Development Mechanism (CDM) and the Common Carbon Metric (CCM) developed by the UNEP. Activities included the identification and recommendation of appropriate measures for the development of NAMAs in partner countries and the development and implementation of a regional networking component, in order to facilitate capacity building and the replication of results in other countries within the same region. Furthermore, the project piloted the developed MRV methodology.	Japan International Cooperation Agency (JICA)	Regional
Capacity Development on Climate Change Mitigation / Adaptation in the Southeast Asia Region	2013-2016	The project consisted of 4 training programs: 1) Greenhouse Gas Inventory; 2) Low Carbon and Resilience Society Development; 3) Mitigation Mechanism; and 4) Climate Change Economics.	Japan International Cooperation Agency (JICA)	Bilateral

Table 6-3 Sources of Funding from international organizations for climate change activities regarding technology transfer, capacity building, mitigation and adaptation (continued)

Project Name	Project Period	Project Description	Donor Agency / Government	Types of Support
Mitigation				
Partnership for WaCClim: Water and Wastewater Companies for Climate Mitigation	2013-2019	The project introduces greenhouse gas-reducing technologies to water and wastewater companies and thereby, improving those companies' CO_2 balance. It supports climate protection efforts in the water sector using a cross-sectoral approach known as the 'urban nexus', which addresses water, energy and food security in an integrated manner. In four pilot countries (Mexico, Peru, Jordan, Thailand), the project works with experts and managers, advising them on how to improve the policy, regulatory and institutional framework for the integration of emission reduction measures in the water sector.	BMUB/IKI	Global
Industry GHG Reduction to Support the Implementation of Thailand's Climate Change Master Plan 2014-2050	2014-2016	This project provided technical assistance in the development of industrial sector GHG reduction strategies for GHG that complements the Climate Change Master Plan 2014-2050. The project included 3 components: Developing GHG reduction roadmaps for the country's industrial sectors with a special focus on automotive parts, palm oil and frozen food sub-sectors; identifying potential GHG reduction measures and technologies, and conducting technological and economic analysis; and enhancing capacity and coordination within RTG and the private sector in order to conduct GHG inventories, emission projections, and economic impact assessments of mitigation measures on the selected sub-sectors.	Government of Germany – BMUB	Bilateral
Capacity Development on Renewable Energy and Grid Integration (CapREG)	2014-2016	This project delivered basic and advanced training on renewable energy grid integration in countries in Mexico, Peru, Ecuador, Vietnam, Thailand, the Philippines and Indonesia. Its target groups consisted of specialist personnel in key institutions in the private and public energy sector. The specialist personnel were trained in grid operations and the development of an enabling economic and policy environment for the energy sector.	BMUB/IKI	Global

Table 6-3 Sources of Funding from international organizations for climate change activities regarding technology transfer, capacity building, mitigation and adaptation (continued)

Project Name	Project Period	Project Description	Donor Agency / Government	Types of Support
Mitigation				
Mitigation Momentum II	2014-2017	he project supported nationally appropriate mitigation actions (NAMAs) in the partner countries. It improved the institutional structures. It supported partner countries in increasing their contributions to global climate change mitigation. To this end, the project was developing strategies for financing mitigation activities. Furthermore, it seeked to communicate best practices related to implementation and financing of mitigation strategies. Phase II built on Mitigation Momentum I, which supported Chile, Indonesia, Kenya, Peru and Tunisia in developing NAMA proposals. These proposals (with the exception of Chile) will continue to be supported financially, and in some cases additional NAMAs will be developed. Additional countries developing NAMAs are Ethiopia, Georgia, and Thailand. Through the NAMA Annual Status Report published by the project and specific research on NAMA related topics, the project also inform the international debate on NAMAs.	BMUB/IKI	Global
Strategic Environmental Dialogues	2014-2019	Building on two previous projects of the International Climate Initiative, this project intensifies the ongoing strategic environmental dialogue with important emerging economies, such as Brazil, China, India and Thailand, and expands the dialogue to include other countries. In addition to policy-makers, key stakeholders from industry, academia and civil society take part in the dialogue forums. The aim is to promote bilateral and international exchange on environmentally friendly and low-carbon business strategies, and thereby, have a positive impact on the positions of the partner countries in climate negotiations. The project supports the German Federal Environment Ministry with technical advice and administrative/logistical tasks for hosting high-level, bilateral environmental forums. It also organizes bilateral expert working groups, as well as, international and regional conferences, and carries out studies to prepare for the dialogues.	BMUB/IKI	Global

Table 6-3 Sources of Funding from international organizations for climate change activities regarding technology transfer, capacity building, mitigation and adaptation (continued)

Project Name	Project Period	Project Description	Donor Agency / Government	Types of Support
Mitigation				
GHG Reduction and Carbon Credit Development Projects under Joint Credit Mechanism (JCM)	2015-2016	The Japan government supported several activities: (1) Financial support no more than 50% of the total investment of each GHG reduction project under JCM; (2) Technical support in GHG reduction measurement; (3) subsidized the expenses of the Third Party Entity (TPE); and (4) Funds for capacity building of project developers and monitors.	Government of Japan	Bilateral
Green Banking - Capacity Building on Green Energy and Climate Finance	2015-2018	Lacking availability of appropriate financing options is still a major hurdle for unlocking the climate change mitigation potential for Renewable Energy (RE) and Energy Efficiency (EE) in developing countries. A main reason is the missing know-how of bankers and investors in RE and EE, resulting in an exaggerated risk perception. The "Green Banking", a joint project by RENAC and "Association of Development Financing Institutions in Asia & Pacific" (ADFIAP), focuses on sustainable capacity building measures and support for bankers and investors in Thailand, Vietnam, Indonesia, the Philippines and India.	BMUB/IKI	Regional
Partnership for Market Readiness (PMR)	2016-2019	PMR is the financial and technical support for capacity building in countries that aim to develop market mechanism for reducing GHG emissions. There were 3 main elements: 1) preparation for increasing energy efficiency and GHG reduction in buildings and factories (Energy Performance Certificate scheme: EPC); 2) preparation for municipalities and communities toward Low Carbon Cities; and 3) Study and propose legal framework for an Emission Trading Scheme (ETS)	World Bank	Global

Table 6-3 Sources of Funding from international organizations for climate change activities regarding technology transfer, capacity building, mitigation and adaptation (continued)

Project Name	Project Period	Project Description	Donor Agency / Government	Types of Support
Mitigation				
Thailand Refrigeration and Air Conditioning NAMA (RAC NAMA)	2016-2020	The project aims at leapfrogging technological developments in the RAC sector and covers: 1) shaping policy & regulatory framework, 2) supporting the production & assembly of local green RAC equipment, 3) preparing the service sector, and 4) supporting the market introduction. The NAMA will transform the production and use of RAC appliances for both the domestic and commercial sectors. RAC equipment introduced within the project period will cut emissions by over 15 Mt CO_2eq over the equipment lifetime, resulting in an annual reduction of around 0.9 Mt by 2020 and a market penetration of about 20%.	NAMA Facility	Bilateral
Establish Low Carbon Consumption and Production in Indonesia, Thailand and the Philippines	2017-2019	The project supports national governments in their development of NAMAs or related mitigation strategies in the agricultural, forestry or related sectors. Companies are encouraged to implement sustainable business models. Consumer awareness at the national level with regard to sustainable production and consumption (SCP) is raised by integrating stakeholders into discussion fora/ platforms and through information and communication campaigns.	BMUB/IKI	Regional
Achieving Low Carbon Growth in Cities through Sustainable Urban Systems Management	2017-2021	The project aims at promoting sustainable low carbon development in four pilot cities including Nakhon Ratchasima Municipality, Khon Kaen Municipality, Koh Samui Municipality and Chiang Mai Municipality through capacity enhancement, as well as, integrated framework at the local level	GEF	Global

Table 6-3 Sources of Funding from international organizations for climate change activities regarding technology transfer, capacity building, mitigation and adaptation (continued)

Project Name	Project Period	Project Description	Donor Agency / Government	Types of Support
Adaptation				
Climate Protection in Nature-Based Tourism	2008-2013	The project aimed to contribute to the sustainable development of the tourism sector in Thailand by helping Thai partners take into account aspects of climate change and nature conservation when preparing and implementing tourism development plans within the context of a national strategy. The project partners tested management tools for sustainable tourism development in the pilot region of Koh Chang. Furthermore, the project partners seeked to build capacity among the relevant authorities and raise awareness among policymakers of the impact of climate change on the tourism sector.	BMUB/IKI	Bilateral
Geodetic Earth Observation Technologies for Thailand: Environmental Change Detection and Investigation (GEO2TECDI) towards a Sea Offensive Next Generation	2009-2010	This plan scaled up the scientific research outcome on sea level rise, plate motion and land subsidence to policy level. This scaling up of the TEC-I GEO2TECDI projects was done by expanding the target areas, refining scientific results including latest data, generating scenarios for the coming decades, and presenting these scenarios to local coastal management authorities and the general public.	EU	Bilateral
Programme for the Development and Implementation of Climate Policy	2009-2014	The project supported elaborating and implementing its national climate change strategy and reducing greenhouse gas emissions. International experts advised the various political bodies. The project built the necessary implementation capacities at the relevant institutions at national and sub-national levels. In addition, it assisted Thailand in regard to international cooperation on climate policy and promoted awareness-raising and societal participation in dealing with climate change issues.	BMUB/IKI	Bilateral

Table 6-3 Sources of Funding from international organizations for climate change activities regarding technology transfer, capacity building, mitigation and adaptation (continued)

Project Name	Project Period	Project Description	Donor Agency / Government	Types of Support
Adaptation				
Development and Scaling up of a Climate Change Community-Based Adaptation (CC CBA) Model for Food Security in Thailand	2011-2013	This is a project under the Thailand - EU Cooperation Facility phase II (TEC II). The program was designed to strengthen and diversify the relationship between the European Community and Thailand in a wide range of areas to deepen the economic, political and cultural partnership between the two. The objective of this project was to increase the resilience and adaptation capacity of small-scale farmers in Northern and Northeastern Thailand to weather variability and climate change.	EU	Bilateral
Sustainable Consumption and Production: Policy Support Component Thailand	2011-2014	This project supported the Thai government in selecting, adapting and implementing suitable economic and regulatory policy instruments to promote SCP, thereby enhancing the long-term sustainability of Thai consumption and production patterns. Project components included SCP policy assessment and monitoring, promoting green procurement procedure, promoting green industry mark in selected industries, and promoting SCP awareness at local level.	EU	Bilateral
GEF 3445: Integrated Community-based forest and Catchment Management through an Ecosystem Service Approach (CBFCM)	2011-2015	This approach created an enabling policy and institutional environment for scaling-up of integrated community-based forest and catchment management (CBFCM) practices through harnessing of innovative financing mechanisms in Thailand. There were two components: strengthening of systemic capacities in sustainable forest and catchment management; and expansion of CBFCM coverage through pilot testing and scaling of best practices.	GEF	Global

Table 6-3 Sources of Funding from international organizations for climate change activities regarding technology transfer, capacity building, mitigation and adaptation (continued)

Project Name	Project Period	Project Description	Donor Agency / Government	Types of Support
Adaptation				
Promotion of Community Rights on Coastal Resource Management for Sustainable Livelihoods of Coastal Communities	2012-2015	This plan promoted community rights on coastal resources management of fisher folk communities in five coastal provinces of southern Thailand: Nakhon Si Thammarat, Phatthalung, Prachuap Khiri Khan, Satun and Songkhla provinces.	EU	Bilateral
GEF: 4037 Overcoming Policy Market and Technological Barriers to Support Technological Innovation and South-South Technology Transfer "the Pilot Case of Ethanol Production from Cassava"	2012-2016	This project aimed to address and overcome technology, market and policy barriers to help Thailand realize its ethanol goals and to share its experience, its know-how and "success" with other developing countries through full package South-South technology transfer and demonstration sites. There were four components: technology improvement and institutional capacity strengthening; commercialization and private sector development; South-South technology cooperation with neighboring countries; improved financing opportunities; and improved policy environments.	GEF	Global
Enhancing Food Security for Smallholder Farmers through Participatory Knowledge Creation and Multi-Sector Collaboration on Sustainable Agriculture and Natural Resource Management	2012-2016	This plan enhanced food security for smallholder farmers through participatory knowledge creation and multi-sector collaboration on sustainable agriculture and natural resource management. The project was funded by Hug Muang Nan Foundation, in Nan Province on 3 river basin areas: 1) Nam Meed; 2) Nam Wa/Nam Jam and 3) Khun Samun.	EU	Bilateral

Table 6-3 Sources of Funding from international organizations for climate change activities regarding technology transfer, capacity building, mitigation and adaptation (continued)

Project Name	Project Period	Project Description	Donor Agency / Government	Types of Support
Adaptation				
Biodiversity Finance Initiative – BIOFIN	2012-2016	The Biodiversity Finance Initiative (BIOFIN) was managed by the UNDP, in cooperation with the EU Commission, Switzerland and Germany (BMUB). In accordance with COP 11 resolutions, BIOFIN aimed to support CBD parties in preparing demand analyses and developing national resource mobilizing strategies in order to implement the strategic plan. A central technical unit with four employees was established in Istanbul. They were assigned with providing methodology development, general coordination and technical advice services to partner countries.	BMUB/IKI	Global
Ecosystems Protecting Infrastructure and Communities (EPIC)	2012-2017	Using an innovative approach involving five case studies, the project consortium of international non-governmental organizations and universities worked to identify and document the benefits of preserving ecosystems. The objective was to raise awareness of the role and function of ecosystems as protective barriers and as contributors to reducing climate-related risks. Intact ecosystems, not only counter the consequences of climate change such as rising sea levels, they also contribute to carbon storage and safeguard livelihoods. On the basis of their findings, the project partners provided knowledge and expertise on ecosystem-based practices to reduce risk in selected countries. These approaches were also disseminated among relevant actors through networks, forums and workshops.	BMUB/IKI	Global

Table 6-3 Sources of Funding from international organizations for climate change activities regarding technology transfer, capacity building, mitigation and adaptation (continued)

Project Name	Project Period	Project Description	Donor Agency / Government	Types of Support
Adaptation				
100 Resilience Cities (100 RC) Bangkok	Since 2013	This is the preparation project for coping to climate change. The objectives are (a) to reduce risk and increase capacity building in adapting to climate change; and (b) to drive the economy towards stronger competitiveness. There are 60 projects in Bangkok. In 2017, 10 more projects were implemented.	Rockefeller Foundation	Bilateral
Climate Technology Centre and Network – Phase 1	2013-2015	This network created and managed a Climate Technology Centre that met the broad range of demands of developing countries in an efficient and effective manner. It brought together a carefully constituted group of leading institutions located in both developing and developed countries combining decades of complementary expertise.	UNEP	Global
National Agro-economic Zoning for Major Crops in Thailand	2013-2015	This project aimed to introduce the national Agro-economic Zoning (AEZ) system applied in this agro-economic zoning study of Thailand. The AEZ followed an environmental approach and used detailed spatial data and prices of 2010 – 2014. The results were used to map the comparative advantage of eight major economic crops and to compare their economic performance with regard to current land use patterns as derived from high- resolution spatial data of 2009 - 2012. This permitted detection of locations where current land use deviates from assessed agro-ecological suitability or produces poor agro-economic results in comparison to best available options.	FAO	Global

Table 6-3 Sources of Funding from international organizations for climate change activities regarding technology transfer, capacity building, mitigation and adaptation (continued)

Project Name	Project Period	Project Description	Donor Agency / Government	Types of Support
Adaptation				
Water Management Pilot Project: Improved Management of Extreme Events through Ecosystem- based Adaptation in Watersheds (ECOSWat)	2013-2016	With Thailand facing the threat of more frequent floods and droughts in its water catchment areas as a result of climate change, the project worked to prevent an increase in damages caused by these events. To this end, it implemented Ecosystem-based Adaptation (EbA) measures together with its local partners. EbA approaches were being piloted in the Chi and Tha Di catchment areas and the experiences gained are informing national processes such as the national adaptation strategy, as well as, international debate on the issue. The made use of existing networks in the partner country and further developed them with the aim of improving cooperation between the authorities responsible for adaptation to climate change and the authorities operating in the water sector.	BMUB/IKI	Bilateral
Community Water Management for Adaptation to Climate Change	2014-2016	This was sharing of information and research related to water management at the community level for coping with climate change using science and technology to utilize water resources efficiently and to raise living standards. Funding sources included the Chinese Institute of Agricultural Economics and Development (IAED), and the Chinese Academy of Agricultural Sciences (CAAS)	IAED, CAAS	Bilateral

Table 6-3 Sources of Funding from international organizations for climate change activities regarding technology transfer, capacity building, mitigation and adaptation (continued)

Project Name	Project Period	Project Description	Donor Agency / Government	Types of Support
Adaptation				
Support to the Strategic Alignment and Implementation of Climate Change Policy in Thailand (Development and Implementation of Climate Policy)	2014-2017	The project aimed to support Thailand's government in the implementation of an ambitious climate policy. Corresponding benchmarks included the planned Climate Change Master Plan (CCMP), Thailand's five-year development plan and several energy strategies. The project provided training on climate issues and advisory support on institutional development. Furthermore, it supported the coordination of NAMAs, the development of subnational climate change master plans and action plans in pilot regions. The project advised partners on carrying out an energy transition. A national forum on Energy Transition and an international dialogue with Germany incentivized a practice-oriented emissions reduction policy. The project promoted effective networking among the international climate projects operating in Thailand. It built on the project "Development and implementation of climate policy".	BMUB/IKI	Bilateral
Supporting Developing Countries to Integrate the Agricultural Sectors into National Adaptation Plans (NAPs)	2014-2018	Parties to the UNFCCC invited UN organizations to enhance support to countries with their National Adaptation Plan (NAP) process. In the context of ongoing support for NAPs, this project seeks to assist developing countries to build technical capacities to integrate key adaptation requirements for the agriculture sectors into cross-sectoral planning and budget processes. Evidence-based results, using experimental design principles of monitoring frameworks of existing project portfolios (BMUB, LDCF, SCCF), will be shared for informed policy decisions. Capacity building support will be linked to the assistance provided by the GEF Global Support Programme -NAPs. This project will enable UNDP and FAO to apply their respective strengths in jointly assisting developing countries. This integrated approach will serve as a role model for other sectors on how to integrate sector based issues into the overall NAPs process.	BMUB/IKI	Global

Table 6-3 Sources of Funding from international organizations for climate change activities regarding technology transfer, capacity building, mitigation and adaptation (continued)

Project Name	Project Period	Project Description	Donor Agency / Government	Types of Support
Adaptation				
Strategic Research on Adaptive Flood Risk Management and Innovative Tools for Water Management	2014-2019	Objectives of the project are to establish research collaboration focusing on developing flexible strategies for adaptive flood management; to enhance capacity building for the development of flood modeling and operational management systems; to develop and promote the use of innovative tools for flood and water management; and to initiate a joint project between Deltares and HAII to stimulate scientific exchange between specialists and researchers to organize workshops and training.	Deltares (Netherlands)	Bilateral
Qualitative Assessment of Health Vulnerability and Adaptation to Climate Change Risks in Thailand	2015	This project assessed health vulnerability from climate change impact. Support was provided to the Department of Health, Ministry of Public Health, by the World Health Organization (WHO).	WHO	Global
Climate Profile-Thailand 2015	2015	This project accessed climate information related to health.	WHO	Global
Risk-based National Adaptation Plan (Risk NAP)	2015-2019	This plan integrates adaptation activities in the Project “master plan for climate change adaptation in risk management” There are four action plans: (1) climate change risk assessment and analysis; (2) national adaptation master plan; (3) integrate climate change risk in making plan; and (4) financial incentives for climate change adaptation activities.	BMUB/IKI	Bilateral
Qualitative Assessment of the Risks of Heat Stress in Thailand	2016	This project assessed the risks of heat stress in Thailand.	WHO	Global

Table 6-3 Sources of Funding from international organizations for climate change activities regarding technology transfer, capacity building, mitigation and adaptation (continued)

Project Name	Project Period	Project Description	Donor Agency / Government	Types of Support
Adaptation				
The Strengthening Institutional and Policy Framework on Disaster Risk Reduction and Climate Change Adaptation Integration	2016-2017	This project was funded by the Japan International Cooperation Agency (JICA) for the Department of Disaster Prevention and Mitigation, Thailand under the ASEAN Agreement on Disaster Management and Emergency Response (AADMER) Work Programme. It analyzed and proposed an integrated policy framework in ASEAN to reduce disaster risk and adaptive capacity in climate change at the community, country, and regional levels.	JICA	Bilateral
Advancing Co-Design of Integrated Strategies with Adaptation to Climate Change in Thailand (ADAP-T)	2016-2021	This project shares knowledge in climate change issues and to take appropriate adaptation measures to protect from adverse impacts from climate change in a sustainable way. This is supported by the Thai Meteorological Department (TWD).	JICA/JST	Bilateral
Project for Capacity Development to Accelerate Low Carbon and Resilient Society Realization in the Southeast Asia Region	2017-2020	The Project consists of 3 elements: 1. Developing training programs for specific target groups (i.e. Mitigation Mechanism/MRV training program and Climate Finance training program). 2. Establishing a network of academic and technical experts at regional level with international organization, e.g. ASEAN Secretariat, UNFCCC and GCF. 3. Enhancing knowledge related to climate change for stakeholders (government, private sector, education, public and journalists) in Thailand and ASEAN members.	Japan International Cooperation Agency (JICA)	Bilateral
Production Driven Forest Landscape Restoration under REDD+ through Private Sector – Community Partnerships as Asian Regional Learning Exchange	2017-2021	Regional Support	BMUB/IKI	Regional

REFERENCES

Amnat Chittaisong, et. al. (2010). Climate Change in Thailand, book no. 2, GCM and Future Climate, 1stPrint, TRF, Bangkok.

ADPC (2013). Integrating Disaster Risk Management into Climate Change Adaptation. Disaster Risk Management Practitioner's Handbook Series. Bangkok.

ADPC (2012). Risk Assessment and Formulation of Disaster Risk Reduction Strategy for Sindh and Punjab Provinces. Unpublished report.

Applied Economic Research Center (2010). 2nd National Communication, submitted to ONEB.

Carlsen H, Dreborg KH, Wikman-Svahn P. (2012). Tailor-made scenario planning for local adaptation to climate change.Mitig Adapt Strateg Glob Change, DOI 10.1007/s11027-012-9419-x.

Chiangmai University (2013). Design and Development of Risk Assessment Model for Decision Support on Risk Management and Adaptation on Climate Change for Urban area in Thailand (Phase 1), Technical Report, TRF.

ChinvannoS., and A.Snidvongs A. (2005) The study of future climate changes impact on water resources and rain-fed agriculture production. Proceeding of the APNCAPaBLE CB-01 Synthesis Worksnop, Vientien, Lao PDR,29-30 July 2004.SEA START RC. Technical Report No.13: 113 pp.

Chulalongkorn (2010). The Impact of Climate Change on Irrigation Systems and Adaptation Measures (Case Study: Plaichumphol Irrigation Project, Thailand), presented at JIID Seminar on Impact of Climate Change on Irrigation Systems, Bangkok,26 Jan.

Chulalongkorn University (2008). Climate Change Impact Assessment Methodology to Water Resource Management in East Coast Basin, TRF seminar, Faculty of Engineering Chulalongkorn University, 13 Mar.

Chula Unisearch (2010). Master Plan to cope with Climate Change, Energy Price Fluctuation, World Food Crisis, submitted to NESDB, Chulalongkorn University.

DDPM (2011). Risk Reduction towards sustainable development, 1st Print, Ministry of Interior, November, ISBN: 978-974-680-384-7.

DDPM (2013). Workshop on Disaster Preventive and Mitigation Planning in the Province level, Workshop document, 6-7 June, Bangkok.

Department of Industrial Work. Manual for Green House Gas Inventory for Thailand Industry. Treaties and International Strategies Bureau. Department of Industrial Work. Bangkok

REFERENCES

Department of Industrial Work. (2012). Manual for Green House Gas Inventory for 4 Industrial Types. First edition. Department of Industrial Work. Bangkok

DMR (2014). Adaptation strategies for the impacts of sea level rise in Thailand caused by the climate change, Technical Report.

Dufresne, J.,Foujols, M., Denvil, S. et al. (2013). Climate change projections using the IPSL-CM5 Earth System Model: from CMIP3 to CMIP5. ClimDyn, 40: 2123. doi:10.1007/s00382-012-1636-1

Ebi KL (2014). Health in the new scenarios for climate change research.Int J Environ Res Public Health; 10, 1-x manuscripts; doi:10.3390/ijerph100x000x.

Ebi KL, Hallegatte S, Kram T, Arnell NW, Carter TR, Edmonds J, Kriegler E, Mathur R, O'Neill BC, Kewyan R, Winkler H, van Vuuren DP, ZwickeTI. (2014). A new scenario framework for climate change research: background, process, and future directions. Climatic Change, DOI 10.1007/s10584 -013-0912-3.

Flato, G., J. Marotzke, B. Abiodun, P. Braconnot, S.C. Chou, W. Collins, P. Cox, F. Driouech, S. Emori, V. Eyring, C. Forest, P. Gleckler, E. Guilyardi, C. Jakob, V. Kattsov, C. Reason and M. Rummukainen, (2013). : Evaluation of Climate Models. In: Climate Change (2013). The Physical Science Basis. Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change [Stocker, T.F., D. Qin, G.-K. Plattner, M. Tignor, S.K. Allen, J. Boschung, A. Nauels, Y. Xia, V. Bex and P.M. Midgley (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA.

Giorgi, F. (2006). Regional climate modeling: Status and Perspectives. Journal de Physique, IV, 139, 101-118.

Global Warming and Climate Change Research Development and Coordinating Center (2010). : Climate Change Knowledge Synthesis Report, Working Group 1-3, TRF.

Hibbard K, Meehl GA, Cox PM, Friedlingstein P. (2007). A strategy for climate change stabilization experiments. EOS 88(20); 217, 219, 221

Hubert Lohr. Adaptation Measures Study via ecological system in HuaiSai Bart and KlongTadee Subbasin.

IPCC (1996). IPCC Guidelines for National Greenhouse Gas Inventories, Reporting Instructions (Volume 1); Workbook (Volume 2); Reference Manual (Volume 3)

REFERENCES

IPCC (1997). "Revised 1996 IPCC Guidelines for National Greenhouse Inventories Workbook (Volume2) Chapter 1: Energy". Intergovernmental Panel on Climate Change (IPCC), IPCC/OECD/IEA, Paris, France.

IPCC (1997). "Revised 1996 IPCC Guidelines for National Greenhouse Inventories Reference Manual (Volume 3) Chapter 1: Energy". Intergovernmental Panel on Climate Change (IPCC), IPCC/OECD/IEA, Paris, France.

IPCC (1997). Revised 1996 IPCC Guidelines for National Greenhouse Inventories. Houghton J.T., Meira Filho L.G., Lim B., Tréanton K., Mamaty I., Bonduki Y., Griggs D.J. Callander B.A.(Eds). Intergovernmental Panel on Climate Change (IPCC), IPCC/OECD/IEA, Paris, France.

IPCC (2000). Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories. Penman J., Kruger D., Galbally I., Hiraishi T., Nyenzi B., Emmanuel S., Buendia L., Hoppaus R., Martinsen T., Meijer J., Miwa K., Tanabe K. (Eds). Intergovernmental Panel on Climate Change (IPCC), IPCC/OECD/IEA/IGES, Hayama, Japan

IPCC (2000). Watson R., Noble I.R., Bolin B., Ravindranath, N.H., Verardo D.J. and Dokken D.J. (Eds). Land use, Land-use Change, and Forestry: A Special Report. Cambridge University Press. Cambridge, UK.

IPCC (2003). Good Practice Guidance for Land Use, Land-Use Change and Forestry. Penman J., Gytarsky M., Hiraishi T., Krug, T., Kruger D., Pipatti R., Buendia L., Miwa K., Ngara T., Tanabe K., Wagner F. (Eds). Intergovernmental Panel on Climate Change (IPCC), IPCC/IGES, Hayama, Japan.

IPCC (2006), 2006 IPCC Guidelines for National Greenhouse Gas Inventories, Prepared by the National Greenhouse Gas Inventories Programme, Eggleston H.S., Buendia L., Miwa K., Ngara T. and Tanabe K. (eds). Published: IGES, Japan.

IPCC (2013). Climate Change, 2013. Contribution of Working Groups I, II, and III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge, United Kingdom, and New York: Cambridge University Press.

REFERENCES

IPCC (2014). Summary for policymakers. In: Climate Change 2014. *Impacts, Adaptation, and Vulnerability. Part A: Global and Sectoral Aspects. Contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change* [Field, C.B., V.R. Barros, D.J. Dokken, K.J. Mach, M.D. Mastrandrea,T.E. Bilir, M. Chatterjee, K.L. Ebi, Y.O. Estrada, R.C. Genova, B. Girma, E.S. Kissel, A.N. Levy, S. MacCracken,P.R. Mastrandrea, and L.L. White (eds.)]. Cambridge University Press, Cambridge, United Kingdom and NewYork, NY, USA, pp. 1-32.

Jampanil, D., Nasu, S., Bongochgetsakul, N., Suttinon, P. (2011). Assessment on current global climate model simulations based on precipitation data by model selection for Thailand. International Journal of Advanced in Science and Technology, 184 – 187.

Joint Graduate School on Energy and Environment (2010). 2nd National Communication on Green House gas Account of Thailand, submitted to ONEB, KMUTT.

Kotsuki, S., Tanaka, K. and Watanabe, S. (2014). Projected hydrological change and their consistency under future climate in the Chao Phraya River Basin using multi-model and multi-scenarios of CMIP5 dataset. Hydrological Research Letters, 8(1), 27 – 32. doi: 10.3178/hrl.8.27.

Kriegler E, Edmonds J, Hallegatte S, Ebi KL, Kram T, Riahl K, Winker H, van Vuuren DP. (2014). A new scenario framework for climate change research: the concept of shared policy assumptions. Climatic Change, DOI 10.1007/s10584-013-0971-5.

Laprise, R., et. al. (2008). Challenging some tenets of Regional Climate Modelling. Meteorology and Atmospheric Physics, 100, 3-22.

Leo J. Donner, Bruce L. Wyman, Richard S. Hemler, Larry W. Horowitz, Yi Ming, Ming Zhao, Jean-Christophe Golaz, Paul Ginoux, S.-J. Lin, M. Daniel Schwarzkopf, John Austin, GhassanAlaka, William F. Cooke, Thomas L. Delworth, Stuart M. Freidenreich, C. T. Gordon, Stephen M. Grif es, Isaac M. Held, William J. Hurlin, Stephen A. Klein, Thomas R. Knutson, Amy R. Langenhorst, Hyun-Chul Lee, Yanluan Lin, Brian I. Magi, Sergey L. Malyshev, P. C. D. Milly, VaishaliNaik, Mary J. Nath, Robert Pincus, Jeffrey J. Ploshay, V. Ramaswamy, Charles J. Seman, Elena Shevliakova, Joseph J. Sirutis, William F. Stern, Ronald J. Stouffer, R. John Wilson, Michael Winton, Andrew T. Wittenberg, and FanrongZeng, (2011). J. Climate, 24, 3484–3519, doi: 10.1175/2011JCLI3955.1.

REFERENCES

Limjirakan S. and Limsakul A. (2012). Observed trends in surface air temperature and their extremes in Thailand from 1970 to 2009. Journal of the Meteorological Society of Japan, 90, 647-662. doi:10.2151/jmsj.2012-505.

Limsakul A. and Singhruck P. (2016). Long-term trendsand variability of total and extreme precipitation inThailand. Journal of Atmospheric Research, 301-317. (Online).AvailableURL:http://dx.doi.org/10.1016/j.atmosres.2015.10.015.

Meehl GA, Hibbard K. (2007). Aspen Global Change Institute (AGCI). 2007. Summary Report: A strategy for climate change stabilization experiments with AOGCMs and ESMs. Aspen Global Change Institute 2006 Session: Earth System Models: The Next Generation. Report from Aspen Global Change Institute session, July 30-August 5, 2006 and joint WGCM/AIMES Steering Committee Meeting 27 September, 2006 (Aspen, Colorado, uly 30-August 5, 2006).
Available at: http://www.agci.org/dB/PDFs/Publications/06S1_WhitePaper.pdf.

Moss RH, Edmonds J.A, Hibbard KA, Manning MR, Rose SK, van Vuuren DP, Timothy R, Carter TR, Emori S, Kainuma M, Kram T, Meehl GA, Mitchell JFB, Nakicenovic N, Riahi K, Smith SJ. Stouffer RJ, Thomson AM, Weyan JP, Wilbanks TW. (2010). The next generation of scenarios for climate change research and assessment. Nature 463, 747-756.

Moss, R. H., and Coauthors (2010). The next generation of scenarios for climate change research andassessment.Nature,463,747–756,doi:10.1038/nature08823.

Nakicenovic N, Alcamo J, de Vries B, et. al. (2000). Special Report on Emissions Scenarios: A Special Report of Working Group III of the Intergovernmental Panel on Climate Change. Cambridge University Press, Cambridge, U.K.

National Reform Committee (2015). Bangkok Sinking Respond Study, Technical Report on Reform Issue 27 July.

Nelson GC, Rosegrant MW, Koo J, Robertson R, Sulser T, Zhu T, Ringler C, Msangi S, Palazzo A, Batka M, Magalhaes M, Valmonte-Santos R, Ewing M, Lee D. (2009). Climate Change: Impact on Agriculture and Costs of Adaptation. International Food Policy Research Institute (IFPRI), Washington, DC, USA, 19 pp.

Office of Industrial Economic (2015), Statistical Industry, Thailand
Available at: http://www.oie.go.th/academic/statistics

REFERENCES

O'Neill BC, Kriegler E, Riahl K, Ebi K, Hallegatte S, Carter TR, Mathur R, van Vuuren DP. (2014). A new scenario framework for climate change research: the concept of shared socio-economic pathways. Climatic Change, DOI 10.1007/s10584-013-0905-2.

O'Neill BC, Kriegler E, Ebi KL, Kemp-Benedict E, Riahi K, Rothman D, van Ruijven B, van Vuuren DP, BirkmannJ, Kok K, Levy M, Solecki W. (2015). The roads ahead: narratives for shared socioeconomic pathways describing world futures in the 21st century. Global Environmental Change, doi:10.1016/j.gloenvcha.2015.01.004.

Pongsak Suttinon, et. al. (2015). Analysis and Synthesis of Climate Change towards Water Resources Management, Technical Report submitted to Department of Water Resources, Ministry of Natural Resources and Environment.

Rakkthai Foundation (2015). Coping Capacity and Vulnerability Assessment Manual, Vulnerability and Adaptation Measures Study via ecological system in Lam Pachi , ITT

Ruangrassamee, P., Khamkong, A., Chuenchum, P. (2015). Assessment of precipitation simulations from CMIP5 climate models in Thailand, Proceeding of The 3rd EIT International Conference on Water Resources Engineering (ICWRE3), 5-7 August 2015, UdonThani, Thailand

Santisirisomboon J., Boonprakob K., Santisirisomboon J., Wongseree V., Singhruck P., Phromjiraprawat K., Sukhamongkol Y., Lewan P., and Chobtham M., (2015). Capacity building on regional climate model and climate change of Thailand.Progress report, Thailand Research Fund.

Samir, KC and Lutz W. (2014). The human core of the shared socioeconomic pathways: population scenarios by age, sex and level of education for all countries to 2100. Global Environ. Change.
Available at: http://dx.doi.org/10.1016/j.gloenv-cha.2014.06.004.

Schmidli, J., et. al. (2007). Statistical and dynamical downscaling of precipitation: An evaluation and comparison of scenarios for the European Alps. Journal of Geophysical Research, 112, D04105.

REFERENCES

Seiji YUKIMOTO, Yukimasa ADACHI, Masahiro HOSAKA, Tomonori SAKAMI, Hiromasa YOSHIMURA,Mikitoshi HIRABARA, Taichu Y. TANAKA, Eiki SHINDO, Hiroyuki TSUJINO, Makoto DEUSHI, Ryo MIZUTA, Shoukichi YABU, Atsushi OBATA,Hideyuki NAKANO, Tsuyoshi KOSHIRO, Tomoaki OSE, and Akio KITOH (2012). A New Global Climate Model of the Meteorological Research Institute: MRI-CGCM3 —Model Description and Basic Performance - Journal of the Meteorological Society of Japan, Vol. 90A, pp. 23--64, 2012. DOI:10.2151/jmsj.2012-A02

Sucharit Koontanakulvong and Thongplew Kongchan (2016). Impact of Climate Change towards Irrigation Operations in Central and Northeast Thailand and its adaptation towards SDG, The Twelfth International Conference on Dry land Development, with the theme “Sustainable Development of Dry lands in the Post 2015 World”, will be organized by the International Dry land Development Commission (IDDC) and hosted by Bibliotheca Alexandrina, Alexandria, Egypt, 21-24 August

Sucharit Koontanakulvong, et. al. (2010). Climate Change Impact on Groundwater Situations (Plaichumpol Irrigation Project case study), Research Report, Chulalongkorn University, June.

Sucharit Koontanakulvong, et. al. (2010). Climate Change Impact study on Water Sector.

Sucharit Koontanakulvong, et. al. (2010). Corrected MRI GCM data for Thailand, Technical Report, Chulalongkorn University.

Sucharit Koontanakulvong, et. al. (2010). The Impact of Climate Change on Irrigation Systems and Adaptation Measures (Plaichumphol Irrigation Project case study) Final Report submitted to JIID, Feb.

Sucharit Koontanakulvong, et. al. (2011). The Impact of Climate Change on Irrigation Systems and Adaptation Measures (Wang Bua Irrigation Project, Kamphaegphet Province: case study) Final Report submitted to JIID, Feb.

Sucharit Koontanakulvong, et. al. (2012). The Impact of Climate Change on Irrigation Systems and Adaptation Measures (The Royal Irrigation of ce region 12: case study) Final Report submitted to JIID, Feb.

SucharitKoontanakulvong, et. al. (2013). The Impact of Climate Change on Irrigation Systems and Adaptation Measures (Dam Operation Analysis) Final Report submitted to JIID, Feb.

REFERENCES

Sucharit Koontanakulvong (2009). Impact of Global Climate Change on Water Resources in Rayong Province, CU-TRF seminar on climate Change in Eastern Region, 31 Mar.

Sucharit Koontanakulvong (2015). Impact of Climate Changes to Water-Agricultural Sectors in Thailand, Seminar on Holistic and Inter-Disciplinary Approaches for Natural Disaster Risk Reduction and Climate Change: Challenge for Republic of China (Taiwan) and Thailand, MahaChulalongkorn Building, Room 205, Fl. 2, Faculty of Arts, Chulalongkorn University, Bangkok, Thailand, Tuesday 24th November.

Sucharit Koontanakulvong, Winai Chaowiwat (2009). Climate Change Impact Report on Water Management in the Eastern Seaboard, Proc. National Civil Engineering Conference, 14 May. Research Report, Chulalongkorn University, October.

Suppakorn Chinvanno (2006). Climate risks and rice farming in the lower Mekong River countries, AIACC Working Paper No. 40, October (http://www.sea-climatechange.org/)

Supharatid, S. (2015). Assessment of CMIP3-CMIP5 Climate Models Precipitation Projection and Implication of Flood Vulnerability of Bangkok. American Journal of Climate Change, 4, 140-162.
Available at: http://dx.doi.org/10.4236/ajcc.2015.41011

Taylor, K.E., R.J. Stouffer, G.A. Meehl (2012). An Overview of CMIP5 and the experiment design Bull. Amer. Meteor. Soc., 93, 485-498, doi:10.1175/BAMS-D-11-00094.1.

Thrasher, B., Maurer, E. P., McKellar, C., & Duffy, P. B. (2012). Technical Note: Bias correcting climate model simulated daily temperature extremes with quantile mapping. *Hydrology and Earth System Sciences*, 16(9), 3309-3314.

TRF (2016). Thailand's Second Assessment Report on Climate Change 2016. Thailand Research Fund, Bangkok. [Amnat Chidthaisong, Pariwate Varnakovida, Matanapan Jewjiam, Atsamon Limsakul, Suppakorn Chinvanno, and Chalotorn Kansuntisukmongkol (editors)].

UNFCCC (2015). CGE Training Materials for Vulnerability and Adaptation Assessment.

United Nations (2011). Framework Convention on Climate Change, Assessing Climate Change Impacts and Vulnerability: Making Informed Adaptation Decisions,

van Vuuren DP, Carter TR. (2014). Climate and socio-economic scenarios for climate change research and assessment: reconciling the new with the old. Climatic Change,
DOI 10.1007/s10584-013-0974-2.

REFERENCES

van Vuuren DP, Edmonds JA, Kainuma M, Riahi K, Weyant J. (2011). A special issue on the RCPs. Climatic Change 109, 1-4, DOI: 10.1007/s10584-011-0157-y.

van Vuuren DP, Kriegler E, O'Neill BC, Ebi KL, Riahl K, Carter TR, Edmonds J, Hallegatte S, Kram T, Mathur R, Winkler H. (2014). A new scenario framework for climate change research: scenario matrix architecture. Climatic Change, DOI 10.1007/s10584-013-0906-1.

van Vuuren DP, Riahi K, Moss R, Edmonds J, Thomson A, Nakicenovic N, Kram T, Berkhout F, Swart R, Janetos A, Rose SK, Arnell N. (2012). A proposal for a new scenario framework to support research and assessment in different climate research communities. Global Environmental Change 22, 21-35.

Wang, Y., et. al., (2004). Regional climate modeling: progress challenges and prospects. Journal of the Meteorological Society of Japan, 82, 159-9 1628.

Watanabe, S., Hirabayashi, Y., Kotsuki, S., Hanasaki, N., Tanaka, K., Mateo, C.M.R., Kiguchi, M., Ikoma, E., Kanae, S. and Oki, T. (2014). Application of performance metrics to climate models for projecting future river discharge in the ChaoPhrayaRiverBasin. Hydrological Research Letters, 8(1), 33 - 38. doi: 10.3178/hrl.8.33.

Wichien Kertsuk, Suppakorn Chinwanno, Pornwilai Taipothong (2011). Impact, Risk, Vulnerability Assessment and Adaptation on agricultural system towards climate change and economical and social change in the future: Chi and Mum Basin case study, TRF.

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