



# *Thailand's*

## ***Second National Communication***

under  
the United Nations Framework Convention  
on Climate Change



**Office of Natural Resources and Environmental Policy and Planning  
Ministry of Natural Resources and Environment**

# Foreword

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The Second National Communication of Thailand was prepared through wide cooperation between various government agencies, research and academic institutes. Under the policy guidance from the National Climate Change Committee, the project was carried out by the Office of Natural Resources and Environmental Policy and Planning. The project steering committee which composed of representatives from public and private sector as well as NGOs has provided helpful technical supports. It is hoped that this report will prove useful to the national and international community and increase general awareness of climate change among interested readers.

This report describes Thailand's inventory status for the year 2000 and up to the year 2004. Some notable development is observed. Among others, the forest sector has turned to be a net source of sink since the year 2000 while energy sector has remained the key source of emission with a small growth rate. Emissions from agricultural sector have been relatively low and stable. Inventory trends in Thailand reflect the fact that GHG emissions are closely linked to social and economic development of the country.

As indicated in the report, increasing vulnerability to climate change and climate variability and extreme events remain the biggest challenges of Thailand in addressing climate change. The technical and technological development is lacking and the international cooperative support been extremely limited. It is essential for the international community to enhance the efforts in this area. Thailand will continue to play active roles in this area.

As far as mitigation is concerned, Thailand has mobilized economic and institutional instruments and devoted a large amount of resources to increase the use of renewable and alternative energy. As win-win options are decreasing, development of appropriate and cost effective technologies has been critical for the future mitigation efforts. More international efforts to enhance development and transfer of technology under the UNFCCC are required.

The Second National Communication of Thailand has also described areas that need to be enhanced. It is hoped that the constraints, gaps and support needed, as described in the report, will be given priorities in the future cooperative efforts under the UNFCCC.

As National Communication is an enabling activity of the parties under the UNFCCC, Thailand will continue to communicate with other parties on the national inventory and efforts to address climate change. Thailand will also continue to cooperate with other countries, especially in the region and sub-region to strengthen the national capacity in national communication preparation.

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# Executive Summary

# Executive Summary

**T**hailand submitted its initial national communication (INC) to the UNFCCC in 2000. The second national communication (SNC) is being prepared using the UNFCCC reporting guidelines and the IPCC technical guidelines, including the good practice guidelines and uncertainty management. Besides the national inventory for 2000, in connection with the COP decision, the SNC focuses on climate change developments in Thailand for the period following the INC.

## National Circumstances

### ✿ Demographic Development

Over the past decade, Thailand's population growth followed a diminishing rate. It is expected that the total population will increase from 63.4 million in 2008 to more than 71 million in 2028. Thailand's demographic structure is changing with the emergence of an aging society. The elderly population will significantly increase. Approximately one-half of the total population will reside in urban areas within the next 50 years. Hence, increasing demand for basic infrastructure, public utilities and services, especially for the elderly, is envisaged.

### ✿ Economic Development

In the 1990s, Thailand suffered an economic crisis, known as the "Tom Yam Kung disease", due to the collapse of its financial sector. The crisis gradually eased and the economy recovered. Imports of raw materials and capital growth, in proportion to the national GDP, increased continuously, saving and investment gaps narrowed, the ratio of public debt to GDP declined, and the current account improved.



The recovery was very short-lived, however. Thailand's economy encountered difficulties due to political instability in 2006. The economy declined, further affected by the economic crisis in the United States. Exports dropped substantially by up to minus 10%. The deep recession caused the Thai Government to implement various emergency rescue packages to restore the economy.

These difficult times during the past decade caused revisions in the targets of the 8<sup>th</sup> and 9<sup>th</sup> National Economic and Social Development Plans. Similarly, the global food and energy crises in the past two years caused revisions in the 10<sup>th</sup> Plan. In summary, national and global economic and political instabilities have had immense impacts on Thailand's economic development in the past decade. The 11<sup>th</sup> Plan, which is being prepared, places greater emphasis on economic stability and development of the country's self-reliance and resilience to external factors.

## Social Development

After three decades of national development, problems associated with social issues, resource utilization and environmental concerns were on the rise. Seeking a balanced development, Thailand changed its development vision to emphasize "people" as the center of development. Starting with the 8<sup>th</sup> Plan up to the 10<sup>th</sup> Plan, Thailand has adopted the philosophy of sufficiency economy to enhance stable community development. The philosophy will also be adopted in the forthcoming 11<sup>th</sup> Plan.

A review of social developments over the past decade indicates that economic conditions at the grassroots level have improved. The proportion of poor people declined, while that of the middle income group increased. Indicators for the people's happiness increased but not at a satisfactory level. Causing most concern was the drop in the value placed on family warmth and love. The value placed on community cohesion did not improve.

Considering these outcomes and the changing demographic structure, Thailand needs to improve its social development, especially the need to strengthen the family as a unit and to build community cohesion. Strong family and community relationship is a basic requirement for public participation and is a key mechanism to achieve sustainable economic and social development.

## Natural Resources

Land is the most important basic natural resource, especially with regards the development of forest and agriculture. Utilization of land resources is closely related to global warming. The overall allocation of land resources among agriculture, forestry, and other sectors has changed only slightly. Paddy land has more or less been constant, although the proportion of field crops to total agricultural land declined, while that of permanent trees and fruit trees increased. Thailand has long been exerting efforts to conserve forest land.

Deterioration of land quality and problematic soils are major constraints to land resource development. Nearly one-third of the total land is either of low quality or with problematic soils. Many areas have been classified as drought- or flood-prone areas. Damage caused by droughts or floods has increased, with some fluctuations over time.

Experiences during the tsunami disaster have proven the ecological and environmental importance of mangroves. Public awareness of the role of mangrove forests in coastal protection has increased greatly. Nevertheless, the pressure on land and mangrove forests remains. Poaching in natural forest area continues despite the high investment made to ensure protection, which has resulted in a slight drop in the number of poaching incidents. Providing protection to land and mangrove forests is a huge task for the public sector. The need for local community participation in forest protection is a big challenge for Thailand.

Water resources are vital to all sectors of the economy. Existing water resource management has not been able to cope effectively with the demand. Water storage capacities vary from region to region and can only partially support the demand. A large part of Thailand remains vulnerable to the limited availability of surface water. Droughts and floods have become increasingly frequent and severe. The damages are potentially aggravated by global warming. Thailand needs to develop a long-term water resource management and an administration approach that is capable of coping with higher risks due to seasonal water supply. The approach needs to ensure that the allocation and utilization of water resources are flexible enough to adapt to changing ecological systems.

## ✿ Sustainable Development of Thailand

Economic, social and natural resources and environmental concerns have been integrated into Thailand's sustainable development. Environmental quality promotion and conservation have been implemented in parallel with economic and social development since the 7<sup>th</sup> Plan. Two policy committees are working in parallel and are coordinating closely to ensure consistency and balance between economic and social development and resource conservation and environmental protection.

Thailand's development vision has increasingly emphasized the social dimension to cope with the effects of globalization. To meet the quality of life objective, the philosophy of sufficiency economy and the concept of "people as the center of development" have been the fundamental principles for national development in the past 15 years. Climate change has complicated the process of sustainable development. Thailand needs to integrate the problem of global warming, especially the effects of climate change, into the policy and plan for national sustainable development. Sustainable development incorporating the international environmental phenomena is a new challenge for the Thai Government as it pursues the country's sustainable development.

## Greenhouse Gas Inventory

The national greenhouse gas inventory for 2000 is the second inventory prepared according to the COP decision. The preparation and estimation approaches followed the reporting guidelines of the UNFCCC and technical guidelines of the IPCC, including good practice guidance and uncertainty management.

Three main GHGs, CO<sub>2</sub>, CH<sub>4</sub> and N<sub>2</sub>O, are reported by source and sink. Other GHGs also reported are CO, NO<sub>x</sub> and NMVOCs as well as SO<sub>x</sub>. The main emission factors used are default ones provided by IPCC. Tier 1 methodologies are applied in most cases. Tier 2 and local emission factors are used in manure management, rice, forest and waste management.

### ✿ GHG Emissions, by type

In 2000, Thailand emitted 210.23 million tons of CO<sub>2</sub> and absorbed 52.37 million tons of CO<sub>2</sub>. Thus, Thailand's net CO<sub>2</sub> emission in 2000 was 157.86 million tons. The amount was lower than in 1994, when 202 million tons net of CO<sub>2</sub> was emitted. Of the total CO<sub>2</sub> emission in 2000, power generation emitted 150 million tons or more than 90% of net CO<sub>2</sub> emission. The remaining amount was mainly emitted by industrial processes (16 million tons), while an insignificant amount was emitted by waste management (see table below).

As for CH<sub>4</sub>, Thailand emitted a total of 2.8 million tons in 2000. Of the total, more than 70% came from agriculture, with rice accounting for a major proportion. Another 15% was emitted by the energy sector and 14% by waste management. With regards N<sub>2</sub>O, Thailand emitted about 40,000 tons in 2000. The major source was land use (emitting more than 82%), followed by waste management and energy production. (Table A)

In the energy sector, power generation was the largest emitter of CO<sub>2</sub> (64.2 million tons), followed by transportation at 44.4 million tons, and industry at 30.3 million tons. As for industrial processes, almost all CO<sub>2</sub> emission from this sector was emitted by cement production.

As shown below, CO, NO<sub>x</sub> and NMVOC were generated mainly from the energy sector and partly from agriculture and land use change and forestry. In 2000, Thailand emitted CO, NO<sub>x</sub> and NMVOC, amounting to 5.6 million tons, 910,000 tons and 760,000 tons, respectively. (Table B)

### ✿ Total Emissions by CO<sub>2</sub> Equivalent

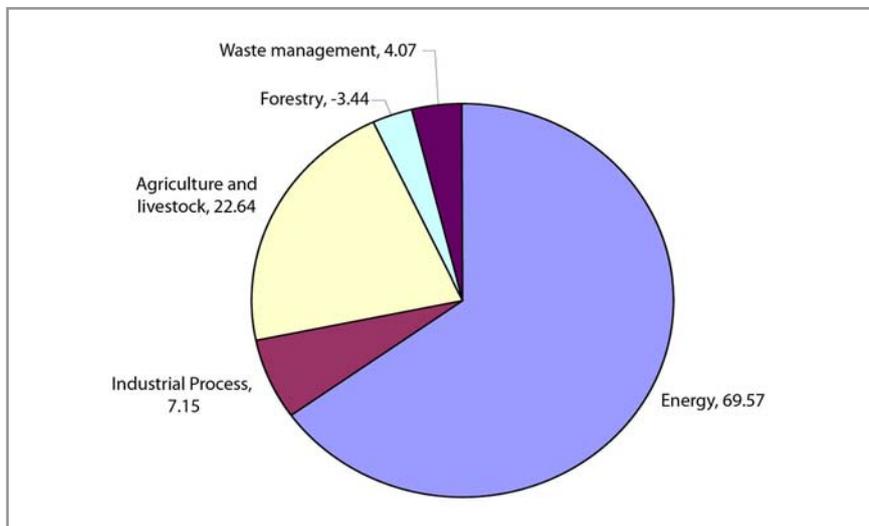
Using the GWP factors given by the IPCC for CH<sub>4</sub> and N<sub>2</sub>O, it is estimated that in 2000, the total net GHG emission in Thailand, in terms of CO<sub>2</sub> equivalent, was 229 million tons. The energy sector was the largest contributor at 70%, followed by crops and livestock at 23%. The remaining proportion was shared among industry, forest (net sink) and waste management (see figure A).

**Table A**

Main Greenhouse Gas	CO <sub>2</sub> emissions (Gg)	CO <sub>2</sub> removals (Gg)	CH <sub>4</sub> (Gg)	N <sub>2</sub> O (Gg)
Total national emissions and removals	210,231.2	-52,374.0	2,801.5	40.0
1. Energy	149,914.6	0.0	413.9	2.5
2. Industrial processes	16,059.3	0.0	6.4	0.6
4. Agriculture			1,977.0	33.4
5. Land use change and forestry	44,234.1	-52,374.0	10.4	0.1
6. Waste	23.3		393.8	3.3

**Table B**

Other Greenhouse Gases	NO <sub>x</sub> (Gg)	CO (Gg)	NMVOCs (Gg)	SO <sub>x</sub> (Gg)
Total national emissions and removals	907.0	5,624.4	759.5	618.8
1. Energy	873.3	4,773.0	668.1	605.7
2. Industrial processes	1.2	6.3	91.4	13.1
4. Agriculture	29.9	754.1	0.0	0.0
5. Land use change and forestry	2.6	91.0	0.0	0.0



**Figure A** GHG emission by source in CO<sub>2</sub> equivalent, for 2000 (%)



In summary, the 2000 GHG inventory cited the energy sector as the most important emitter of the main GHGs, except CH<sub>4</sub>. The forestry sector became the net sink in 2000. Methane emission was mainly from agriculture, especially rice farming and livestock raising. Taking into consideration the total emission, agriculture remained a small emitter. It is noted that rice and livestock are considered as emitters for survival. In the 2000 inventory, quality control and assurance were implemented and uncertainty was within an acceptable level.

## ✿ Emission Trend in Selected Years, 1994-2000

The estimation of GHG inventory during the period 1994-2000 used the same emission factors. Hence, the trend for the estimated values represented the trend for activity data. As shown in the figure below, CO<sub>2</sub> emission trend in the energy sector increased in general, although the rates fluctuated following the country's economic development, such as between economic expansion and depression periods, high and low fuel prices. In contrast, CO<sub>2</sub> emission in the forestry sector increased at a lower rate than absorption, and hence the forest became a net sink in 2000.

As for CH<sub>4</sub> and N<sub>2</sub>O, the amounts varied depending on agricultural production and the effects of droughts and floods. Nevertheless, given the land resource constraint, future emission expansion for CH<sub>4</sub> and N<sub>2</sub>O from agriculture, if any, is likely to be slow.

Distribution of emission by source is changing slightly. Power generation, manufacturing and construction, and transportation have been major greenhouse gas emissions in the energy sector. Rice and livestock have been the main CH<sub>4</sub> emitters in agriculture.

As indicated in the figure below, from the CO<sub>2</sub> equivalent emission trend, it can be seen that the structure of emission sources has not changed much. The energy sector has been the main emitter, followed by agriculture. It should be noted that in 2000, the forestry sector became a net sink until 2004. As a result, net emission in Thailand in 2004 was 263 million tons, compared to 229 million tons in 2000, or an average increase of 3.7% per year. (Figure B)

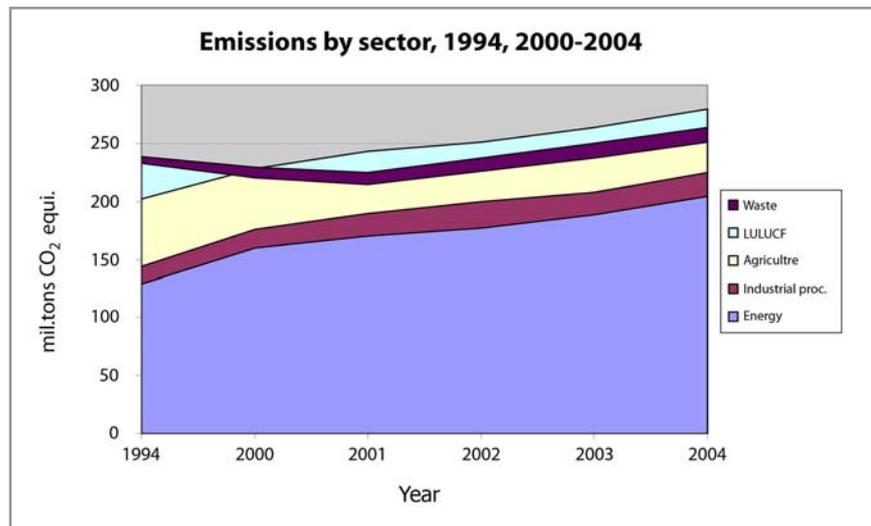


Figure B

## Impact, Vulnerability and Adaptation

The UNFCCC has taken several major decisions related to impact, vulnerability, and adaptation. For instance, the Marakesh Accord in COP7 in 2001 decided to develop databases to enhance technology capacity, especially on NAPA, and to establish the Special Climate Change Fund. In COP10 in 2004, the Buenos Aires Programme of Work on Adaptation and Response Measures was agreed upon to accelerate implementation of the COP7 decision, and to develop the Nairobi Work Program (NWP) for 2005-2010. However, implementation of the decisions had been slow.

Unlike mitigation, the benefits from implementing vulnerability and adaptation measures are area-specific. The same is true for research and development on vulnerability and adaptation. Hence, international support has been limited and has been primarily channeled to least-developed countries that are the most vulnerable to climate change impact. Most of the support that Thailand has received is for capacity development through training workshops/seminars and enabling activities to prepare the national communication.



Addressing impact, vulnerability, and adaptation to climate change is a priority for Thailand, as reflected in the national strategy to address climate change. The sectors emphasized are agriculture, water resources, health, and marine and coastal resources.

### **✿ Vulnerability and Adaptation to Climate Change**

Research studies on the impact of climate change in Thailand have been conducted for the past 20 years. The development is comparable to other countries in the Asian region. The main limitation encountered till now has been the high uncertainties of climate scenarios. Since 2000, Thailand has supported more than 15 climate scenario-related projects, mostly to enhance technical and scientific knowledge of climate change and its impacts, especially concerning uncertainty issues. Only a few projects covered the system's vulnerability to climate change. Thailand's national climate change strategy continues to give importance to technical knowledge, particularly on linkages between impacts and vulnerability of major sectors.

Linkages between impact and vulnerability are required in order to develop additional adaptation options to cope with climate change. As with other countries, in Thailand scientific uncertainties hinder the analysis of adaptation options and their integration into national development planning. Efforts are continuing to enhance research and development in this area.

### **✿ Vulnerability and Adaptation to Climate Variability and Extreme Event**

Research in vulnerability and adaptation to climate variability and extreme event emphasizes historical and local experiences of climate-related disastrous events, such as droughts, floods, storms, and so on. These disasters have become more frequent and increasingly severe. The approach is used in NAPA of the UNFCCC process.

Thailand combined climate scenarios and the NAPA approach for the Chee Moon watershed in northeast Thailand. A similar approach was applied in selected communities in the north and northeast regions, with a view to enhancing the risk management capacity of local communities. Basic adaptation approaches, for example, conservation of crop varieties or adjustment of cropping systems, were recommended. This area of study needs further development.

An action research with SCCF support is the integration of climate change impact with disaster mitigation to strengthen the resilience of higher-risk coastal communities. Through action research, local communities will develop climate change-related disaster action plans and mainstream into provincial-level and national-level development planning process. This pilot project will start in 2010.

## ✿ Impact of Sea Level Rise

The sea level estimated by IPCC is the global mean sea level which may not be the same as that of the regional or national sea, such as the Gulf of Thailand. Most studies on sea level rise emphasize coastal inundation and sea water intrusion.

Studies on sea level rise in Thailand are still limited. A case study in Kho Tao applied the consultation approach to assess potential adaptation to climate change and sea level rise at the community level. Preliminary results suggest a need to carefully plan the utilization of coastal areas, especially risk-prone ones. Green development of the island should be emphasized.

## ✿ Linking to Policies

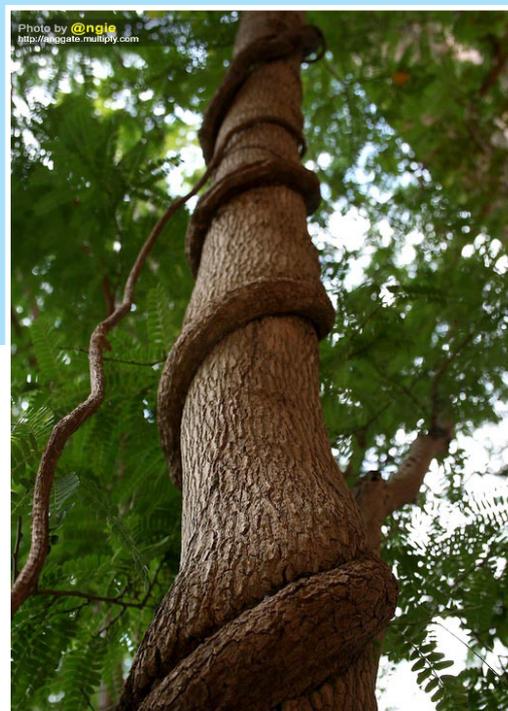
The major bottlenecks in policy formulation to address climate change vulnerability and adaptation are the reliability and validity of research results. Uncertainties of climate scenarios pose a major constraint to develop impact scenarios. The long time period covered and local characteristics are also key factors in developing policies. Research and development to address the above constraints and problems are of great importance.

Increasing evidence of climate change impacts and their consequences in recent years suggests the need for action. Innovative approaches to assess vulnerability and adaptation, in the short- and long-term, are also important. International cooperation in this area can enhance research capacities in Thailand. Thailand's national strategy to address climate change has given priority to this area as well.

## ✿ Climate Change Impact and Thailand

So far, research has provided a broad picture of the effects of global warming in Thailand. Rainfall across all the regions in the country has a potential to increase by about 10-20%. The rainy season will not change much, although the weather will tend to be warmer due to an increase in maximum and minimum temperatures by 2 degrees Celsius. It is noted that the extent of the effects of climate change can vary from area to area, such as between the east and west coasts in southern Thailand.

The agricultural sector in Thailand is most vulnerable to climate change impact, since most farmers are small landholders in rainfed areas. The shift from annual field crops to permanent trees in recent years further limits the flexibility of changing the cropping system, and hence creates more vulnerability. Research and development in this area has so far not been able to sufficiently address uncertainty issues. Policy development is mostly general, calling for increasing the management capacity of farmers under high-risk situations and for enhancing the climate and early warning systems.



Studies on climate change effects on the reservoirs of Bhumibhol and Sirikit dams, the two largest dams in Thailand, found that by the middle of this century, the Bhumibhol dam could be affected by lower surface water run-off. On the other hand, surface water run-off into the two reservoirs will tend to increase substantially in the latter half of the century.

Similarly, research on sea level rise in marine and coastal areas in the southern region of Thailand indicates marginal change in sea level in general. However, a study at the provincial level (that is, Krabi province) suggests a potential rise in sea level. These variations require more refined research and development.

A study of the health effects of climate change was carried in the preparation of the initial national communication (INC). There has not been any progress since then. The national strategy for climate change and action plans for environmental health have emphasized research in this area in the next few years.

### **Potential Impacts of Climate Variability and Extreme Event**

Natural disasters, especially droughts and floods, have become increasingly common in Thailand. Global warming is expected to aggravate these problems. Statistics show increasing damage due to droughts and floods in general, fluctuating from a few million to billions of Baht. Thailand has introduced climate factors into disaster management and further research and development in this area are urgently needed.

## **Greenhouse Gas Mitigation**

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Greenhouse gas mitigation in Thailand is more advanced than other areas of climate change, due mostly to international promotion and cooperation, as well as commitments under the UNFCCC and the Kyoto Protocol.

Thailand's greenhouse gas inventory clearly indicates that the main options to reduce GHG emission are in the energy and land use change and forestry sectors. Over the past decade, Thailand has continuously promoted energy conservation and implemented measures to accelerate use of alternative fuels to support GHG reduction efforts. Thailand has also consistently expanded forest areas as well as protected existing natural conserved forests to enhance the GHG sink.

### **Energy**

The Thai Government has implemented several plans and measures to enhance energy efficiency and alternative energy. The 8<sup>th</sup> Plan set a target for power demand reduction of 1,400 megawatts and energy conservation of one million tons of crude oil equivalent. In the 10<sup>th</sup> Plan, a more aggressive policy was drawn up to enhance energy efficiency and the development of alternative energy. Taking into consideration environmental impacts and energy security, Thailand has prepared the third phase of its energy conservation framework. The target to reduce energy intensity (the ratio of energy consumption to national GDP) from 1.4:1 to 1:1 was established. The contribution of renewable energy to total energy will increase from 0.5% to 8% by the 2011, the end of the 10<sup>th</sup> Plan.

At present, three lines of light rail services are being constructed. Compulsory and voluntary energy audits have been implemented for many years. Various aggressive incentive measures on energy efficiency and alternative energy have been planned. The third phase of the Energy Efficiency Plan (2009-2011) has proposed further measures to increase incentives to manufacturers to improve energy efficiency. If this is successful, Thailand will further reduce or prevent CO<sub>2</sub> emissions by 33 million tons at the end of the Plan. It is noted that this will cost Thailand almost 90 billion Baht (about US\$ 277 million) to achieve the target. Working towards achieving a low carbon economy, Thailand is prepared to replace fossil fuels with alternative energy by 20% by 2022.

Social or voluntary measures, such as carbon labels on consumer products and the introduction of carbon footprints and low carbon city, are being aggressively promoted.

## Forestry

The forestry sector demonstrates the advantages of the win-win policy in Thailand. Since 2000, substantial efforts to expand forest areas have been carried out in the form of conserved forests, reforestation and rehabilitation of deforested areas, and expansion of community forest and commercial forest. Reforested areas in Thailand have increased by more than 400,000 rai (64,000 hectares). This is in addition to the expansion of conserved forest areas. As a result, the forestry sector became a net sink of CO<sub>2</sub> in 2000.

The next four-year implementation plan of the Ministry of Natural Resources and Environment will continue to effectively protect conserved forests. Also given priorities are forest rehabilitation and conservation and rehabilitation of upper watersheds and degraded forest land and maintenance of commercial forests. More than 3.1 million rai or about 500,000 hectares of mangrove forests along the coast of Thailand will be well protected.

## Agriculture and Greenhouse Gas Mitigation

The fact that agriculture is one of the sectors that emits greenhouse gases should not be seen as being in conflict with the UNFCCC's ultimate objective of ensuring stable food production for the world. This makes the agriculture sector more special than others. One cannot simply trade-off human survival with emission mitigation. Hence, it is even more important to ensure the win-win policy in the agricultural sector. The Thai Government and the global society, in general, must guarantee that greenhouse gas emissions in agriculture will not affect food production and the livelihood of poor farmers.

In Thailand, among the key climate change strategies of the Ministry of Agriculture and Cooperatives are, as follows: to reduce crop residue burning by about 20,000 hectares, to increase areas for permanent trees by 72,000 hectares, and to reduce agricultural land where open burning is done by 24,000 thousand hectares. Crop residue does not emit CO<sub>2</sub>. This is because crops convert CO<sub>2</sub> from the atmosphere through the process of photosynthesis. Hence, burning crop residue merely results in neutral CO<sub>2</sub> emission. This excludes other gases from soil disturbance. It is noted that the reduction of burning crop residue provides environmental benefits, especially by preventing road accidents and undesirable health effects. It can be said that this strategy is a win-win measure.

## Clean Development Mechanism

The Clean Development Mechanism (CDM) contributes to Thailand's greenhouse gas mitigation efforts to some extent. As of 5 March 2010, Thailand has approved 100 CDM projects with a CO<sub>2</sub> reduction potential of 6.3 million tons per year. Most projects deal with biogas or biomass energy. So far, 32 projects with a CO<sub>2</sub> reduction potential of 2 million tons per year have been approved by the CDM Executive Board.

The approved CDM projects are consistent with the criteria of the Kyoto Protocol and the sustainable development criteria of Thailand. They are subject to environmental impact assessments, as required. Nevertheless, no systematic research studies on the additionality contribution of the projects, especially on technology transfer and investment, have been conducted. As the end of the first phase of the CDM under the Kyoto Protocol is approaching and its future being dependent on outcomes from on-going negotiation, CDM faces an uncertain future role in fostering sustainable development in developing countries and contributing to global greenhouse gas mitigation.

## Others

Various public agencies and offices have also actively contributed to greenhouse gas mitigation. Good examples of public sector initiatives to address global warming are the declarations of the Bangkok Metropolitan Administration and the local government of Khon Kaen province, the Public Green Procurement Project of the Ministry of Natural Resources and Environment, and the Green and Clean Project of the Ministry of Public Health, among others.

## Greenhouse Gas Mitigation and National Development

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Win-win options are the best options to mitigate greenhouse gases. Unfortunately, such options are limited and will be eventually used up. Mitigation beyond win-win options means certain trade-off between the people's welfare and the environment. Environment- friendly and cost-effective technologies are the answer. Distribution or allocation of the mitigation burden also affects relative costs among parties. It is in this respect that the outcomes of negotiation for long-term cooperation are so crucial to all countries. The relationship between greenhouse gas mitigation options and the process of national development is a key research area for many countries, including Thailand.

The 11<sup>th</sup> Plan cites global warming as a key component that influences future national development. Thailand's 20-year development vision has identified approaches to enhance efficiency in energy conservation, expansion of biomass energy, and adaptation to climate change. The key factors that determine the country's development strategy are global warming and climate change, aging society, and competition for resource use. Thailand has adopted the sufficiency economy philosophy as a key principle in its national development plan.

## Development and Transfer of Technology

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Under Article 4.5, Annex I Country Parties have an obligation to support and facilitate development and transfer of environment- friendly technologies to Non-annex I Country Parties. Such technologies include hardware and technical knowledge concerning inventory, impact and adaptation, and mitigation. The UNFCCC has developed a framework for meaningful and effective actions to enhance the implementation of Article 4.5 of the Convention since 2000.

Implementation of the framework has not been satisfactory, particularly with regards technology needs and needs assessment, enabling environments, and capacity building. Attempts have been made to strengthen public sector support for technology development and transfer under the UNFCCC and Kyoto Protocol.

Thailand has benefited from minor activities, such as preliminary assessment of technology needs under the EAI and technical workshops. These activities are not specifically under the framework of Article 4.5. Similarly, technology transfer under the Kyoto Protocol has been ambiguous. Accelerating technology transfer and capacity enhancement under the UNFCCC and Kyoto Protocol and integrating them into national needs will enhance Thailand's capacity to more effectively address climate change.

Regarding international technical cooperation, Thailand has shifted from being a recipient country to a providing country through a partnership program, especially with countries in the Mekong sub-region. The cooperation is currently valued at more than US\$ 12 million. This type of south-south cooperation has extended to Africa, Latin America, and the Caribbean. Thailand also participates in multilateral cooperation, such as the APEC Center for Technology Foresight and ASEAN.

Threats due to climate change are increasing. The integration of technology development and transfer under the UNFCCC and Kyoto Protocol to enhance Thailand's technology development is vital to the improvement of the national capacity to address climate change.

## Research and Systematic Observation Network

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The UNFCCC encourages the Parties to cooperate in climate change systematic observation networks. The Global Climate Observation System (GCOS) was established to accelerate international investments in the system. Despite these efforts, most development has so far been at the national level, particularly among developed countries.

Thailand participates in GCOS through the WMO data transfer network. Standardized air and weather data from Thailand are regularly collected and submitted to WMO. Data on oceanic conditions, pollution, radiation and ozone are limited, raising the need for technology and data collection system support.

Learning from the tsunami disaster, Thailand has implemented the Community Based Disaster Resilience Management (CBDRM) Program to enhance the capacity of local communities to cope with disaster risks. The program has introduced climate factors in disaster risk management. Thailand has developed a pilot program to integrate climate change and disaster risks into sustainable development planning for the community.

## Education, Training and Public Awareness

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Article 6 of the UNFCCC encourages the Parties to integrate climate change knowledge into national education systems, training, and public awareness campaigns. Regional cooperation in climate change education and training, under the UNFCCC has been limited to exchange of information and experiences and networking. The same is true in the Asian region and its sub-regions.

Thailand's new education system and modern information technology strongly support the promotion of climate change education. Climate change knowledge is developed and shared through the home pages of schools, colleges and universities. The revised education curricula expose students to more indigenous and local environmental experiences, including those associated with climate change. Climate change awareness campaigns through the education system have expanded greatly at all levels. Public awareness campaigns promoting waste reduction, energy conservation, reducing plastic bag use, and so on, have emerged in the past few years.

A social approach to promote greenhouse gas reduction in manufacturing and consumption, that is, using carbon labels, carbon footprints, is being promoted. Manufacturers of large consumer products are collaborating to promote consumer awareness as well as their sales.

## Capacity Building

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Capacity building is a crosscutting issue in the UNFCCC and the Kyoto Protocol. The UNFCCC established a capacity building framework for developing countries. The framework calls on the public and private sectors in developed countries to support capacity building in developing countries, especially in least-developed countries. An assessment of the framework has indicated the potential to further improve capacity, especially institutional capacity building, participation of organizations, and learning-by-doing activities.

International support for capacity building under the UNFCCC consists mainly of exchanges of experiences and knowledge in preparing different topics for national communications, and exchanges of technical information, adaptation policies, and measures. Both occasional and major support for cooperation at the regional level is provided by international organizations, such as AIACC and APN.

Thailand has benefited from the UNFCCC capacity building activities through technical training workshops on such topics as the use of inventory software and energy planning software, analysis of vulnerability and adaptation. Thailand has also increased its capacity through the Kyoto Protocol. Developed country Parties to the Kyoto Protocol, including Japan, Denmark, and Germany, have provided technical support to enhance Thailand's national capacity to implement the CDM.

Thailand's national focal point has carried out on a regular basis technical training workshops and seminars on climate change issues, especially on vulnerability and adaptation and basic climate change knowledge. The fifth strategy of the National Climate Change also promotes the exchange of experiences among public and private organizations.

## Information System and Network

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The Internet plays a critical role in the development of information systems and networks. At the international level, the UNFCCC, IPCC and other international organizations have developed good information systems and linkages with the national focal point (NFP). However, at the regional level, support is restricted to specific areas, such as the establishment of a database for emission factors. There is no regional center that acts as a gateway on climate change.

At the national level, the NFP is the core body designated to develop a climate change information system and network for Thailand. The NFP established ONEP's information portal to exchange climate change information and to coordinate with its peer groups, for example, research organizations, academic institutes, and NGOs. Other institutes involved in climate change have developed climate change information systems in their areas of interest, such as the Center for Environmental Research and Training in the Ministry of Energy.

An important feature of an information system and network is the liveliness of its operations. Thailand faces the challenge of keeping the information system flowing and its network operations lively. The National Strategy for Climate Change has developed activities to support Thailand's information system and network development.

## Problems, Constraints and Need for Support

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Besides management and administrative constraints, technical capacities are the main concerns in implementing programs that address climate change. Research and development on climate change are vital to the development of national policies and measures. Four other important areas that need technical and financial support are identified below.

### ❁ Greenhouse Gas Inventory

- ❁ Develop local emission factors in major sectors and those sectors that are important to economic development. The priority sectors are agriculture and forestry
- ❁ Collect appropriate activity data to support the estimation of greenhouse gas inventory. The priority sectors are energy, agriculture, forestry and waste management
- ❁ Develop an estimation method for key sectors to higher tier. These are the energy, agriculture and forestry sectors
- ❁ Train relevant officials and agencies to carry out the estimation regularly
- ❁ Train technical personnel in specific areas to develop estimation methodologies or techniques that are appropriate for Thailand
- ❁ Develop techniques in greenhouse gas emission forecast

### ❁ Vulnerability and Adaptation

- ❁ Develop more climate change scenarios that are appropriate to the sub-region, to reduce uncertainty problems
- ❁ Introduce techniques for preparing socio-economic scenarios that are consistent with climate change, for the vulnerability analysis
- ❁ Develop advanced techniques to analyze the impacts of major sectors, especially on annual and perennial crops, water resources, and public health
- ❁ Develop techniques to prioritize adaptation options within and across different sectors
- ❁ Introduce public health warning systems in critical areas that are prone to the spread of diseases caused by climate change

- ❖ Develop analytical techniques to prioritize selected adaptation options across different sectors and issues, and meaningfully convey the message at policy making levels
- ❖ Develop technologies for disaster warning systems in disaster-prone areas
- ❖ Develop technologies used to cope with coastal erosions and suited to local conditions
- ❖ Develop technologies for agricultural climate forecast and warning system
- ❖ Develop technologies to raise plant species that are resistant to climate variation
- ❖ Develop public health and disease prevention management systems in disaster-prone or climate change-risk areas
- ❖ Promote the application of climate scenarios and new analytical approaches, especially in agriculture, water resources and health

## ❖ Greenhouse Gas Mitigation

- ❖ Develop analytical techniques to prioritize mitigation options for energy conservations and renewable energy
- ❖ Develop advanced technologies for energy conservation, electricity production and consumption
- ❖ Introduce efficient technologies and systems for traffic and mass transport
- ❖ Develop technologies for biomass and biogas energy production that are appropriate to local conditions
- ❖ Develop environment-friendly technologies for industrial production process e.g. cement production
- ❖ Develop knowledge and infrastructure for innovation of clean technologies including technologies for carbon capture and storage
- ❖ Develop technologies to mitigate GHG from rice paddy fields

## ❖ Others

- ❖ Conduct research concerning systematic observation of climate variables to support GCOS, particularly oceanic observation in Asia and the Pacific,
- ❖ Enhance climate change stations and networks
- ❖ Develop regional information exchanges and communication
- ❖ Conduct capacity building for short- and medium-term weather forecasts
- ❖ Enhance the capacity of meteorologists
- ❖ Develop a center of excellence for Asia and the Pacific
- ❖ Conduct capacity building for negotiators for the UNFCCC and Kyoto Protocol



# National Circumstances

# National Circumstances

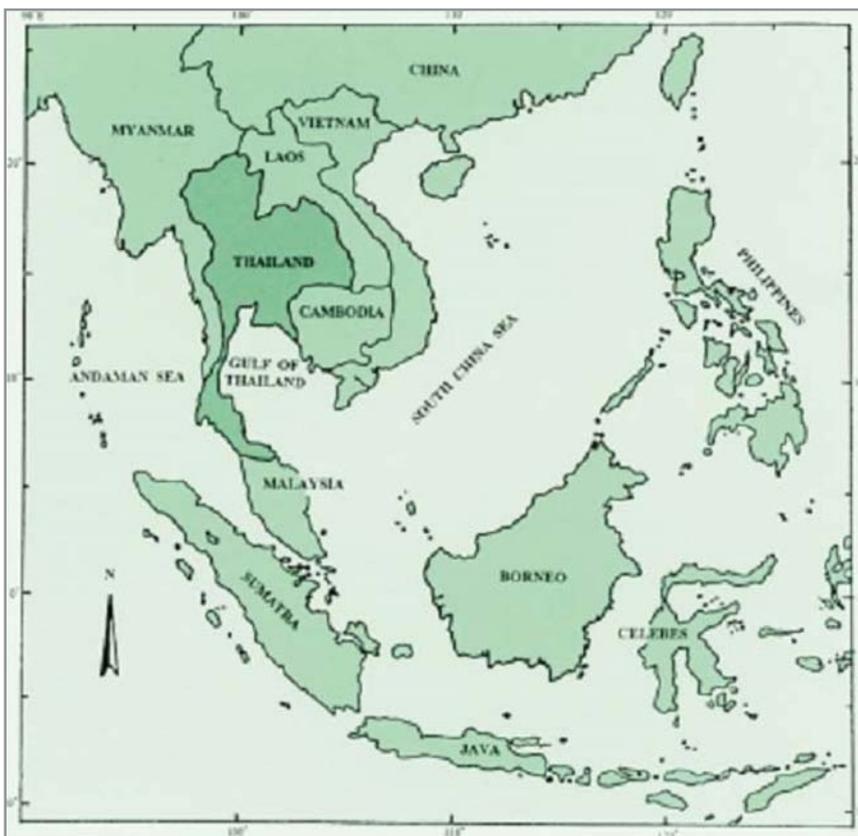


Figure 1-1 Map of Thailand

## Physical Characteristics

Thailand lies between latitudes  $5^{\circ} 40'$  and  $20^{\circ} 30'$  N and longitudes  $97^{\circ} 20'$  and  $105^{\circ} 45'$  E in the southeastern part of the Asian mainland. Myanmar is on the western and northern borders, Laos lies to the northeast, Cambodia to the east, and Malaysia to the south of the country. The country's total land area is 513,115 sq kms (320.7 million rai). The length from south to north is about 1,650 kms and 800 kms from east to west. The province with the shortest length is Prachuab Kirikhan province which covers 10.6 kms. Located in the tropical region, Thailand has a climate that is relatively warm throughout the year (Figure 1-1).

Topographically, Thailand falls under four classifications:

- ❖ Central plains. The wide flat land in the central plains is composed of sediment and non-sediment land. The major plains are found in the upper and lower parts of the region, such as the Pasak watershed area, the eastern plain and the Mae Klong, and the Petchburi river plains.

- ❖ Valleys in the north. These valleys lie between mountainous ranges. There are several plain areas in the mountainous valley of the north. The more important plains are those in Chiang Mai, Prae, and Nan.

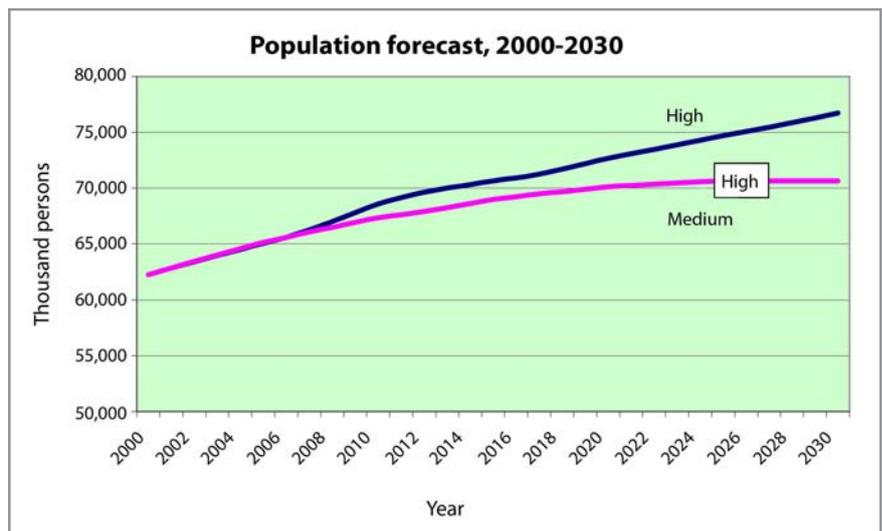
- ❖ Plateaus in the northeast. In the main, land in the northeastern region features plateaus. These are the Mae Kong River and Mun River plateaus.

- ❖ Southern plain areas. Southern Thailand is located on a narrow cape that is less than 200 kms wide, the narrowest being only 60 kms wide. In the middle of the cape lies a mountain range. Hence, most plain areas in the south lie along either side of the peninsula. The important ones are the plains of Ban Don, Phattalung and Pattani.

## Demography

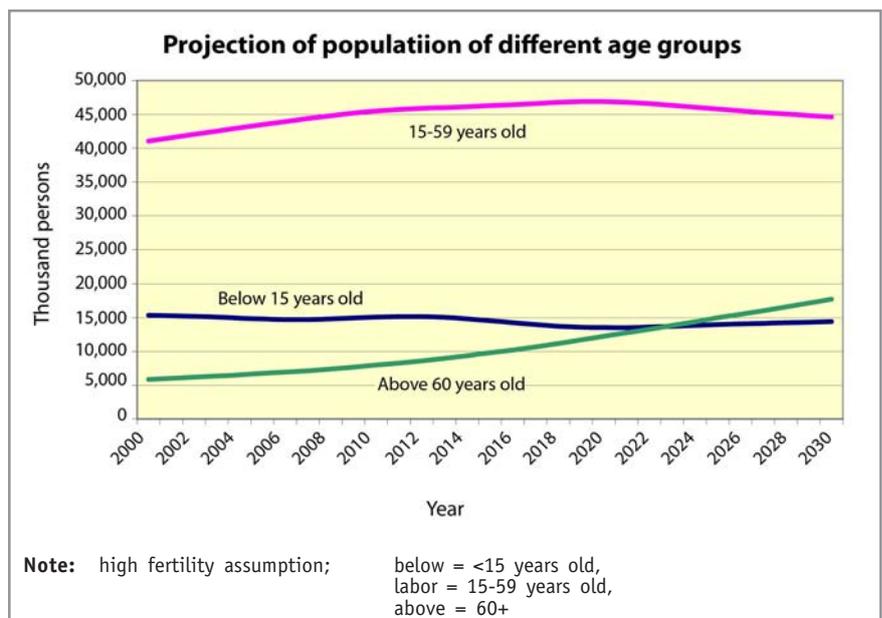
Over the past 15 years, Thailand's population has increased gradually from 58 million in 1993 to 63.4 millions in 2008, with the number of females slightly higher than the male population. Population density has also increased gradually with diminishing rates and has fluctuated to some extent. The proportion of the urban population to the total population has also gradually increased following the expansion of the economy<sup>1</sup>.

By 2030 Thailand's population is projected to reach about 71 to 77 million (Figure 1-2). As a result of socio-economic developments and improvements in public health, the demographic structure is changing. An aging society is expected within the next few decades, accompanied by consequent decline in the labor force (Figure 1-3). Thailand faces new socio-economic challenges that require corresponding changes in the social infrastructure, in order to benefit the aging population. Technological development will have to be accelerated to enhance national productivity, as well as to respond to the society's emerging needs.



**Figure 1-2** Population forecast, 2000-2030

**Source:** National Economic and Social Development Board, *Population forecast for Thailand, 2000-2030*, October, 2007



**Note:** high fertility assumption; below = <15 years old, labor = 15-59 years old, above = 60+

**Figure 1-3** Projection of population growth in Thailand, by age group

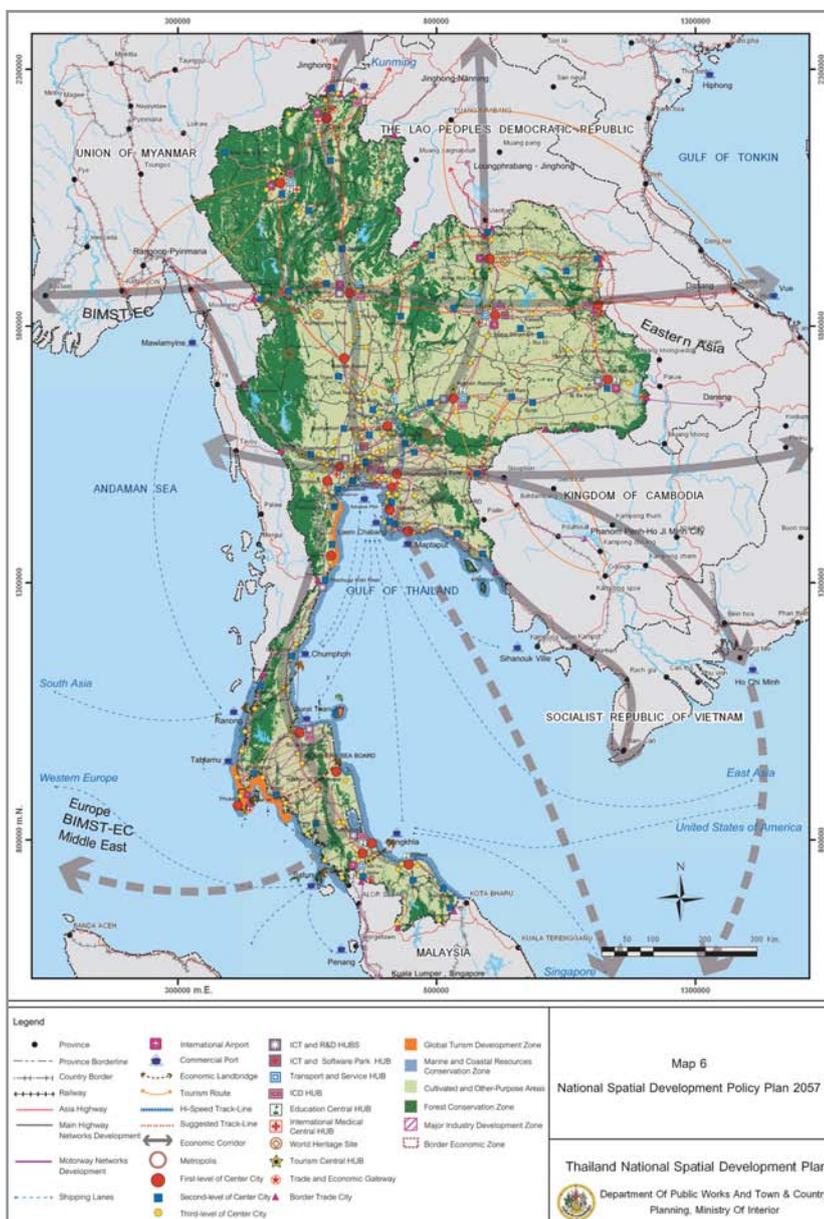
**Source:** National Economic and Social Development Board, *Population forecast for Thailand, 2000-2030*, October, 2007

<sup>1</sup> College of Population Studies, Chulalongkorn University

**Table 1-1** Town hierarchy in Thailand over the next 50 years (2057)

Region	Primary city (number)	Secondary city (number)
North	4	2
Northeast	5	5
Central	8	11
South	5	7

**Source:** Department of Public Works and Town and Country Planning, 2006, National landscape planning project: Policy for area development in Thailand



**Figure 1-4** City development trends over the next 50 years

**Source:** Department of Public Works and Town and Country Planning, 2006, National landscape planning project: Policy for area development in Thailand

Population distribution and economic development, particularly with regards the industrial sector, are concentrated in areas that are core economic centers in each region. This has further accelerated urban population growth and the expansion of cities. It is forecasted that within the next half of the century, Thailand's urban population will constitute over 50% of the total population, based on the development poles of provinces, as shown in Table 1-1 and Figure 1-4. Urban expansion could occur in problematic urban communities, necessitating careful and systematic planning to ensure sound urban development in all its dimensions, that is, physical, infrastructure, resources, environment and socio-economic.



## Economic and Social Circumstances

### Economic Aspect

The 1997 financial crisis caused serious problems in the Thai economy, with the current account deficit being the main cause behind the weakened economy. Non-productive expenses and speculative investments in assets fueled the crisis. Thailand adopted various measures, including revision and rehabilitation of financial institutions. These measures gradually improved the Thai economy (Figure 1-5). As shown in Table 1-2, the external trade, net flow of fund, balance of payment improved gradually, the proportion of public debt to GDP declined, and the current account balance improved.

The recovering Thai economy faced another round of difficulties brought about by political instability in 2006. The recovery slowed down due to negative effects of rates of exchange and political conflicts. The confidence of consumers and producers dropped. The slowdown was further aggravated by recession in the World economy and declining GDP growth in later years following 2000. It is notable that the economic slowdown was more severe in the non-agriculture sector (Figure 1-5). Thailand's international trade was severely affected, as seen in a steep drop in exports and imports (Figure 1-6).

**Table 1-2** Indicators for Thailand's economic strength (%)

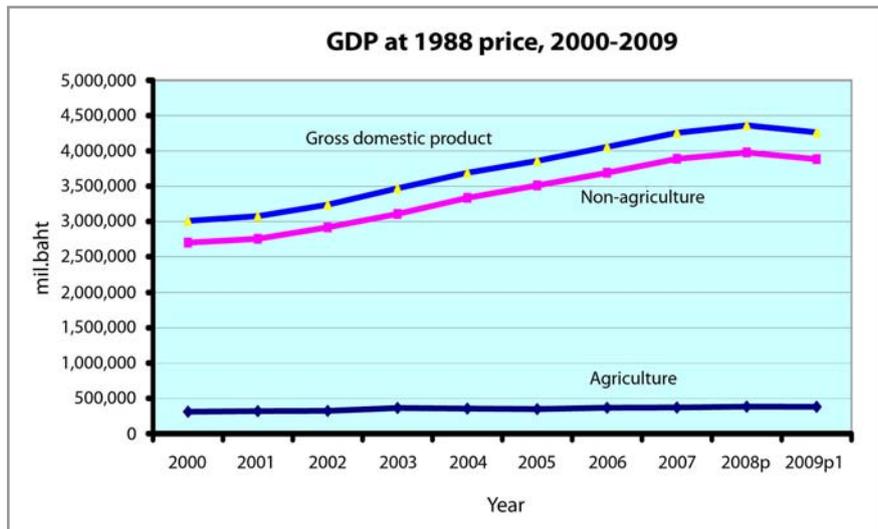
Indicator	2001	2002	2003	2004	2005	2006	2007	2008p	2009p
GDP growth (%)	2.2	5.3	7.1	6.3	4.6	5.1	4.9	2.5	-2.3
GDP (thousand baht/capita)	79.6	83.0	88.7	96.0	103.7	114.9	124.4	131.1	129.2
Inflation rate	1.6	0.7	1.8	2.7	4.5	4.7	2.3	5.5	-0.9
Export growth (%)	-7.1	4.7	18.1	21.5	15.1	16.9	17.2	15.8	-13.9
Import growth (%)	-2.9	4.5	17.3	25.7	25.8	7.9	9.0	26.4	-24.9
Current account/GDP (%)	4.4	3.6	3.3	1.7	-4.3	1.1	5.7	0.6	8.2
Flow of fund (net in US\$ billion)	-3.4	-1.8	-4.7	3.6	11.0	6.8	-2.4	14.6	14.6
Balance of payment (US\$ billion)	1.3	4.2	0.1	5.7	5.4	12.7	17.1	24.6	24.1
External debt (US\$ billion.)	67.5	59.5	51.9	51.4	52.1	61.0	61.8	65.2	69.9
Public debt 1/	28.3	23.3	17.0	15.0	14.1	14.2	12.1	13.1	15.7
Share of public debt to GDP (%) 40.95	30.95	20.36	16.38	14.72	13.28	9.82	10.02	12.65	
Debt service ratio (%)	20.8	19.6	16.0	8.5	10.7	11.2	11.6	7.2	6.8
Gross saving/GDP (%)	28.47	27.51	28.30	28.49	27.18	29.36	32.75	29.42	Na
Total Factor Productivity	0.62	3.38	5.06	3.66	2.11	2.41	2.10	-0.29	-4.46

Source: Bank of Thailand, NESDB

Note: p = preliminary,  
Na = not available  
1/ including debt of Bank of Thailand

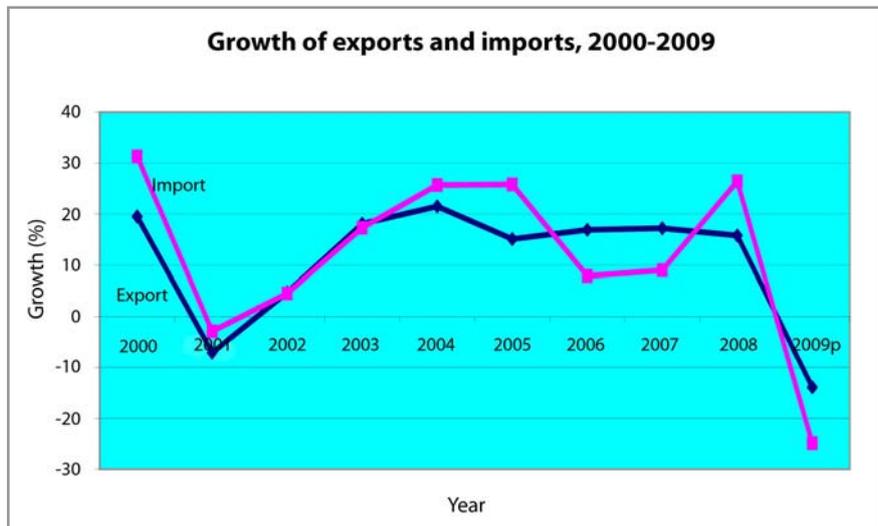
Seriously concerned about the situation, the Thai Government adopted one of the most aggressive fiscal policies to boost the economy. Besides giving cash-for-consumption to low income families, the Thai Government drew up various emergency measures to stimulate the economy by more than 50 billion baht<sup>2</sup>. The package included reducing household expenditures for public utilities, transport and energy.

These measures contributed to the Convention in different ways, both negatively and positively. Evidence shows the difficulty in formulating and implementing measures that address both climate change and economic development, under prevailing economic conditions and given the existing market system.



**Figure 1-5** Agriculture, non-agriculture and total GDP at 1988 prices, 2000-2009

Source: National Economic and Social Development Board



**Figure 1-6** Growth of Thailand's Exports and Imports, 2000-2009

Source: Bank of Thailand

## 🌸 Social Aspect

An assessment of Thailand's development over the past 35 years, with the guidance of seven national economic and social development plans, indicates that "the Thai economy is good, the society is problematic and the development is unsustainable". Thus, after more than three decades of guided development plans, the national welfare was deemed satisfactory but the benefits had not been distributed equitably. The majority of the people did not receive their fair share of benefits. This would give rise to unsustainable development in the long term. The 8<sup>th</sup> National Economic and Social Development Plan (1997-2001) shifted the development vision by recognizing the people as mechanisms for growth as well as its stakeholders. Economic development is considered as a tool for human development to achieve happiness and well-being for the people. Unfortunately, the economic and financial crises caused the Government to place its immediate focus on the crises prevailing at that time, rather than on pursuing development as planned.

<sup>2</sup> National Economic and Social Development Board <http://www.nesdb.go.th/Default.aspx?tabid=256>

The 9<sup>th</sup> Plan (2002-2006) followed the holistic development approach of the 8<sup>th</sup> Plan, with “people as the core of development” and adopted the “sufficiency economy philosophy”. The 9<sup>th</sup> Plan gave top priority to the development of social capital<sup>3</sup>. This is because social capital is highly vital to providing a good way of life for the society. It is also a key factor for economic development, particularly with regards services and production in the industrial sector.

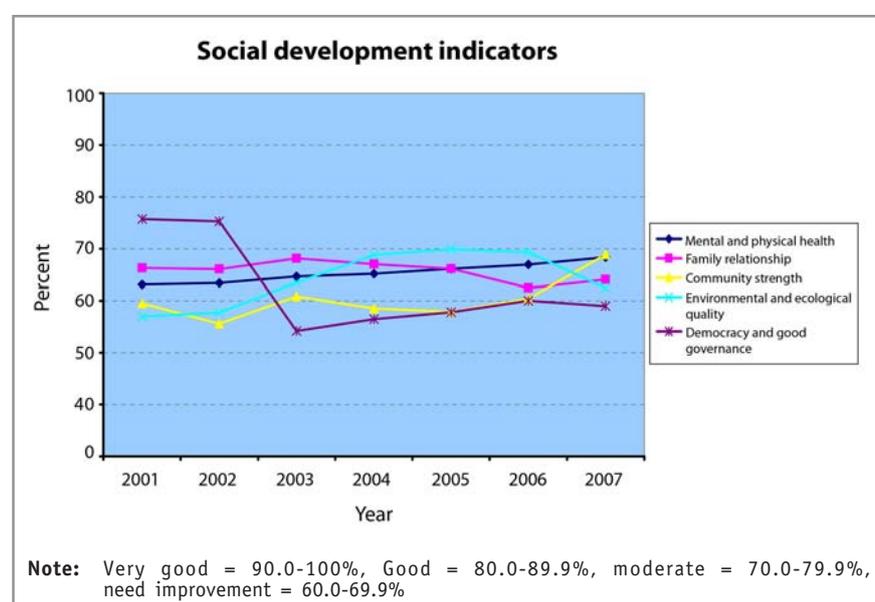
This resulted in positive developments in the quality of life of the people. Income distribution improved (Table 1-3), although some weaknesses remained (Figures 1-7 to 1-9).

**Table 1-3** Poverty status of the Thai people, 1994-2009

	1994	1996	1998	2000	2002	2004	2006	2007	2008	2009
Poverty line (baht/person/month)	838	953	1,130	1,135	1,190	1,242	1,386	1,443	1,579	1,586
Poverty ratio by expenditure (%)	8.36	8.21	7.40	8.09	7.72	8.00	7.90	7.07	7.13	6.97
People under poverty (mil.)	10.7	8.5	10.2	12,6	9.1	7.0	6.1	5.4	Na	5.3
Expenditure gap (the 3 <sup>rd</sup> 20%/the 1 <sup>st</sup> 20%)	2.23	2.23	2.18	2.22	2.22	2.26	2.31	2.20	2.18	2.17
Gini coefficient by expenditure	0.438	0.431	0.409	0.428	0.418	0.425	0.418	0.397	Na	Na
Total population (mil.)	58.7	60.0	61.2	62.2	63.4	64.5	65.6	66.0	66.5	66.9

Source: Office of National Economic and Social Development Board

Na = not available



**Figure 1-7** Composite indicators for happiness in Thai Society, 2001-2007

Source: Development Evaluation and Communication Office, Office of National Economic and Social Development Board

❖ Human capacity development was biased towards quantity rather than quality

❖ Education for the youth could not catch up with the changing environment and had not sufficiently responded to the process of lifelong learning and community development

❖ Existing level of knowledge among the Thai people was not sufficient for the development of a knowledge-based society

❖ Health improved but with increasingly risky behavioral patterns

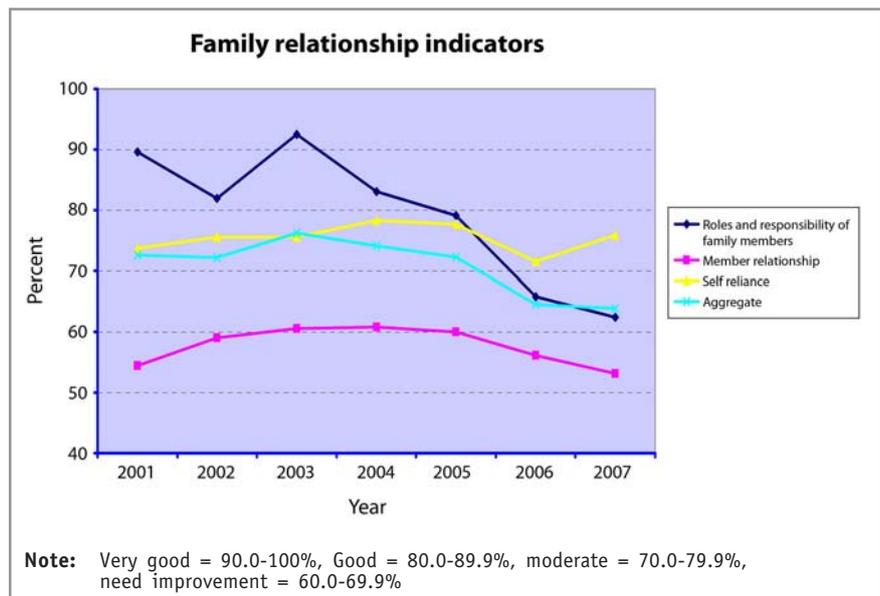
❖ Dissemination of knowledge was unequal

❖ Household institutions were weak and social norms were deteriorating

<sup>3</sup> “social capital” is built from collective thinking and working on the ground of trust, social cohesion and the Thai culture. Through the relationship of the key social pillars (man, institution, culture and knowledge), the process will generate social power in the community and society (excerpt from National Economic and Social Development Board)

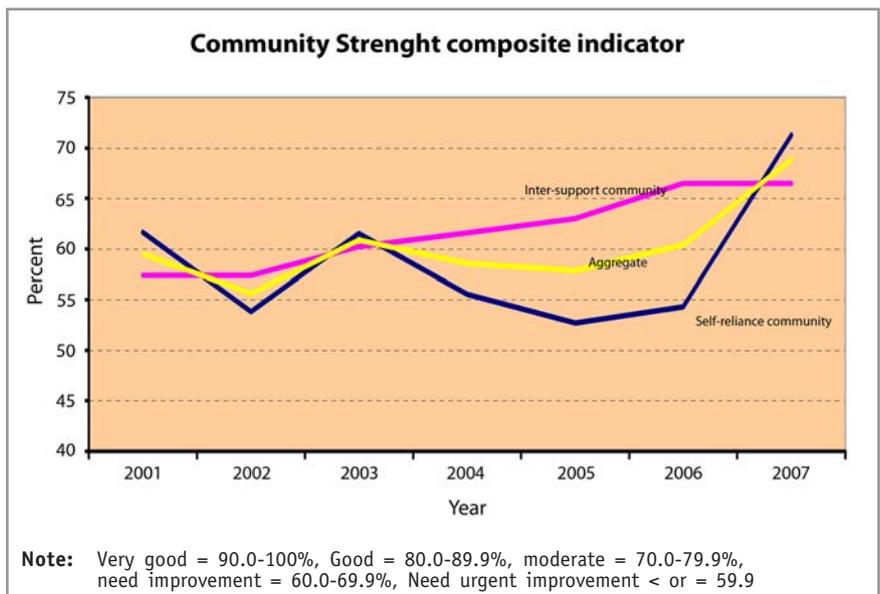
The 10<sup>th</sup> Plan (2007-2011) adopted the vision and development path of the 9<sup>th</sup> Plan. Unfortunately, political problems and the global economic recession caused the Thai Government to adjust the Plan, in order to respond to the prevailing economic crisis, as stated earlier.

The development of social capital, which is Thailand's approach to sustainable development, challenges the vision of national leaders. Deteriorated domestic and global natural resources and environment, as well as the problems of global warming and climate change, require the application of innovative economic tools and mechanisms that can effectively manage demand and supply. Social and political mechanisms are also required to strengthen the social infrastructure.



**Figure 1-8** Composite indicators for family relationships in Thai Society, 2001-2007

**Source:** Development Evaluation and Communication Office, Office of National Economic and Social Development Board



**Figure 1-9** Composite indicators for community strength in Thai Society, 2001-2007

**Source:** Development Evaluation and Communication Office, Office of National Economic and Social Development Board

## Natural Resources and Environment

### Land resources and land use

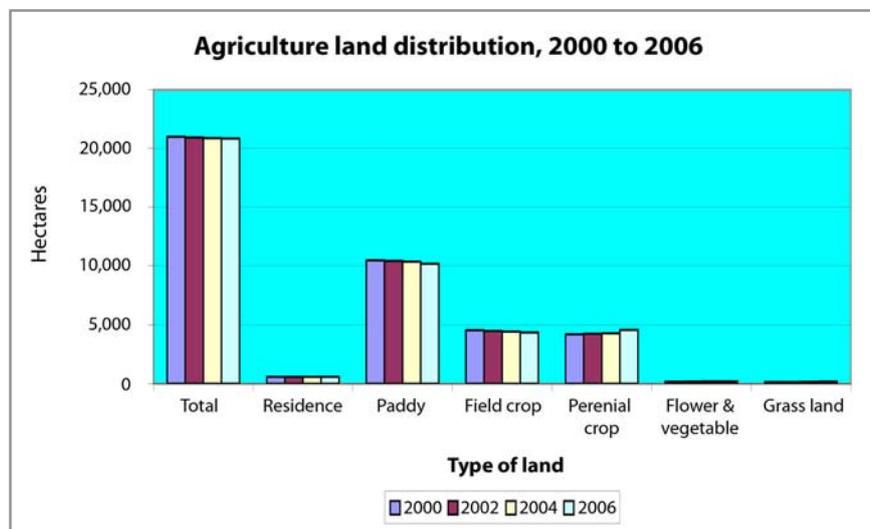
Land is an important natural resource that supports the agriculture and non-agriculture sectors. Thailand has a total land area of 51.3 million hectares. Three types of land use are discussed here - agriculture, forestry, and others (including waterways and reservoirs). Land use for agriculture has been relatively stable at 21 million hectares or about 40% of the total land area (Table 1-4), whereas land use for forestry has increased slightly in proportion to the total land area due to reforestation and conservation.

**Table 1-4** Land Use in Thailand, 1987-2005

Year	Total land	Forest land		Agricultural land		Others	
	mil.ha.	mil.ha.	%	mil.ha.	%	mil.ha.	%
1987	51.312	14.606	28.47	20.992	40.91	15.714	30.62
1992	51.312	13.494	26.3	21.128	41.18	16.688	32.52
1997	51.312	13.030	25.4	20.978	40.88	17.304	33.72
1998	51.312	12.971	25.28	20.862	40.66	17.475	34.06
1999	51.312	12.898	25.14	21.014	40.95	17.398	33.91
2000	51.312	17.011	33.15	20.992	40.91	13.309	25.94
2001	51.312	16.102	31.38	20.970	40.87	14.238	27.75
2002	51.312	17.011	33.15	20.942	40.81	13.358	26.03
2003	51.312	17.011	33.15	20.909	40.75	13.392	26.1
2004	51.312	16.758	32.66	20.877	40.69	13.675	26.65
2005	51.312	16.758	32.66	20.845	40.62	13.709	26.72

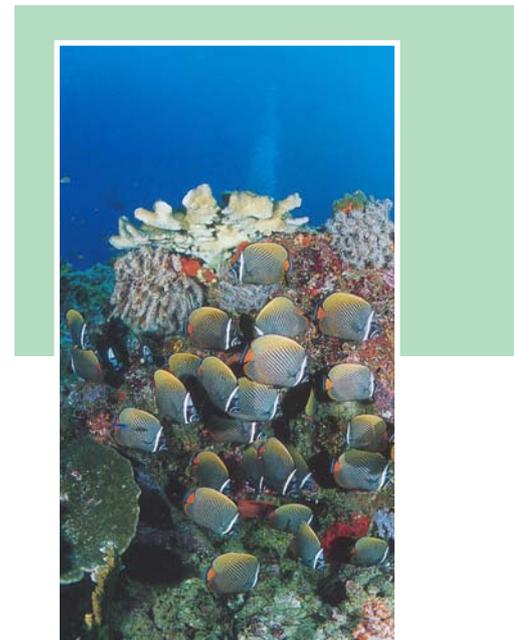
Despite its relative stability, agricultural land use has seen changes in recent years (Figure 1-10). Rice-planted areas, although generally stable, slightly declined in recent years from about 10.5 million hectares in 2000 to about 10 million hectares in 2006. The same is true for land planted to field crops, which dropped from 4.6 million hectares to 4.4 million hectares during the same period. Land planted to perennial crops and grass increased by nearly 300,000 hectares between 2004 and 2006.

The shift in land use from annual to perennial crops was due to changes in the climate and market conditions. Frequent droughts motivated farmers to grow fast-growing trees for the paper industry. Also, high prices for rubber and palm oil induced farmers, particularly in the south and northeast, to switch to these two crops. It is important to note that switching from annual to perennial crops reduces the farmers’ flexibility to adjust to external factors, and hence exposes them to higher climate change risks.



**Figure 1-10** Agricultural land distribution in Thailand, 2000-2006

Source: Office of Agricultural Economics, Ministry of Agriculture and Cooperatives



In addition to the climate, other causes of risks to farmers are changes in agricultural land use, land degradation and infertile land. More than half of all agricultural land in Thailand have saline, sandy, shallow or acidic soils (Table 1-5). These areas have low productivity and have restricted ability to adapt to climate changes.

Tables 1-6 and 1-7 show the impacts of climate change and variations in climate conditions on agriculture, especially floods and droughts. It is noted that floods and droughts can occur within the same year, although droughts are more common and more frequent than floods. This is due partly to highly intensive land use and partly to different rainfall patterns and physical characteristics in different regions throughout the country. During 1992-2002, there were more areas affected by frequent flooding (Table 1-6). The extent of damage varies from year to year, sometimes reaching hundreds of million dollars and affecting more than 2 to 3 million households (Table 1-7).

**Table 1-5** Land with Problematic Soils in Thailand, 2004

Problematic land	Area(ha)
1. Saline soils	721,920
2. Sandy soils	2,043,173
3. Shallow soils	6,938,499
4. Acid sulfate soils	881,623
5. Organic soils	42,456
6. Slope complex	15,361,117
7. Acid soils	15,749,199

Source: Land Development Department

**Table 1-6** Flood damages by provinces, aquaculture, and agricultural land, 1989-2008

Year	Provinces (number)	Fish and shrimp ponds (number)	Agricultural land (ha.)
1989	52	112,650	1,623,305
1990	58	26,580	360,960
1991	66	24,500	1,580,004
1992	66	35,620	2,287,680
1993	42	42,560	2,563,881
1994	74	33,250	2,240,041
1995	73	124,560	606,778
1996	74	45,678	3,362,313
1997	64	32,560	1,963,042
1998	65	20,154	74,572
1999	69	32,658	486,107
2000	62	91,520	1,654,493
2001	60	36,589	4,661,402
2002	72	103,533	1,669,618
2003	66	22,339	255,289
2004	59	12,884	527,797
2005	63	13,664	272,232
2006	58	122,123	1,049,687
2007	54	13,866	258,765
2008	65	87,413	1,054,505

Source: Department of Disaster Prevention and Mitigation, Ministry of Interior

**Table 1-7** Drought damages by provinces, residences and agricultural land, 1989-2008

Year	Provinces	Population	Household (number)	Agricultural land (ha.)	Damages (US\$)
1989	29	1,760,192	496,062	207,078	3,752,822
1990	48	2,107,100	536,550	315,312	2,836,018
1991	59	4,926,177	1,221,416	165,963	8,066,774
1992	70	8,100,916	2,430,663	853,515	5,420,928
1993	68	9,107,675	2,533,194	326,471	6,115,697
1994	66	8,763,014	2,736,643	2,867,811	3,038,836
1995	72	12,482,502	2,661,678	480,230	5,465,244
1996	61	10,967,930	2,277,787	16,304	8,897,354
1997	64	14,678,373	3,094,280	229,007	7,666,467
1998	72	6,510,111	1,531,295	286,286	2,128,311
1999	58	6,127,165	1,546,107	503,189	46,784,635
2000	59	10,561,526	2,830,297	75,632	19,745,011
2001	51	18,933,905	7,334,816	274,031	2,214,245
2002	68	12,841,110	2,939,139	331,450	15,654,829
2003	63	5,939,282	1,399,936	77,470	5,363,982
2004	64	8,388,728	1,970,516	236,833	5,866,735
2005	71	11,147,627	2,768,919	2,197,866	232,795,727
2006	61	11,862,358	2,960,824	92,600	15,239,253
2007	66	16,754,980	4,378,225	216,019	6,101,684
2008	61	13,298,895	3,531,570	84,000	3,196,949

Source: Department of Disaster Prevention and Mitigation, Ministry of Interior

Note: US\$ 1 = 32.5 Baht

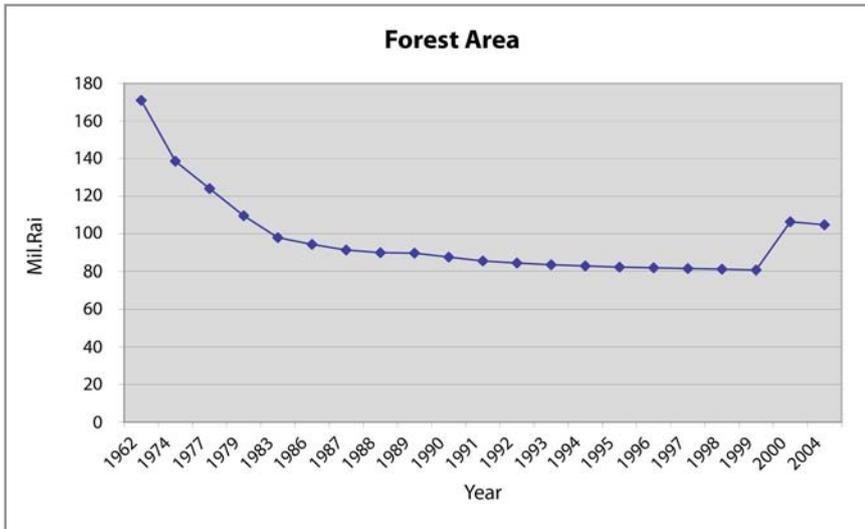
## Forest Resources

A natural resource that is vital to humans in various ways, the forest is a source of food, raw materials, and a variety of products and services. It is a part of the ecosystem that is needed for human survival. Forest areas in Thailand have gradually declined and have been relatively stable only in the 1990s due to strong measures implemented by the Thai Government, particularly those that banned logging and expanded forest conservation areas (Figures 1-11 and 1-13)<sup>4</sup>. In the early years of 2000, forest land was redefined and forest areas were adjusted accordingly. In 2004, Thailand's forest areas of 16.8 million hectares accounted for about 33% of the total land area. Most of the forest areas are in the northern and western parts of the country, although there are some along the southern peninsula. Northeast Thailand has the least conserved forest areas of all (Figure 1-12).

Due to exploitation, Thailand's mangrove forest was reduced from nearly 320,000 hectares in 1975 to less than 200,000 hectares in 1987. In 1996, the Thai Government decided to revoke all mangrove forest concessions and to rehabilitate these areas. In 2000, Thailand's mangrove forest covered over 250,000 hectares and increased to 275,000 hectares in 2004. The importance of mangrove forest has never been more recognized than during the tsunami tragedy in 2004. Areas sheltered by mangrove forests were saved from the devastating effects of the tsunami, while those without such shield were completely destroyed.

Encroachment into terrestrial and mangrove forests continues despite efforts to protect them and the lessons learned from the tsunami tragedy. Management problems remain due to the following:

<sup>4</sup> In certain years such as 2000, the forest and forest type definitions were redefined and resulted in unusual changes in forest areas.



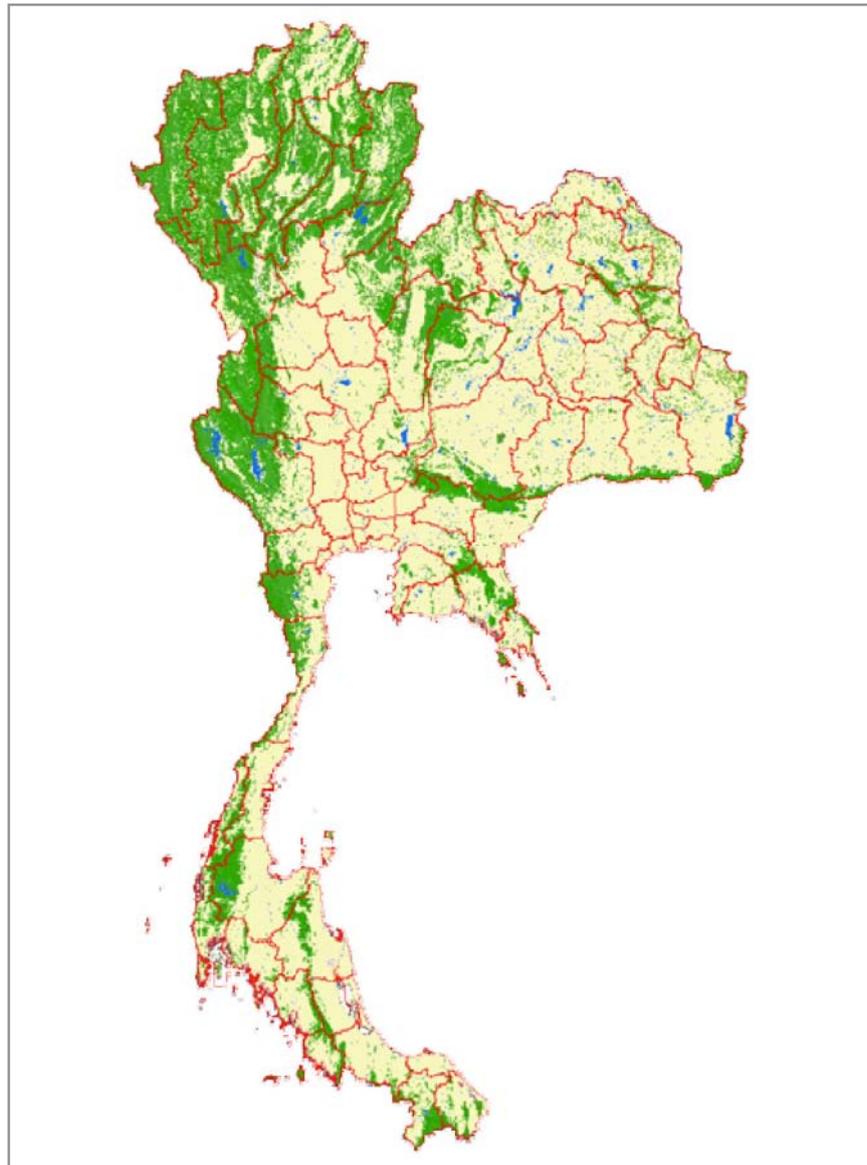
**Figure 1-11** Forest Land in Thailand, 1962-2004

Source: Royal Forest Department



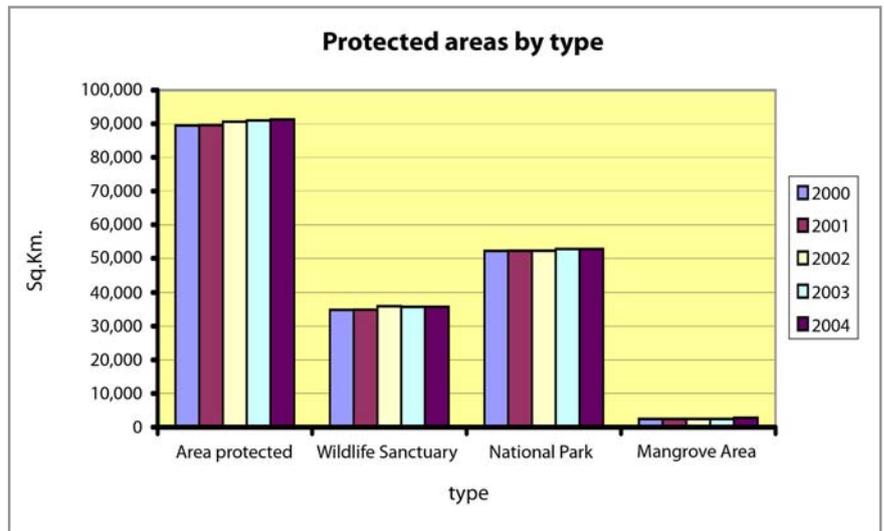
- ❖ Industrial and urban expansion and infrastructure development
- ❖ Continuing deterioration of natural resources
- ❖ Lack of efficient mechanism to manage natural resources and the environment
- ❖ Application of constitutional rights to protect natural resources, the environment, culture and quality of life

While these factors often lead to more systematic and efficient management of natural resources, such as integrated management of watershed areas and resource watch network, they also have the potential to aggravate conflicts, as seen in the case of coal power plants. Thailand still needs to develop a more efficient natural resource and environmental management mechanism. A key factor contributing to such a mechanism is the application of conflict management, based on a system for good governance.



**Figure 1-12** Forest Land Distribution in Thailand, 2004

Source: Department of National Parks, wildlife and Plant Conservation, 30 November, 2007



**Figure 1-13** Conserved Forest (by type), 2000-2004

Source: Department of National Parks, wildlife and Plant Conservation

## Water Resources

Thailand has 25 watershed areas across the country (Table 1-8). Some 6.4 million hectares are irrigated and 14.6 million hectares are rainfed. Average rainfall ranges between 1,400 and 1,600 mm./year (Table 1-9). The amount of rainfall exceeds 800 billion cum./year. By region, average rainfalls in the north, northeast and central regions are lower than the average, while those in the east and south are higher than the average (Table 1-9).

Of the 800 billion cum./year of rainfall, only about 200 billion cum. is surface water that is available for utilization. Total water storage capacity, by different types of dams and reservoirs, is about 74 billion cum. (Table 1-10). However, water in the reservoirs for the summer season is only about 45 billion cum.<sup>5</sup>. Most of the water is stored in large and medium size reservoirs which account for over 90% of storage capacity in the country.

While storage capacities and water supply are restricted by physical and natural characteristics, the demand for water continues to increase due to population growth and economic development (Table 1-11). It is projected that by 2021 or within the next decade, the demand for water will reach 120 billion cum. This projected demand, unless properly managed, would pose a serious threat to social and economic development.

**Table 1-8** Watershed areas, rainfall and surface water flow (by region), 2001

Region	Watershed (number)	Sub-watershed (number)	Watershed area (sq.km.)	Rainfall (mil.cum.)	Ave. surface water flow (mil.cum.)
North	6	70	128,450	213,412	39,748
Northeast	3	68	176,599	237,578	54,290
Central	5	39	86,128	85,259	24,009
East	4	26	36,480	76,363	23,455
South	7	53	84,450	162,927	67,767
	25	256	512,107	775,539	209,269

**Table 1-9** Average annual rainfall (by region), 1995-2004

Region	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
North	1,349.5	1,360.2	1,094.1	1,012.8	1,339.0	1,334.1	1,376.8	1,469.0	1,073.5	1,258.2
Central	1,335.0	1,493.9	1,005.6	1,368.8	1,501.7	1,341.4	1,238.7	1,241.2	1,252.4	1,009.2
East	2,082.5	1,819.9	1,589.1	1,779.7	2,051.0	1,998.5	1,761.5	1,665.2	1,757.2	1,550.5
Northeast	1,408.5	1,520.5	1,308.9	1,186.7	1,540.6	1,671.7	1,488.6	1,620.3	1,314.5	1,406.8
South (East coast)	1,754.7	2,062.5	1,693.7	1,718.3	2,237.2	2,281.2	2,015.6	1,587.3	1,784.9	1,408.2
South (West coast)	2,861.5	2,704.1	2,384.9	2,795.3	3,026.0	2,808.8	2,958.9	2,361.2	2,689.6	2,413.8
Total	1,686.5	1,734.3	1,432.3	1,505.4	1,829.6	1,813.0	1,707.3	1,607.9	1,525.9	1,438.3

Source: Department of Meteorology, 2005

**Table 1-10** Number of projects and storage capacity of different reservoirs

Agency	Project (number)	Storage capacity (mil.cum)
<b>Royal Irrigation Dept.*</b>		
Large and medium project	765	9,962.21
Small project	9,791	1,441.08
Royal project	851	315.16
Border self-defence project	423	62.01
<b>Electricity Generating Authority**</b>		
Hydroelectric dam	10	61,203
<b>Water Resource Dept.**</b>		
Small project	1,244	713
Total	13,084	73,696.46

Note: \* Royal Irrigation Department, 2005;  
\*\* Department of Water Resources, 2005

Fluctuations in the natural supply of rainwater and limited storage capacities affect rainfed and irrigated agriculture. Climate variability brings about fluctuating rainfalls that cause droughts and floods across regions. This situation has called for a classification of drought- and flood-prone areas and adoption of special measures (Table 1-12). Most cases of severe droughts occur in the north and northeast regions, which account for over 80% of the country's drought-prone areas and nearly 80% of areas that are prone to severe droughts. In 2005, Thailand suffered the most severe drought, especially in the eastern region where the largest industrial estate and fruit orchards are located<sup>6</sup>. Water shortage necessitated short, medium and long term measures.

<sup>5</sup> Department of Water Resources, Departmental 4-year Operation Plan (2008-2011)

**Table 1-11** Water demand (by sector and region) (mil.cum)

Region	Consumption		Industrial		Irrigation		Eco maintenance		Total	
	2001	2021	2001	2021	2001	2021	2001	2021	2001	2021
North	226	243	108	260	7,925	14,637	4,332	4,332	12,593	19,471
Northeast	548	621	297	584	7,989	44,228	2,783	2,783	11,617	48,226
Central	1,355	1,580	784	2,270	23,534	29,988	5,836	5,834	31,509	39,673
South	233	308	127	327	1,836	9,052	9,139	9,139	11,335	18,826
Total	2,363	2,753	1,316	3,440	41,284	97,904	22,090	22,088	67,053	126,196

Source: Office of Natural Resource and Environmental Policy and Planning

**Table 1-12** Drought-persistent areas in Thailand (by region, level and frequency)

level of frequency	North	Northeast	East	Central	South	Total	Percent
Highly severe	10,519,595	26,572,673	1,460,142	4,755,300	-	43,307,710	72.27
moderately severe	77,994	8,385,481	760,930	69,652	718	9,294,775	15.51
less severe	31,188	5,708,256	1,433,361	84,565	66,556	7,323,926	12.22
Total	10,628,777	40,666,410	3,654,433	4,909,517	67,274	59,926,411	100
Percent	17.74	67.86	6.10	8.19	0.11	100	

Source: Office of Natural Resource and Environmental Policy and Planning

Thailand has prepared a water resource development strategy that emphasizes:

- ❖ Development of an integrated management mechanism with public participation at all levels
- ❖ Improvement of conservation, rehabilitation and utilization of water resources, consistent with the ecological system in the area
- ❖ Development of a participatory water watch and an early warning system

It is expected that implementation of the strategic plan will require an investment of more than US\$ 86 million. It is noted that most of the investment is supply enhancement-oriented.

Under conditions of limited water supply and excess demand for it, global warming and climate change are additional factors that could either aggravate or improve these conditions, depending on their effects. Nevertheless, going by general trends of more frequently occurring severe drought in the hot season, it is likely that climate variability would do more harm than good. More technical and systematic analysis is needed to better understand and predict the potential effects.

<sup>6</sup> Office of Natural Resource and Environmental Policy and Planning, Thailand's Environmental Status Report for 2005

## Thailand's Sustainable Development

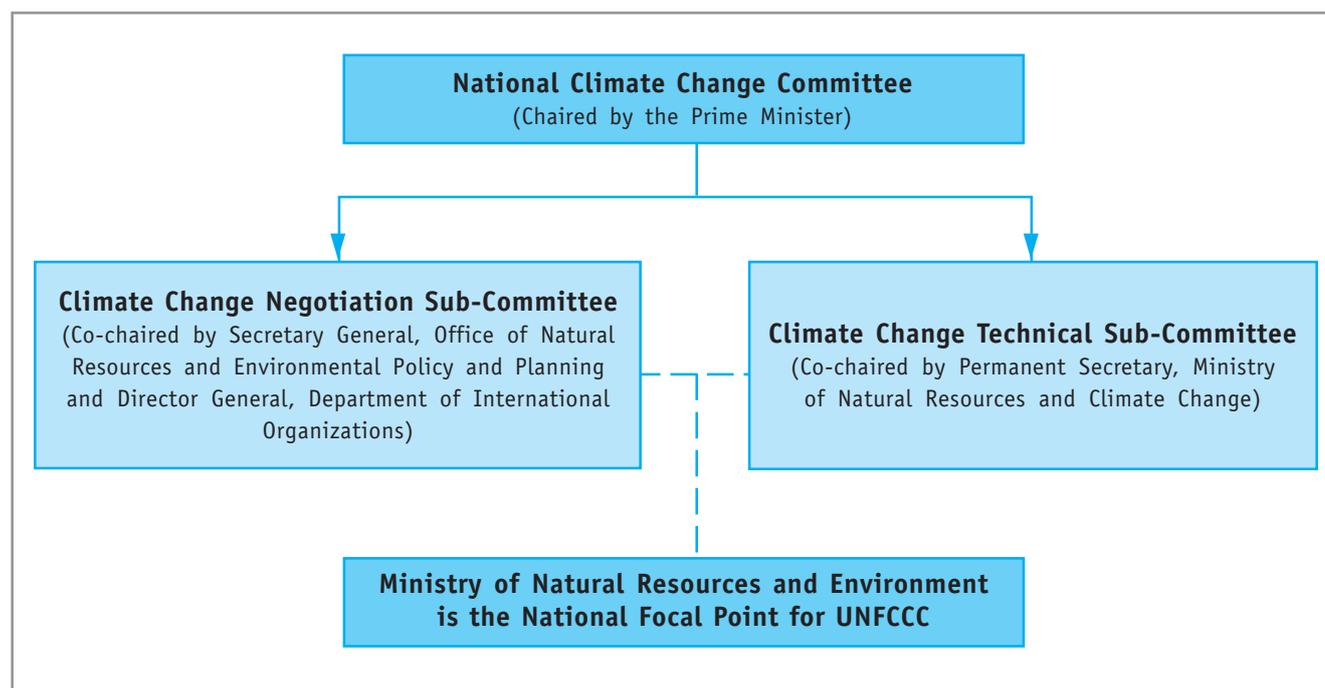
Since 1961, Thailand's five-year national economic and social development plans have provided a framework for sustainable development. Over the past four decades, Thailand has gradually improved the process of sustainable development. Development priorities as well as the planning process and implementation have been adjusted to national, regional circumstances and global development dynamics. At present, Thailand is implementing the 10<sup>th</sup> Plan (2007-2011) and is preparing the 11<sup>th</sup> Plan (2012-2016).

Due to increasing deterioration of natural resources and the environment, Thailand has promulgated the Enhancement and Promotion of the National Environmental Quality Act (B.E. 2535). Under the Act, a five-year action plan for environmental quality management is prepared on a regular basis. At present, Thailand is implementing the Environmental Quality Management Plan for 2007-2011. It is noted that the planning periods for economic and social development and environmental management are in parallel. This is to ensure the country's economic cum environmental development process. The committees working on the Plans are composed of stakeholders. The planning processes for the two Plans are similar. A bottom-up approach through stakeholder consultation is used. The planning process is coordinated and integrated to ensure full consideration of natural resource and environmental conservation in the economic and social development path, leading to the country's sustainable development.

In conclusion, Thailand's economic and social development planning is consistent with the sustainable development concept. Through a process of parallel planning, natural resource conservation and environmental protection are integrated into the economic and social development of the country.

### ✿ National development policy and climate change

**General policy** After ratification of the UNFCCC in 1994, Thailand established a national sub-committee on climate change under the National Environment Board. The sub-committee served as a climate change policy making body and guided Thailand's positions in the climate change negotiation process. Thailand ratified the Kyoto Protocol in 2002. In 2006, the sub-committee on climate change was upgraded to become the National Climate Change Committee chaired by the Prime Minister. Under the National Committee, three sub-committees in charge of the technical, negotiation and public relations aspects of climate change were established (Diagram 1-1).



**Diagram 1-1** Policy making concerning climate change in Thailand



In general, Thailand's policy on climate change has been drawn up to ensure that the country's commitments and obligations to the UNFCCC and the Kyoto Protocol are fulfilled and are consistent with the national interest. As indicated in the INC (initial national communication<sup>7</sup>), Thailand has integrated climate change issues into the national development planning process since the 7<sup>th</sup> Plan (1992-1996).

Under the 8<sup>th</sup> Plan (1997-2001), Thailand's development vision focused on the people's welfare as its core development objective. A holistic development approach was used to achieve a balance among the economic, social and environmental sectors. In the planning process, a bottom-up approach and stakeholder consultation were applied. The 8<sup>th</sup> Plan defined a new paradigm for sustainable development. Unfortunately, during the 8<sup>th</sup> Plan, the economic crisis caused the Thai Government to put the original Plan on hold and to revert to various emergency measures to rescue the economy, especially those pertaining to economic stability and recovery, employment and income. The 8<sup>th</sup> Plan, in effect, had not been carried out effectively. Nevertheless, the 8<sup>th</sup> Plan set a new platform for social mechanisms to spearhead the development process. Public participation was widely recognized, inspiring the preparation of the national constitution (B.E. 2540), which laid an important social foundation that served as key mechanism for national development.

In the 9<sup>th</sup> Plan (2002-2006), sufficiency economy was adopted as a philosophy to guide the conduct of national development, based on a holistic development vision. As initiated in the 8<sup>th</sup> Plan, the center of development remained focused on the people. An assessment of the 9<sup>th</sup> Plan concluded that it achieved its goals satisfactorily. Economic growth continued at an average rate of 5.7% per year, with the economy becoming more stable, poverty reduced and the quality of life improved. Key improvements were seen in enhanced public health and sanitation services. Health insurance schemes, in terms of quantity and quality, covered the majority of the population. Nevertheless, Thailand's economy remained vulnerable to external factors. Major problems remained with regards the quality of education, income distribution, public safety, and transparency and good governance. Although natural resources management improved, especially concerning forest resources, environmental protection did not achieve its target, especially with regards water quality and hazardous waste disposal.

The general policy on climate change under the 8<sup>th</sup> and 9<sup>th</sup> Plans was a win-win policy. The policy is being continued up to the present time. Under this policy, Thailand formulated national policies on energy, forest, and water resources and so on, in order to enhance GHG mitigation directly and indirectly. Public awareness through formal education and information campaigns was developed to enhance adaptation to climate change, especially concerning agriculture and water resources.

<sup>7</sup> Royal Thai Government, 2000, Thailand's Initial National Communication for the UNFCCC.



### Policies during the past decade

Economic and social development in Thailand in the past decade kept pace with changing economic and social conditions at the national and global levels. During the period, there were moderate achievements in overall economic strength and promotion of equality throughout the country. The major indicators were<sup>8</sup> as follows:

- ❖ Continued economic expansion and more efficient economy
- ❖ Low unemployment rate
- ❖ Improved economic stability as public debt ratio declined
- ❖ Continued reduction in the number of households below the poverty line
- ❖ Slight improvements in social development

Nevertheless, the changing global economic structure during the period affected Thailand's economic and social development. Several indicators suggested such changes, especially differences in production efficiency between industry and agriculture, dependence on exports, and unbalanced dependence between the domestic and international economy. Thailand has been sensitive and vulnerable to global economic structural changes. Likewise, high dependency on imported energy resources has made the national economy vulnerable to energy prices. In addition, the social indicators reflected problems in social development. While the people seemed healthy mentally and physically, they lacked the right moral attitude and motivation to learn. It was found that in the past decade, their motivation to learn or to seek knowledge was low. Family cohesion declined and community cohesion weakened.

As stated earlier, Thailand's economic and social development has progressed in accordance with prevailing circumstances and the direction of development. The 9<sup>th</sup> Plan applied the sufficiency economy philosophy as guide to national development. To complement the development vision initiated in the 8<sup>th</sup> Plan, which placed people at the center of development, priorities were placed on the country's economic recovery and on strengthening its economic foundation. With regards the global economy, the Plan aimed at enhancing self-reliance within the national economic system, so that it can withstand global economic changes. This is to ensure stable growth of the Thai economy. At the same time, balanced development among the human, social, economic and environmental aspects is assured, to sustain the welfare and livelihood of the Thai people.

<sup>8</sup> Center for Applied Economic Research, 2008, Strategic framework for regional development during the 10<sup>th</sup> National Economic and Social Development Plan, a research report submitted to National Economic and Social Development Board.

Under the 10<sup>th</sup> Plan, the sufficiency economy philosophy has been maintained to guide national economic and social development and people have remained as the center of development, a balance among the economic, social and environmental aspects of development is ensured, alongside the strengthening of self-reliance among the Thai people. Guided by a vision of sustainable happiness for the Thai society, the 10<sup>th</sup> Plan emphasizes the development of economic, social and natural resource and environmental capitals. These capitals are vital to strengthen and enhance the benefits of the Thai people.

The 10<sup>th</sup> Plan is a strategic plan to guide the direction and position of Thailand in the world economy. There are five strategies:

- ❖ Development of the quality of the Thai people and Thai society
- ❖ Strengthening the community and society
- ❖ Adjustment of the economic structure to ensure that it is balanced and sustainable
- ❖ Development based on sustainable utilization of diversified biological resources
- ❖ Enhancement of good governance in national administration and management.

In addition, Thailand has also defined specific strategies related to key natural resources and the environment. Among them are the first national strategic plan for organic agriculture development (B.E. 2551-2554) and the national action plan for organic agriculture development (B.E. 2552-2554).

In summary, the impacts of unbalanced development, especially as they affect levels of self-reliance within communities, have led Thailand to adopt the sufficiency economy philosophy as guide towards balanced development, in the midst of globalization.

### The 10<sup>th</sup> Plan and climate change

The 10<sup>th</sup> Plan recognizes the dynamics of global economic, social and environmental change. The problems of continued pressure placed by population growth on natural resources and the environment, global warming, climate change and ozone depletion have aggravated conditions in the fragile ecological system. The consequences of restoring the natural balance have been detrimental. Natural disasters, such as droughts, floods, typhoons and hurricanes have caused catastrophic damages to physical infrastructure, the economy, and human lives. New diseases, like SARS and bird flu, have emerged. These have affected the people's welfare and livelihoods and have stalled sustainable development.

As a party to the UNFCCC, Thailand has commitments and obligations to address global warming. The effects of global warming, alongside obligations to the Convention, affect and constrain national development efforts, both at the macro and micro levels.

In addition to constraints to economic and social development due to international obligations, Thailand has also been affected by the use of natural resource and environmental arguments as non-trade barriers imposed by other countries. It is imperative for Thailand to integrate natural resource and environmental management into agreements, cooperation, conditions and obligations that pertain to related transboundary natural resources and environment. It is also necessary for Thailand to apply international agreements to upgrade its national standards for environmental protection, in order to protect its natural resource base and ecological balance and to maximize the social benefits from limited natural resources. This would require public participation and adjustment of production and consumption to make them more environment-friendly and to maximize energy efficiency and conservation. Measures taken must fully consider the potential impacts of the environment, sustainability, energy safety and security, in order to achieve a balance between economic and social development and environmental protection.

Thailand fully recognizes climate change issues at the international and national levels. One main objective of the 10<sup>th</sup> Plan, that is, "to establish decentralization of power and fair distribution of benefits at the local and national levels, including protection of natural interest from international agreements and obligations", suggests that Thailand has maintained a win-win policy with regards climate change.

## Future development and climate change

Thailand has commenced preparation of the 11<sup>th</sup> Plan with the introduction of its vision for the period starting 2070. Part of the vision reflects the importance of the environment to production and consumption patterns, as suggested in the following statement “.....maintain the environment in good condition and mutually supportive to each other, adopt environment-friendly production systems, ensure energy and food security, observe self-reliance in a competitive world and live with pride in the regional and global communities”. An important mission is to cooperate in the management of natural resources and biodiversity to ensure their richness, thus the people will come to recognize the value of natural resources and the environment. An important development issue identified is the management of natural resources and the environment to achieve sustainability. Conditions that are vital to the pursuit of the development strategy are the following.

-  Development of human resources
-  Global warming and climate change that potentially cause non-trade barriers
-  Demographic changes towards the formation of an aging society

With regards the global environmental policy and vision for the next 20 years, Thailand recognizes the relationship between conditions and obligations pertaining to the global environment, technology development, and free trade. Earlier studies indicated that countries tend to consider environmental conditions as non-trade barriers. Future development will be based on knowledge and innovation, especially concerning information technology, nanotechnology, biotechnology and neuro technology and energy security. All these are related to global warming and climate change. It can be said that Thailand has become increasingly concerned about global warming and climate change as critical factors affecting sustainable development.

Under negotiation is a new phase of commitments under the UNFCCC and the Kyoto Protocol. The main issues include the need for long-term cooperative action and a new round of commitments by developed countries. As a Party to the Convention, Thailand has to make policy adjustments on global warming and climate change, following the outcomes of the negotiation. In any case, the national objectives remain the same, that is, to protect the national interest and to honor the country's obligations.



# 2

## Thailand's National Greenhouse Gas Inventory for 2000

# 2

## Thailand's National Greenhouse Gas Inventory for 2000



### Introduction

The national greenhouse gas inventory for 2000 is the second national inventory information submitted by Thailand to the UNFCCC. The first national greenhouse gas inventory was for 1994.

The inventory report of Thailand follows the UNFCCC guidelines for the preparation of national communication from the Parties not included in Annex-1 as provided in Decision 17/CP.8. The IPCC Revised 1996 Guidelines for National Greenhouse Gas Inventories and the 2000 IPCC Good Practice Guidance and Uncertainty Management on National Inventories were used to estimate the national inventory for 2000. The global warming potential (GWP) factors recommended by IPCC were also used to derive emissions in CO<sub>2</sub> equivalent.

Emission factors and activity data are critical factors that affect the estimation of GHG inventory. In the case of Thailand, activity data are obtained from statistical reports from relevant agencies, while emission factors are mostly default ones provided by the IPCC Guidelines. Tier 2 is applied to N<sub>2</sub>O emission from animal waste management and GHG emissions from rice, forest and waste management. It is noted that local emission factors derived using the Delphi technique are also applied in the waste management sector.

### National GHG Inventory for 2000

Table 2-1 shows the national GHG inventory for 2000, when CO<sub>2</sub> emission reached a total of 210.23 million tons, dropping by 52.37 million tons due to the forestry sector. This resulted in a net CO<sub>2</sub> emission of 157.86 million tons. The net emission for 2000 was less than in 1994, when the net emission was 202 million tones.

Of the total CO<sub>2</sub> emission in 2000, the energy sector emitted the highest (150 million tons or about 71%), followed by land use change and the forestry sector (44 million tons or about one-fifth of the total). Because of the removal of 52 million tons in 2000, land use change and the forestry sector became the net sink for about 8 million tons (Table 2-1). In addition to the energy

**Table 2-1** National greenhouse gas inventory of Thailand for 2000 (thousand tons or gigagrams)

National greenhouse gas inventory of anthropogenic emissions by sources and removals by sinks of all greenhouse gases not controlled by the Montreal Protocol and greenhouse gas precursors								
Greenhouse gas source and sink categories	CO <sub>2</sub> emissions	CO <sub>2</sub> removals	CH <sub>4</sub>	N <sub>2</sub> O	NO <sub>x</sub>	CO	NMVOCs	SO <sub>x</sub>
Total national emissions and removals	210,231.2	-52,374.0	2,801.5	40.0	907.0	5,624.4	759.5	618.8
1. Energy	149,914.6	0.0	413.9	2.5	873.3	4,773.0	668.1	605.7
A. Fuel combustion (sectoral approach)	149,914.6		164.8	2.5	873.3	4,773.0	668.1	605.7
1. Energy Industries	64,241.0		97.4	0.5	181.3	703.7	168.1	52.2
2. Manufacturing industries and construction	30,305.8		7.5	1.0	105.6	684.7	13.0	514.4
3. Transport	44,438.7		6.6	0.4	450.4	2,071.1	393.0	6.2
4. Other sectors	10,929.0	0.0	53.3	0.6	136.0	1,313.6	93.9	32.9
B. Fugitive emissions from fuels	0.0		249.1		0.0	0.0	0.0	0.0
1. Solid fuels			32.0		0.0	0.0	0.0	0.0
2. Oil and natural gas			217.1		0.0	0.0	0.0	0.0
2. Industrial processes	16,059.3	0.0	6.4	0.6	1.2	6.3	91.4	13.1
A. Mineral products	16,052.6				0.0	0.0	5.5	7.7
B. Chemical industry	0.0		6.4	0.6	0.2	2.6	51.2	0.8
C. Metal production	6.6		0.0	0.0	0.1	0.0	0.0	0.1
D. Other production	0.0		0.0	0.0	1.0	3.7	34.7	4.6
E. Production of halocarbons and sulphur hexafluoride								
F. Consumption of halocarbons and sulphur hexafluoride								
G. Other	0.0		0.0	0.0	0.0	0.0	0.0	0.0
3. Solvent and other product use	0.0			0.0			0.0	
4. Agriculture			1,977.0	33.4	29.9	754.1	0.0	0.0
A. Enteric fermentation			393.3					
B. Manure management			122.0	8.1			0.0	
C. Rice cultivation			1,425.7				0.0	
D. Agricultural soils				24.5			0.0	
E. Prescribed burning of savannahs			0.0	0.0	0.0	0.0	0.0	
F. Field burning of agricultural residues			35.9	0.8	29.9	754.1	0.0	
G. Other			0.0	0.0	0.0	0.0	0.0	
5. Land-use change and forestry	44,234.1	-52,374.0	10.4	0.1	2.6	91.0	0.0	0.0
A. Changes in forest and other woody biomass stocks	0.0	-13,351.5						
B. Forest and grassland conversion	44,234.1	0.0	10.4	0.1	2.6	91.0		
C. Abandonment of managed lands		-39,022.5						
D. CO <sub>2</sub> emissions and removals from soil	0.0	0.0						
E. Other	0.0	0.0	0.0	0.0	0.0	0.0		
6. Waste	23.3		393.8	3.3	0.0	0.0	0.0	0.0
A. Solid waste disposal on land			231.6		0.0		0.0	
B. Waste-water handling			162.2	3.3	0.0	0.0	0.0	
C. Waste incineration	23.3		0.0	1.8747E-05	0.0	0.0	0.0	0.0
D. Other			0.0	0.0	0.0	0.0	0.0	0.0
7. Other	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Memo items								
International bunkers	10,097.1		0.0	0.0	0.0	0.0	0.0	0.0
Aviation	7,625.1		0.0	0.0	0.0	0.0	0.0	0.0
Marine	2,472.0		0.0	0.0	0.0	0.0	0.0	0.0
CO <sub>2</sub> emissions from biomass	43,626.1							

sector, land use change and the forestry sector, cement production and the industrial sector emitted 16.1 million tons or 8% of total CO<sub>2</sub> emissions in 2000. Hence, similar to other countries, the energy sector in general is the most important source of CO<sub>2</sub> emission, while the industrial sector also contributes to some extent. Land use change and the forestry sector in Thailand have emerged as net sink. These reflect Thailand's progressive national forest conservation policies over the past decade.

As for methane, Thailand emitted a total of 2.8 million tons in 2000. The agriculture sector emitted about 2 million tons or 71% of the total, while the energy sector emitted 410,000 tons or 15%, followed by waste management at 390,000 thousand tons or 14% of the total. Of the total emissions from agriculture, rice cultivation and enteric fermentation from livestock constituted 70% and 20%, respectively. The remaining 10% was from manure management (Table 2-1).

N<sub>2</sub>O, another key GHG, is mainly emitted from land use management. In 2000, N<sub>2</sub>O emissions totaled about 40,000 tons, of which 33,100 tons were from agriculture, 3,300 tons from waste management and 2,500 tons from energy. Land use change and forestry emitted a small amount of N<sub>2</sub>O (Table 2-1).

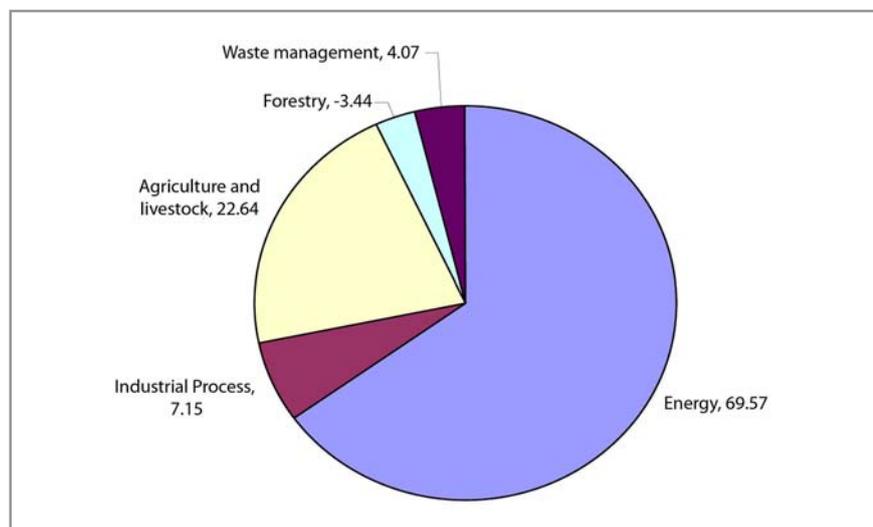
In addition to the three basic GHGs, Thailand reported other GHGs (CO, NO<sub>x</sub>, NMVOC and SO<sub>x</sub>), as shown in Table 2-1. In general, relatively small amounts of these gases were emitted in Thailand. In 2000, CO emissions recorded 5.64 million tons, NO<sub>x</sub> 910,000 tons, NMVOC 760,000 tons, and SO<sub>x</sub> 620,000 tons. It is noted that nearly all these emissions are from the energy sector. Agriculture, land use change and forestry, and the industrial sector emitted relatively small amounts of some types of gases.

In summary, the energy sector in 2000 was the single most important emitter of CO<sub>2</sub> and gases other than CH<sub>4</sub> and N<sub>2</sub>O. Cement production and the industrial sector also emitted some amounts of CO<sub>2</sub>. Agriculture and solid and wastewater management were the main emitters of CH<sub>4</sub>. Most notable are land use change and forestry which changed from being a net source in 1994 to being a net sink in 2000.

### ✿ Total emissions in CO<sub>2</sub> equivalent

In 2000, Thailand emitted GHGs equivalent to 281 million tons of CO<sub>2</sub>. Taking into account a sink of 52 million tons, the net GHG emissions reached 229 million tons of CO<sub>2</sub> equivalent. By source of emission, the energy sector was still the most important source, constituting about 70% of the total, followed by agriculture which recorded about 23%. The remaining 7% was shared among the industrial sector, forestry and waste management (Figure 2-1 and Table 2-2).

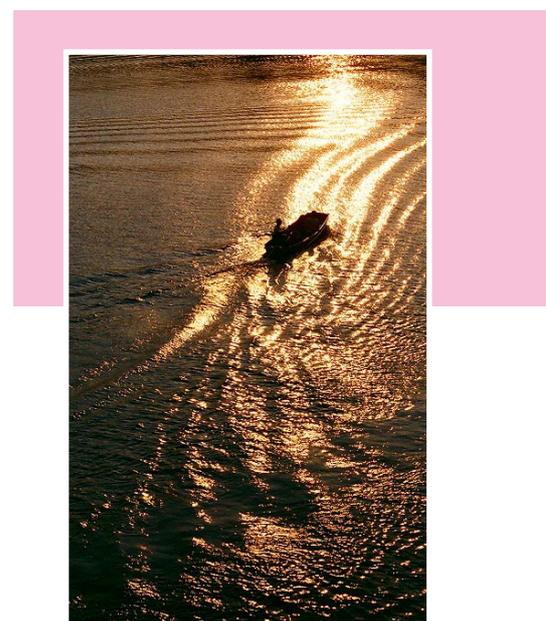
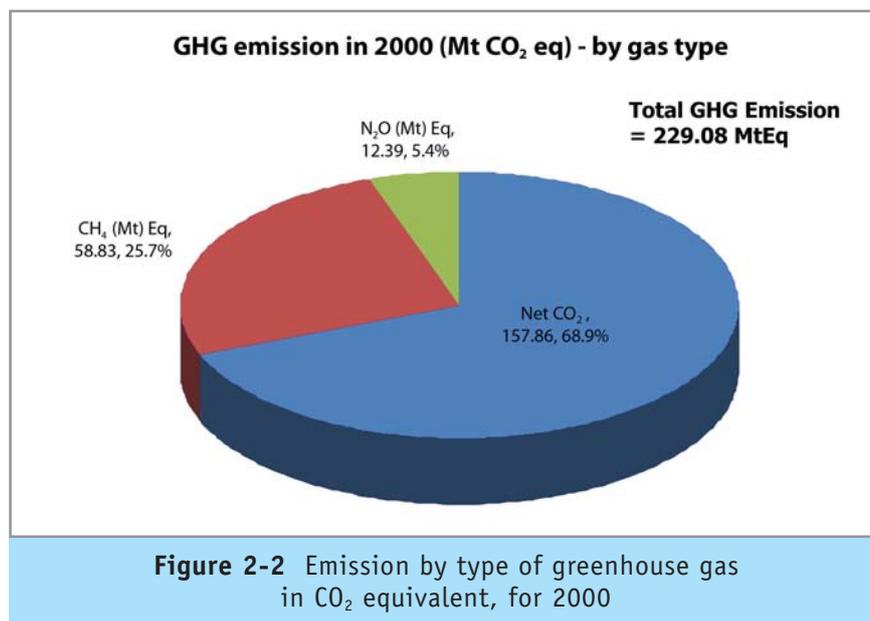
Comparing CO<sub>2</sub> equivalent by type of GHG in 2000, CO<sub>2</sub> constituted about 69% of the total, followed by CH<sub>4</sub> at 26%, and N<sub>2</sub>O at 5% (Figure 2-2). Hence, CO<sub>2</sub> was the most important GHG, while the energy sector was the most important source of emissions in 2000, followed by CH<sub>4</sub> emitted mainly from agriculture and livestock.



**Figure 2-1** GHG emission by source in CO<sub>2</sub> equivalent, for 2000 (%)

**Table 2-2** GHG emission by source in CO<sub>2</sub> equivalent, for 2000 (thousand tons)

	CO <sub>2</sub> Emission	CO <sub>2</sub> Removal	CH <sub>4</sub>	N <sub>2</sub> O	Total	Percent of total
Total	210,231.2	-52,374.0	58,831.5	12400	229,088.7	100.00
Energy	149,914.6	0.0	8,691.9	775	159,381.5	69.57
Industrial Process	16,059.3	0.0	134.4	186	16,379.7	7.15
Agriculture and livestock	0.0	0.0	41,517.0	10354	51,871.0	22.64
Forestry	44,234.10	-52,374.00	218.40	31	-7,890.50	-3.44
Waste management	23.30	0.00	8,269.80	1023	9,316.10	4.07
Percent of Total	68.91 (net)		25.68	5.41	100	



### Greenhouse gas emissions, by source

**Energy Sector** The energy sector is the single largest source of CO<sub>2</sub> emission, as well as CO, NO<sub>x</sub>, NMVOC and SO<sub>2</sub>. It also emitted a small amount of CH<sub>4</sub> and a marginal amount of N<sub>2</sub>O, compared with total national emissions. Table 2-3 shows emissions by different energy utilization sub-sectors. Most emissions were from fuel combustion. In terms of CO<sub>2</sub> emissions from the energy sector, the energy industry constituted about 43%, followed by transportation about 30% and manufacturing and construction about 20% in 2000. The rest (less than 10%) was from agriculture, forestry and fishery. It is noted that direct emissions from residence, commerce and institution reached only 3%.

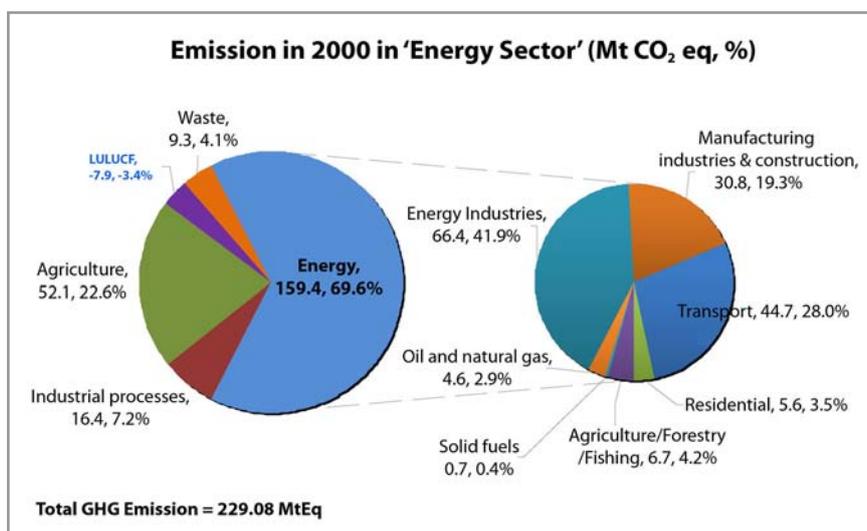
As for methane, fugitive sources in the energy sector accounted for over 60% (410,000 tons) of emissions, followed by energy-related industries which emitted about 24% of total methane emissions. The third source included households and commercial institutions which emitted about 13% of the total. It is noted that methane emissions from transportation remained small (Table 2-3). Emissions of other gases were from sub-sectors that involved fuel combustion. Transportation and households, the commercial sector and institutions were the main sources of N<sub>2</sub>O, CO, NO<sub>x</sub> and NMVOC emissions. Manufacturing and construction emitted about 85% of total SO<sub>x</sub> from the energy sector. The remaining small share was from energy industries and others (Table 2-3).

**Table 2-3** Greenhouse gas emissions from the energy sector, by source and type of gas (thousand tons)

	CO <sub>2</sub>	CH <sub>4</sub>	N <sub>2</sub> O	NO <sub>x</sub>	CO	NM VOC	SO <sub>x</sub>
Total National emission	210,231.2	2,801.5	40.0	907.0	5,624.4	759.5	618.8
Total Energy emission	149,914.6	413.9	2.5	873.3	4,773.0	668.1	605.7
<b>A Fuel Combustion</b>	149,914.6	164.8	2.5	873.3	4,773.0	668.1	605.7
1 Energy Industries	64,241.0	97.4	0.5	181.3	703.7	168.1	52.2
2 Manuf. & const.	30,305.8	7.5	1.0	105.6	684.7	13.0	514.4
3 Transport	44,438.7	6.6	0.4	450.4	2,071.1	393.0	6.2
4 Other Sectors	10,929.0	53.3	0.6	136.0	1,313.6	93.9	32.9
4a. Res/comm./insti	4,287.5	52.8	0.6	27.4	1,223.1	75.8	0.0
4b. Agriculture/Forestry/ Fishing	6,641.5	0.5	0.1	108.6	90.5	18.1	0.0
<b>B Fugitive Emissions from Fuels</b>	0.0	249.1		0.0	0.0	0.0	0.0
1 Solid Fuels		32.0		0.0	0.0	0.0	0.0
2 Oil and Natural Gas		217.1		0.0	0.0	0.0	0.0

Based on the CO<sub>2</sub> equivalent, energy industries emitted about 42% of total emissions, followed by transportation at 28% and manufacturing and construction at 19%. Emissions from these three sources constituted more than 90% of total emissions from the energy sector in 2000 (Figure 2-3). Hence, efforts to mitigate GHG emissions in the energy sector should look primarily into these key sources.

**Industrial Production** In 2000, GHG emission from industrial production was relatively small compared to the total in Thailand (Table 2-4). Most of the emissions were from mineral production processes, particularly cement, lime, dolomite and soda ash. These mineral production processes produced about 8% of total CO<sub>2</sub> emissions in 2000. Glass production produced NMVOC emissions (about 12% of the total national emission) in 2000. Emissions of CH<sub>4</sub>, CO and NO<sub>x</sub> from industrial production were minimal (Table 2-4).



**Figure 2-3** Emissions from the energy sector in CO<sub>2</sub> equivalent, for 2000



**Table 2-4** Greenhouse gas emissions from industrial production, by source and type of gas (thousand tons)

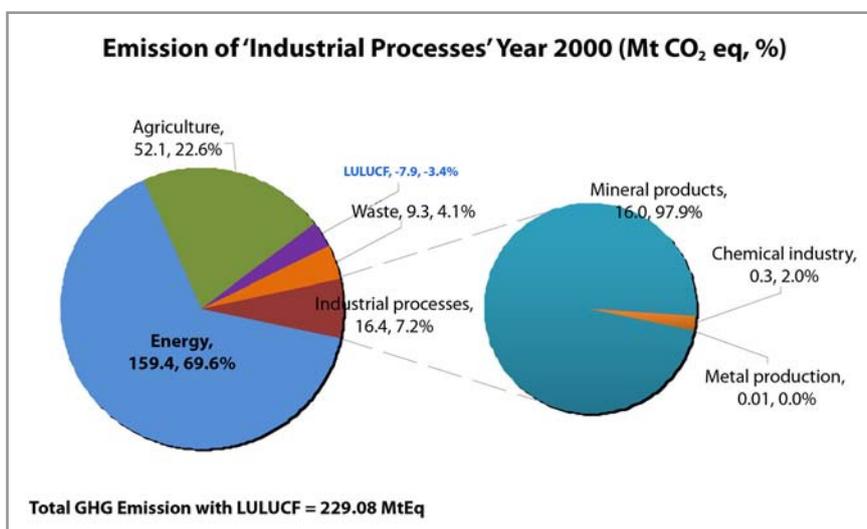
	CO <sub>2</sub>	CH <sub>4</sub>	N <sub>2</sub> O	NO <sub>x</sub>	CO	NM VOC	SO <sub>x</sub>
Total National emission	210,231.2	2,801.5	40.0	907.0	5,624.4	759.5	618.8
Industrial processes	16,059.3	6.4	0.6	1.2	6.3	91.4	13.1
A. Mineral products	16,052.6			0.0	0.0	5.5	7.7
B. Chemical industry	0.0	6.4	0.6	0.2	2.6	51.2	0.8
C. Metal production	6.6	0.0	0.0	0.1	0.0	0.0	0.1
D. Other production	0.0	0.0	0.0	1.0	3.7	34.7	4.6

Based on the CO<sub>2</sub> equivalent, mineral production processes, especially cement production, constituted the single most important source of GHG emissions in this sector, producing about 98% of total emissions from industrial production process (Figure 2-4).

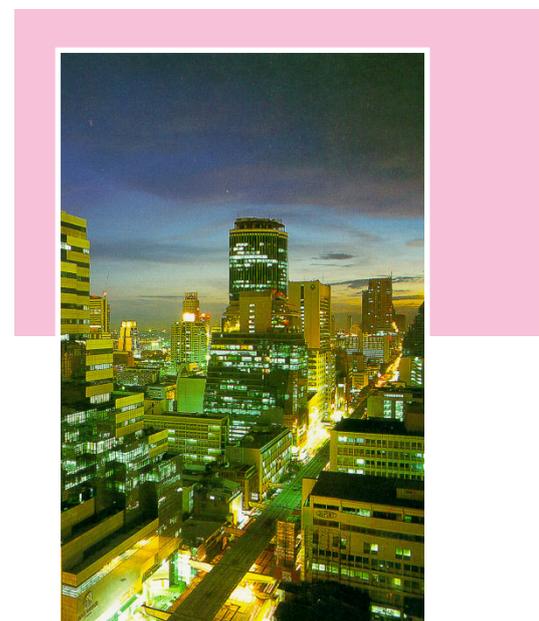
**Agriculture** Agriculture does not emit CO<sub>2</sub>, NMVOC or SO<sub>x</sub>. However, it is the main source of CH<sub>4</sub> and N<sub>2</sub>O emissions. In 2000, it produced about 70% and 83% of the total national emissions (28,000 and 40,000 tons of CH<sub>4</sub> and N<sub>2</sub>O, respectively). Rice production in flooded land emitted more than 72% of total CH<sub>4</sub> from agriculture, followed by livestock at 14%. Animal waste management emitted only a small fraction, while field burning of agricultural residues produced only marginal CH<sub>4</sub> (Table 2-5). Agricultural soils were the single most important source of N<sub>2</sub>O emissions in 2000, both from agriculture and national perspective. Manure management produced about 20% of the total national emission (Table 2-5).

Going by the CO<sub>2</sub> equivalent, rice cultivation was the most important source by emitting more than 57% of total emissions from agriculture. Agricultural soil and enteric fermentation from livestock contributed almost equally to agricultural emissions in CO<sub>2</sub> equivalent, while field burning was a minor source of emissions (Figure 2-5). Hence, mitigation measures should give preliminary attention to crops and livestock as well as agricultural sub-sectors.

**Land use change and forestry** Land use change and forestry can be a source or a sink for CO<sub>2</sub>. In 2000, land use change and the forestry sector emitted about 21% of total national CO<sub>2</sub> emissions or about 44.2 million tons. At the same time, reforestation and natural growth in abandoned lands absorbed 52.4 million tons of CO<sub>2</sub> and resulted in a net sink of about 8 million tons 2000 (Table 2-6). Land use change (converting forest and grassland) also released other gases. In 2000, this activity released small amounts of CH<sub>4</sub>, CO and NO<sub>x</sub> (Table 2-6).



**Figure 2-4** Greenhouse gas emission from all sectors and industrial production processes in CO<sub>2</sub> equivalent



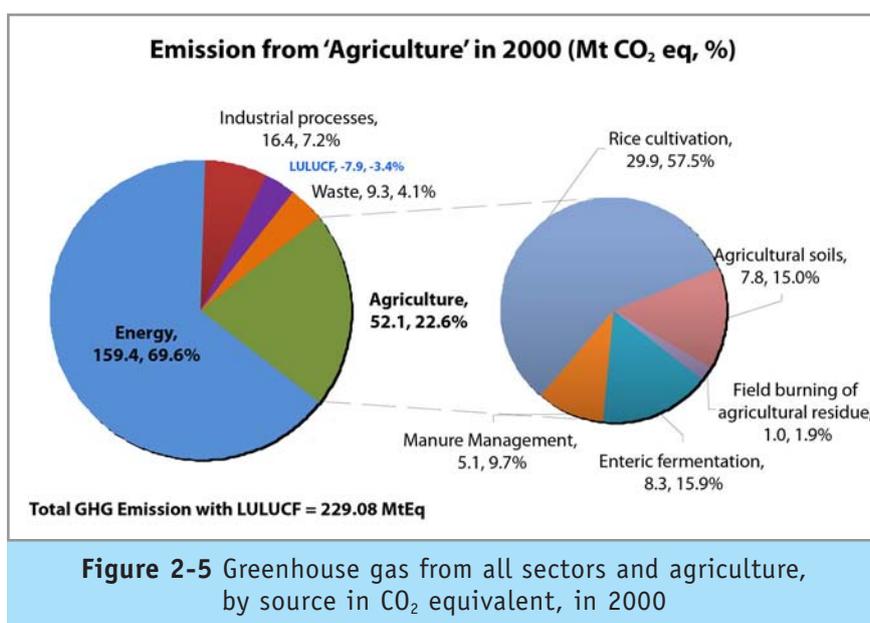
**Table 2-5** Greenhouse gas emissions from agriculture, by type of gas (thousand tons)

	CH <sub>4</sub>	N <sub>2</sub> O	CO	NO <sub>x</sub>
Total national emission	2,801.5	40.0	5,624.4	907.0
4. Agriculture	1,977.0	33.4	754.1	29.9
A. Enteric fermentation	393.3			
B. Manure management	122.0	8.1		
C. Rice cultivation	1,425.741			
D. Agricultural soils		24.5		
F. Field burning of agricultural residues	35.9	0.8	754.1	29.9

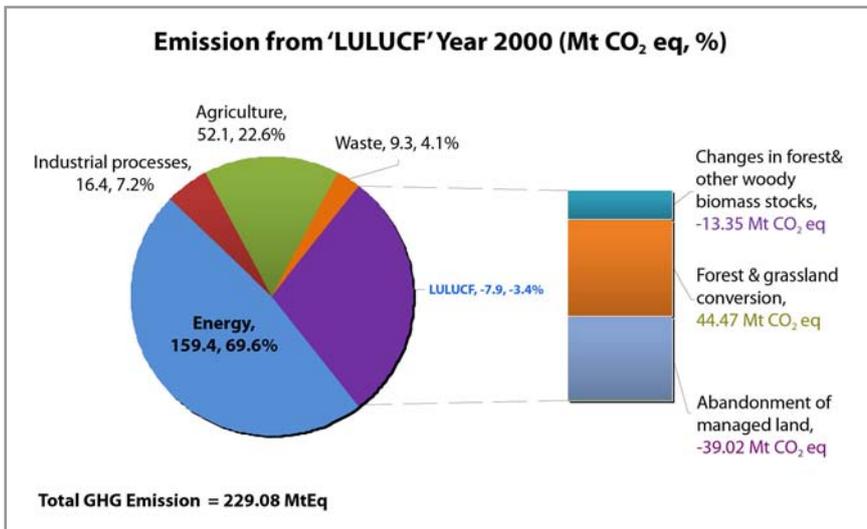
**Table 2-6** Greenhouse gas emissions from land use change and forestry sector, by type of gas (thousand tons)

	CO <sub>2</sub> emission	CO <sub>2</sub> removal	CH <sub>4</sub>	N <sub>2</sub> O	CO	NO <sub>x</sub>
Total national emission and removal	210,231.2	-52,374.0	2,801.5	40	5,624.4	907
Total Land-use change and forestry	44,234.1	-52,374.0	10.4	0.1	91	2.6
A. Changes in forest and other woody biomass stocks	0	-13,351.5				
B. Forest and grassland conversion	44,234.1	0	10.4	0.1	91	2.6
C. Abandonment of managed lands		-39,022.5				

Changes in forest land and reforested land as well as abandoned land play an important role with regards the carbon sink. Expansion of forest conservation and reforestation and proper management of abandoned land enhance the sink's capacity, while efficient enforcement of laws and regulations to prevent deforestation and forest poaching reduce emission sources. These interactively convert the ratio between emissions from source and absorption from the sink (Figure 2-6).



**Figure 2-5** Greenhouse gas from all sectors and agriculture, by source in CO<sub>2</sub> equivalent, in 2000



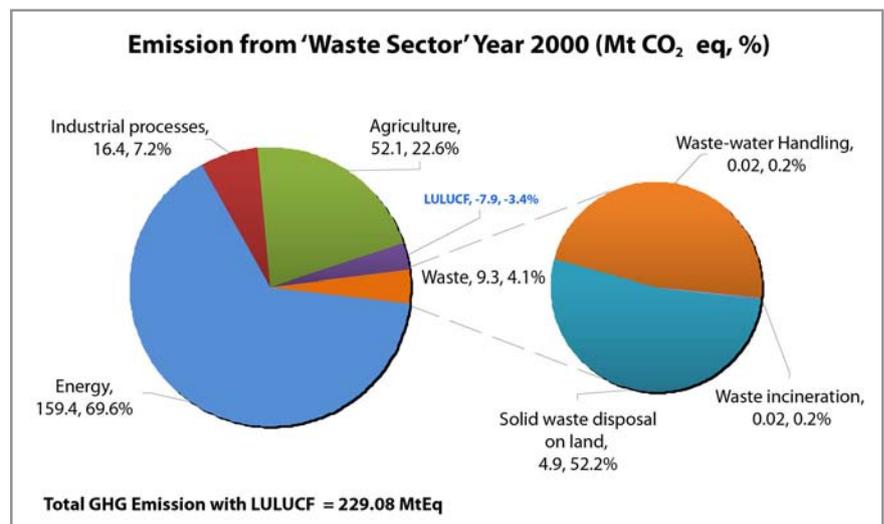
**Figure 2-6** Sources and sinks of all sectors and land use change and the forestry sector in CO<sub>2</sub> equivalent, in 2000

**Table 2-7** Methane and nitrous oxide emissions from solid waste disposal and wastewater handling, in 2000 (thousand tons)

	CH <sub>4</sub>	N <sub>2</sub> O
Total national emission	2,801.50	40
Total Waste	393.8	3.3
A. Solid waste disposal on land	231.6	
B. Waste-water handling	162.2	3.3

**Waste management** Solid waste disposal and wastewater treatment release GHGs. In 2000, waste management released about 390,000 and 330,000 thousand tons of CH<sub>4</sub> and N<sub>2</sub>O, respectively. These accounted for 14% and 8% of total emissions in 2000 (Table 2-7). It is noted that CH<sub>4</sub> is generated from both solid and wastewater management, while N<sub>2</sub>O is only from the latter.

In terms of CO<sub>2</sub> equivalent, the proportion of emissions from solid waste disposal and wastewater handling to total emissions from the waste sector has not changed significantly. Solid waste disposal contributed about 52% of the total, while the remaining share was from wastewater handling (Figure 2-7).



**Figure 2-7** Contribution to total emission from all sectors and waste management, by type of waste, in 2000

## Uncertainty Management and Good Practices

The inventory exercise follows the IPCC guidelines to ensure good quality control and assurance. Uncertainty analysis and recalculation are used. The aggregate uncertainty of GHG emission for 2000 is estimated at 7.39%. In general, the uncertainty of each sector is inversely related to its contribution to total emissions. For instance, the waste sector, which contributed only a small fraction of total emission, has the highest uncertainty of 77.8%. The moderate uncertainties are agriculture and land use change and forestry (15.3% and 17.7%, respectively) and the least uncertainties are the energy sector and industrial process (9.3% and 7.2%, respectively).

Quality control and assurance have been applied throughout the process of inventory estimation. This includes supervision by a project steering committee, advice and suggestions from experts representing different sectors, and participation by agencies responsible for activity data. Regular meetings among researchers and consultations with specialists and experts from different sectors are conducted. The estimated inventory was also reviewed in a series of workshops.

## Thailand's Greenhouse Gas Emission in 1994, 2000-2004

The IPCC 1996 Revised Guideline was used in the estimation of Thailand's GHG emissions in 1994 and during the 2000-2004 period. It is noted that emissions in 2000, as required by UNFCCC, has gone through more uncertainty and good practice processes than those of other periods and those for 2001-2004 are preliminary.

Due to the fact that inventory estimation is determined by emission factors and activity data. Since the same emission factors are used for all periods, the emission trends here are practically those of climate-emission related activities in Thailand over the periods.

### Thailand's greenhouse gas emission trends

The emission trends cover the period 2000-2004. The 1994 inventory was revised by applying the same emission coefficients, as in other years, to the revised statistical figures. This is to ensure consistency in the estimated periods.

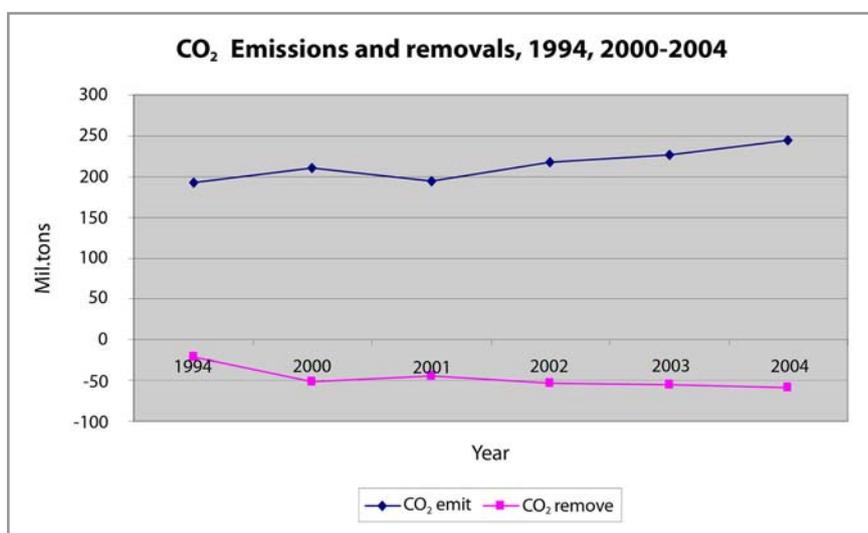


Figure 2-8 Thailand's CO<sub>2</sub> emissions, 1994, 2000-2004 (million tons)

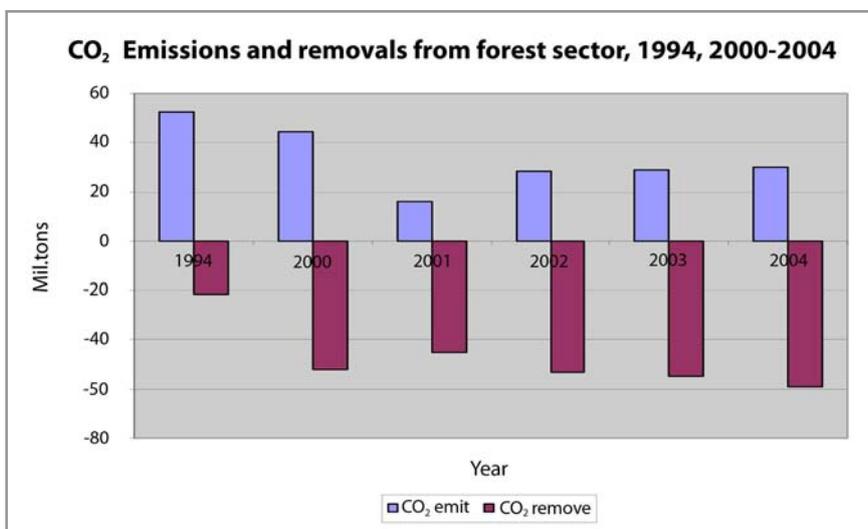


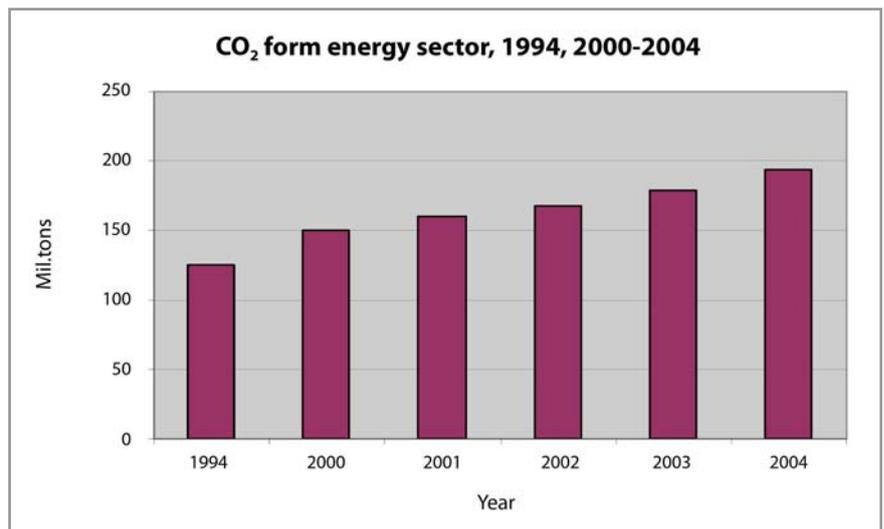
Figure 2-9 Thailand's emissions and removals from the forestry sector, 1994, 2000-2004 (million tons)

Comparing the two reporting periods, 1994 and 2000, both CO<sub>2</sub> emission and sink increased by different magnitudes. During the period 2000-2004, CO<sub>2</sub> emissions had increased over time with a decline between 2000 and 2001. It is noted that the emission trends increased more than the removal trends (Figure 2-8). Aggressive forest conservation policies during the 1990s caused continuous expansion of forest areas, resulting in a carbon sink, as reflected in the sink increase in the forestry sector over the period (Figure 2-9)<sup>9</sup>. It is notable that the gradual increase in CO<sub>2</sub> emissions during 2001-2004 was due mostly to the economic recovery and higher energy consumption (Figure 2-10)

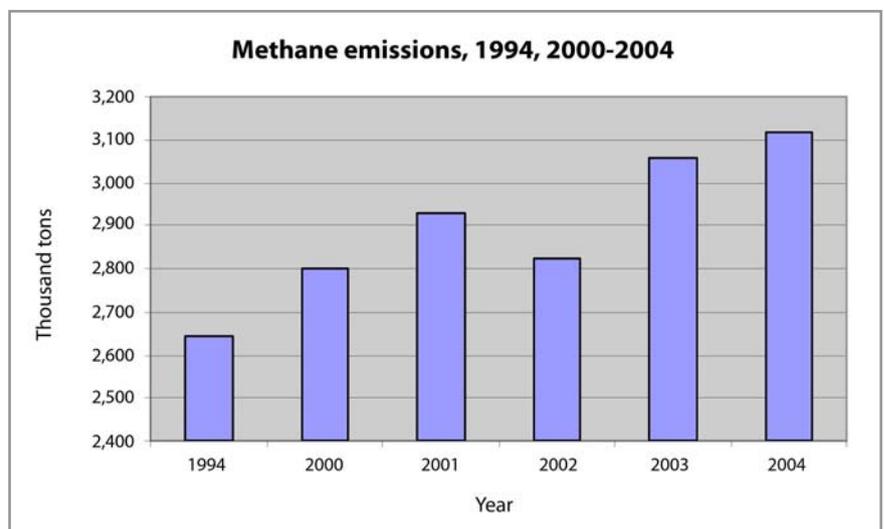
CH<sub>4</sub> and N<sub>2</sub>O emissions vary over time. As shown in Figures 2-11 and 2-12, emission increases or decreases of these two gases depend on agricultural land use and livestock. Climate change affects agricultural cultivation, land use as well as animal waste management. Nevertheless, CH<sub>4</sub> and N<sub>2</sub>O emissions tend to increase over time in general.

Comparing the CO<sub>2</sub> equivalent among different sectors, emission from the energy sector has increased, representing a higher share over the period (Figure 2-13). The most interesting sector is forestry which became a net source and a sink. In 1994, forestry was a net emitter of about 31 million tons. In 2000, its removal was more than the emissions and became a net sink with an increasing trend. This resulted in a moderate increase in GHG emissions in Thailand, averaging 3.7% per year during 2000-2004.

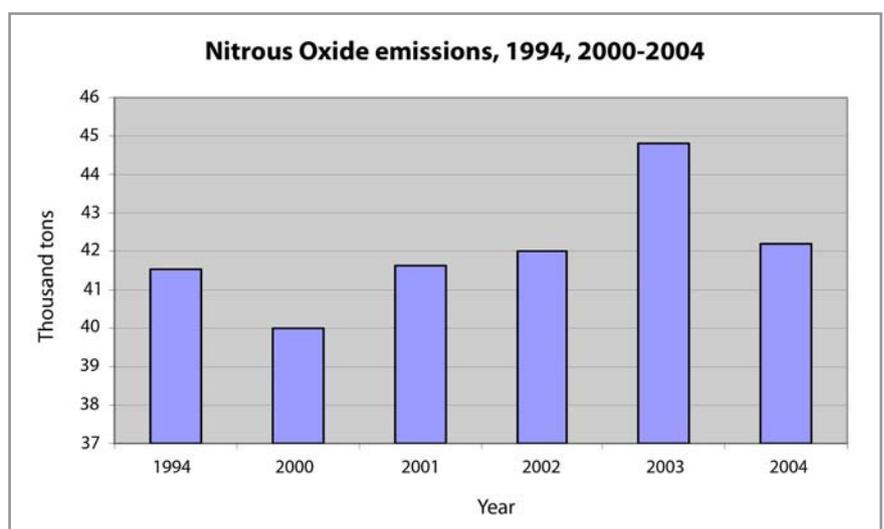
<sup>9</sup> It should be noted that change in source and sink in forestry sector is partly due to the revision of definitions and the mapping techniques that affected the forest areas and types of forest. For instance, in 2000, the change in forest area was partly due to the change in better resolution of the maps and techniques used.



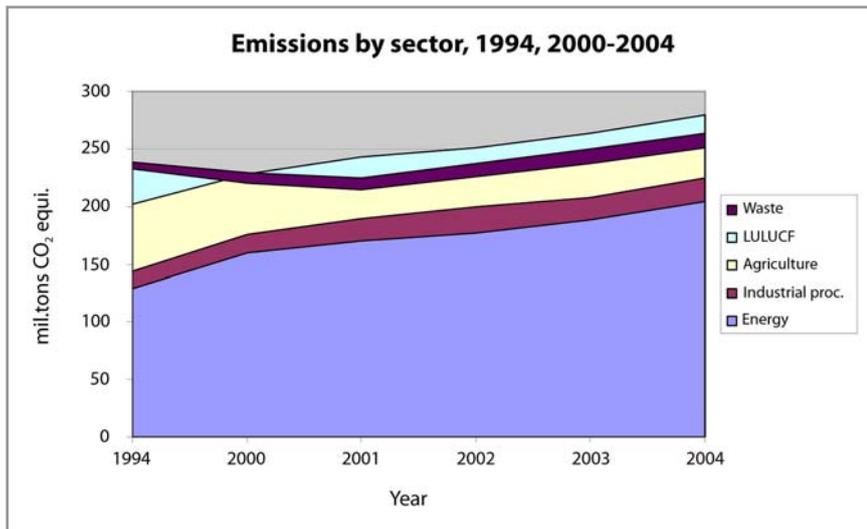
**Figure 2-10** Thailand CO<sub>2</sub> emissions from the energy sector, 1994, 2000-2004 (million tons)



**Figure 2-11** Methane emissions 1994, 2000-2004 (thousand tons)



**Figure 2-12** Nitrous oxide emissions 1994, 2000-2004 (thousand tons)

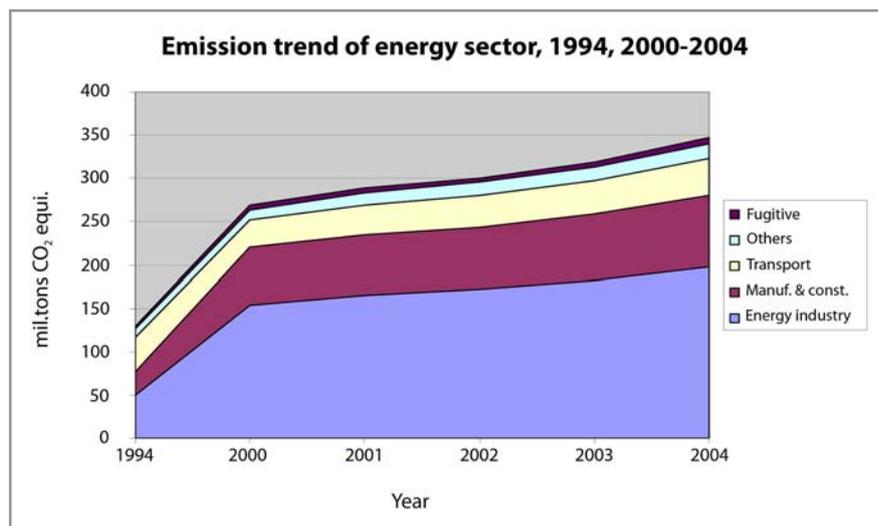
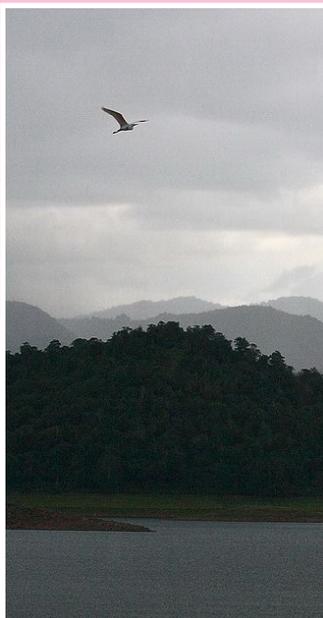


**Figure 2-13** GHG emissions in CO<sub>2</sub> equivalent by sector, 1994, 2000-2004 (million tons)

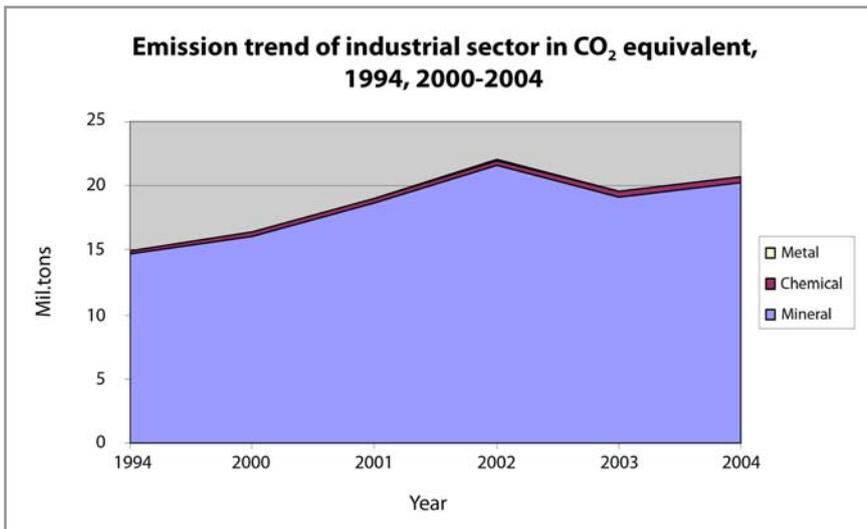
## Greenhouse gas emission trends by sector

**Energy sector** Carbon dioxide emissions from the energy sector vary according to fossil fuel use and the pace of economic development. As shown in Figure 2-14, CO<sub>2</sub> emission in the energy sector during 2000-2004 increased at an average of 6% per year. Within the energy sector, CO<sub>2</sub> emissions from power generation, industry and transportation constituted the largest shares and grew steadily. It is noted that emission growth in power generation was less than the emission growth in transportation and industry.

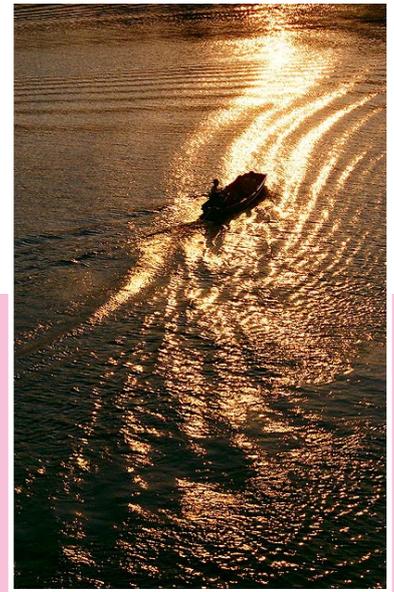
**Industrial processes** Emissions from industrial production processes showed increasing trends and fluctuations due to economic development. Cement processing was the most important emission source in the mineral sub-sector, with emissions increasing over the period, except in 2003 (Figure 2-15). In contrast, chemical and metal production processes produced marginal amounts of GHGs and were insignificant to the sector (Figure 2-15).



**Figure 2-14** Emission trends in the energy sector in CO<sub>2</sub> equivalent, 1994, 2000-2004 (million tons)

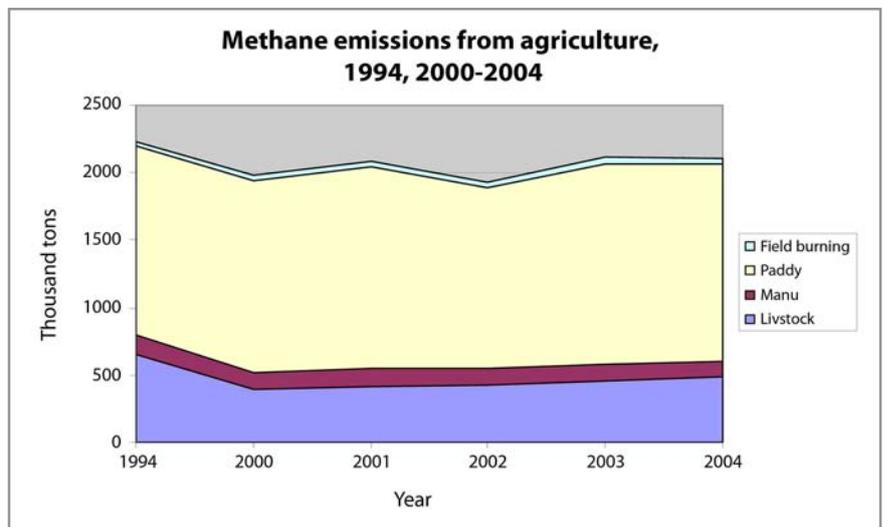


**Figure 2-15** Emission trends in industrial production processes in CO<sub>2</sub> equivalent, 1994, 2000-2004 (million tons)

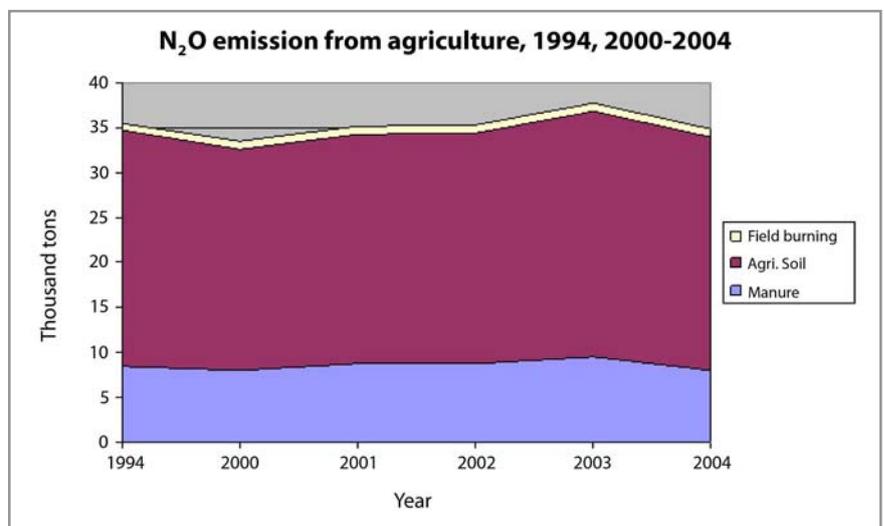


**Agricultural sector** The main sources of GHG emissions from agriculture are rice cultivation, livestock, manure management and field burning. Methane and nitrous oxide are two types of GHGs emitted from agriculture. Methane emission from paddy ranged between 1.4 and 1.5 million tons over the years, suggesting relatively stable emissions from the sub-sector. This is also due to limits set for paddy land in the country. Hence, it is likely that CH<sub>4</sub> emission from rice cultivation will not change significantly from the present. The same is likely to be true for field burning. Methane emission from livestock increased over time, especially during 2000-2004. As for manure management, emission fluctuated (Figure 2-16), partly due to changes in manure management methods.

Nitrous oxide emission is mainly from manure management, agricultural land use and field burning. Nitrous oxide emissions varied, following trends in different activities, as in the case of manure management and field burning (Figure 2-17).



**Figure 2-16** Methane emissions from agriculture, 1994, 2000-2004 (thousand tons)



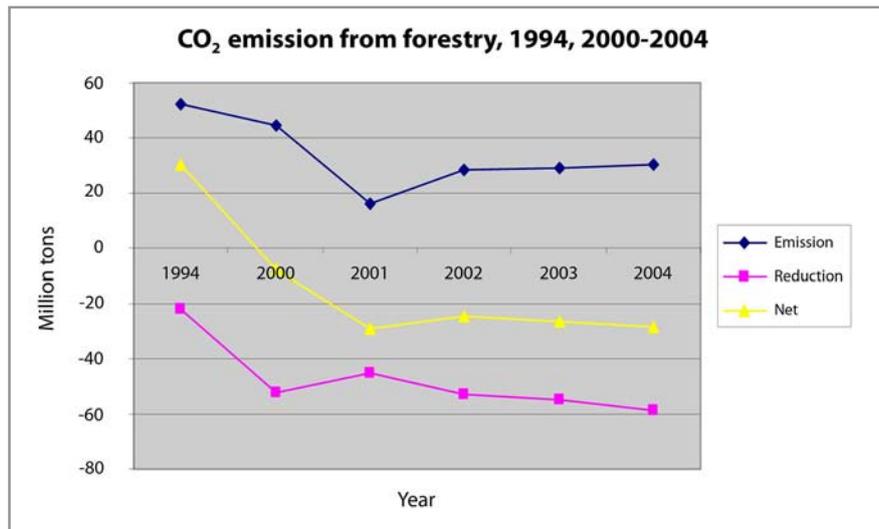
**Figure 2-17** Nitrous oxide emissions from agriculture, 1994, 2000-2004 (thousand tons)



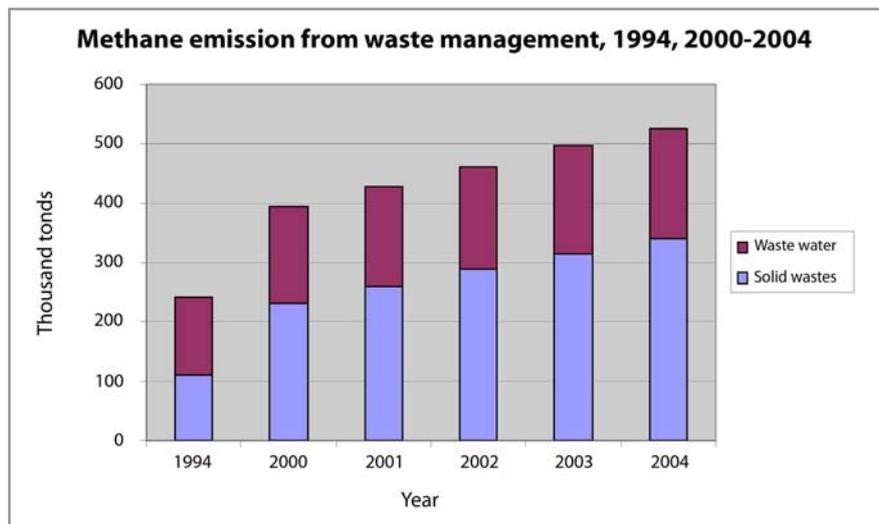
### Land use change and forestry

Land use change and forestry are both a CO<sub>2</sub> source and sink. During the 1990s, Thailand aggressively carried out policies and measures to conserve forest areas. As a result, CO<sub>2</sub> emissions declined and removals increased. Net emission was converted to net removal in 2000. During 2002-2004, emission and removal trends were quite stable and are likely to remain the same in the near future (Figure 2-18).

**Waste management** Emission sources in the waste management sector include solid waste landfills, domestic and industrial wastewater and solid waste burning. Emissions from waste management tend to increase overtime due mainly to population growth and consumption patterns. Figure 2-19 shows gradually increasing trends, although at diminishing rates, of CH<sub>4</sub> emission from solid waste and wastewater handling.



**Figure 2-18** Carbon dioxide emissions and removal trends in land use change and the forestry sector, 1994, 2000-2004 (million tons)



**Figure 2-19** Methane emission trends in waste management, 1994, 2000-2004 (thousand tonds)

A close-up photograph of a rice panicle, showing several clusters of golden-brown grains hanging from green stems. The background is a soft, out-of-focus green.

# 3

Impact,  
Vulnerability  
and Adaptation

# 3

## Impact, Vulnerability and Adaptation

### Introduction

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Vulnerability and adaptation to climate change as well as its impacts are addressed in Articles 4.8 and 4.9 of the UNFCCC. These are also part of the obligations of Parties, particularly Annex I Parties, as stated in Article 4, to facilitate and support measures to address vulnerability and adaptation. Under Article 12, the Parties are requested to provide general description of steps taken or envisaged towards formulating, publishing and regularly updating national programs or measures to facilitate adequate adaptation to climate change.

UNFCCC has emphasized the importance of adaptation to climate change through various decisions and agreements, including the Marakesh Accord, Buenos Aires Programme of Work on Adaptation and Response Measures, and the Nairobi Work Programme.

The Nairobi Work Programme identifies nine major areas pertaining to vulnerability and adaptation. These related areas are vital to the enhancement of scientific knowledge base and the mainstreaming of issues into the process of sustainable national development.

Despite efforts and cooperation in these issues, the process of addressing vulnerability and adaptation issues concerning climate change has been relatively slow, compared with inventory or mitigation. The reviews indicate many remaining gaps and the need for further efforts. Based on the IPCC assessment reports, risks from the impact of climate change are growing over time, and consequently the vulnerabilities of the Parties, particularly developing and least developed countries, are increasing.

### Thailand and Vulnerability and Adaptation to Climate Change

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As communicated in the INC, studies of climate change impact and adaptation were based on double CO<sub>2</sub> emission scenarios. The model-based approach generally covers many decades with high uncertainties. Partly due to scientific and technical limitations and uncertainties, and partly due to increasing evidences of natural disasters associated with climate change, an urgent and practical approach to address the needs of those exposed to such risks has been applied. Studies to address climate variability and extreme events, such as severe droughts or floods covering a few years (5-10 years), have been increasingly used.

Studies on climate change make a distinction between climate change and sea level rise. Since 2000, research work on the impacts of climate change in Thailand has been conducted, particularly with the support of the Thailand Research Fund (Table 3-1). Thailand's National Strategy on Climate Change, 2008-2012, gives top priority to climate change impact, vulnerability and adaptation. It can be said that over the past decade, Thailand has made substantial efforts to expand technical knowledge concerning climate change and to integrate the results into the process of sustainable national development. It should also be noted that very few bilateral and multi-lateral cooperative variability and adaptation (V&A) projects, through the UNFCCC, have been promoted over the same period.

**Table 3-1** Selected V&A projects in Thailand

Project	Institution	Project Period
<b>Under Thailand Research Fund</b>		
Preliminary study of climate change impact on food security in Thailand	Chiangmai University	2003-2004
Climate change and climate variability	King Mongkut's Institute of Technology Ladkrabang	2007
Climate model for Thailand and neighboring countries	Southeast Asia START	2007-2008
Downscaling global climate scenarios for Thailand	Ramkhamhaeng University	2007-2009
Development of climate scenarios for Thailand by MM5 model	Chiangmai University	2007-2009
Study and development of climate model for Thailand using Reg CM3	King Mongkut's University of Technology Thonburi	2007-2009
Testing and development of Weather Research and Forecasting (WRF) in climate forecasting for Thailand	King Mongkut's University of Technology Thonburi	2007-2009
Climate variation due to oceanic disturbance in Thailand	Burapha University	2007-2008
Study of aerosol effects on climate change in Thailand	Silpakorn University	2007-2009
Assessment of climate extreme events in Thailand: vulnerability and risk analysis in critical areas	Chulalongkorn University	2007-2008
Effects of climate change on monthly rainfall and surface flow in Thailand and the effects on water management in Eastern Thailand	Chulalongkorn University	2007-2009
Impact of global warming on rice, sugar cane, cassava and maize production in Thailand	Khon Kaen University	2008-2009
Economic assessment of climate change impact on rice production in Thailand	Kasetsart University	2008
Impact of climate change on thermal comfort and energy consumption in residential buildings in Thailand	Kasetsart University	2008
Approaches to conduct research and to develop human resources for global warming	Thailand Environment Institute	2008
<b>From other sources</b>		
Enabling activities II* (UNDP-GEF)	Office of Natural Resource and Environmental Policy and Planning	2002
Southeast Asia Regional Vulnerability to Changing Water Resources and Extreme Hydrological Events* (AIAAC/UNEP)	Southeast Asia START	2004
Impact of Climate Change on Inflow of Bhumibhol and Sirikit Reservoirs, northern Thailand (National Research Council)		

**Note:** \* refers to projects in English, otherwise in the Thai language



The ultimate goal of research work in vulnerability and adaptation is to enable the integration of climate change adaptation needs into national development policies and planning. The potential impacts of climate change are widely felt across different sectors in the country. On the other hand, the adaptive capacities of communities in different regions differ. Hence, the impact of climate change and vulnerability and adaptation to climate change are locality-specific.

The agriculture, water resources and health sectors are more vulnerable to climate change impacts in Thailand, while coastal ecological resources are vulnerable to sea level rise. The development of studies on vulnerability and adaptation is summarized below.

### **Climate change studies**

Studies on vulnerability and adaptation to climate change are based on global climate scenarios developed from general circulation models with different assumed GHG concentrations. The climate scenarios are used as inputs for different sectoral models to derive potential climate change impacts. Together with the socio-economic scenarios, vulnerability to climate change is derived and additional adaptation needs are analyzed.

The major weakness of the above approach lies in the uncertainties of climate scenarios and the downscaling of the scenarios to national or regional levels. The approach also requires comparable socio-economic development scenarios. Over the past two decades, general circulation models have been improved substantially. Dynamic downscaling has also been applied to develop regional scenarios.

Climate change research in Thailand is at a stage when more scientific knowledge of climate models and their scenario outputs are being learned and accumulated. Most studies concentrated in the application of climate models to conditions in Thailand, including downscaling techniques, application of historical climate trends, and development of regional scenarios for the country. Only a few studies used climate scenarios to estimate potential impacts on different sectors. No studies have attempted to develop socio-economic scenarios. Also, sea level rise and vulnerability to climate change and have not yet really been the focus of studies.

### **Climate variability and extreme event studies**

Studies on climate variability and extreme events in Thailand have been undertaken due to increasing evidences of persistent droughts and floods in the country and the limitations of climate change studies to view scientific results in a socio-economic context and to integrate them into development planning. Local communities are more exposed and closer to evidences of climate variability and extreme events. The consultation approach is commonly used to identify vulnerability and adaptation options.

Thailand has monitored and implemented measures to address droughts and floods, especially in high-risk rural areas. Meteorological statistics and tools have been applied to the extent possible to prevent or mitigate these situations. Climate variability and extreme events in the context of climate change are relatively new and have just been introduced during the preparation of this communication.

The Office of Natural Resource and Environmental Policy and Planning conducted a study on climate variability and extreme events in the Chee Mun watershed in Northeastern Thailand. The office also used Kho Tao Island and the coastal area of Krabi province in southern Thailand as a case to demonstrate sea level rise<sup>10</sup>. The approach combines scientific knowledge and the experiences of communities concerning climate variability trends and extreme events to analyze adaptation options to cope with the risks.

A similar study was independently conducted by a non-government organization in north and northeast Thailand<sup>11</sup>. The study combined scenarios from climate models with the experiences of local communities in selected areas of Chiang Mai province in the north and Yasothon province in the northeast to identify possible remedies to the potential impacts. General approaches were suggested to address the risks in these two areas, including developing and protecting rice genetic resources, changing the cropping system, relying on more locally produced natural food, and conservation of energy, soil and water resources.

The latest development in Thailand related to climate variability and extreme events is a pilot project supported by the Special Climate Change Fund (SCCF). The project is aimed at enhancing capacities of local stakeholders to integrate climate change factors into their disaster prevention and mitigation management system in coastal areas. Such integration will be mainstreamed into the community's development and planning process. This action-oriented project is expected to have tangible outcomes<sup>12</sup>. Its unique features are the integration of climate change factors into existing disaster risk and management projects, integration of climate change factors into the process of community development, and the streamlining of climate change in the process of national development. Three provinces with different exposures to climate change impacts have been selected. These are Nakhon Sri Thammarat, Phattalung and Trang. The project will commence in 2010.

## Studies in sea level rise

The extent of sea level rise varies depending on oceanic, seabed and coastal characteristics in different regions. Sea level rise studies in Thailand use simple mapping techniques to observe potential inundation due to one-meter sea level rise along detailed contour lines<sup>13</sup>. A simple model to analyze sea level rise that is more specific to local areas has been conducted in the Gulf of Thailand<sup>14</sup>.

The weaknesses of studies on vulnerability and adaptation to sea level rise are similar to those of studies on vulnerability and adaptation to climate change. There has been no research on socio-economic development scenarios in coastal areas covering a period compatible with the sea level rise. Without scenarios that show autonomous change in the socio-economic structure, vulnerability data and additional adaptation required cannot be derived.

Thailand has explored the development of socio-economic scenarios at the local level, including provinces and regions, in the study of V&A for the Second National Communication (SNC). The results have not been satisfactory, especially with regards the story line of long-term socio-economic structural change. More research in this area is need.

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<sup>10</sup> ONEP, 2010, Study on impacts of climate change and climate variability and extreme events in major sectors, a project under Enabling Activities of UNFCCC

<sup>11</sup> Vitoon Panyakul, 2008, Development of preparedness for farmers to cope with impact of global warming crisis, a research report of Earth Net Foundation to OXFAM Great Britain.

<sup>12</sup> Strengthening the capacity of vulnerable coastal communities to address the risk of climate change and extreme weather events, project identification form 3711, executing partners, Thai Red Cross Society with collaboration of Sustainable Development Foundation and Department of Disaster Prevention and Mitigation, GEF.

<sup>13</sup> For example, Social policy response to climate change project supported by UNEP and Climate Change project under US Countries study program.

<sup>14</sup> Southeast Asia START Regional Center and World Wildlife Fund, 2008, Climate change impacts in Krabi province, Thailand, A study of environmental, social and economic challenge, December 2008.

## ✿ Development of database

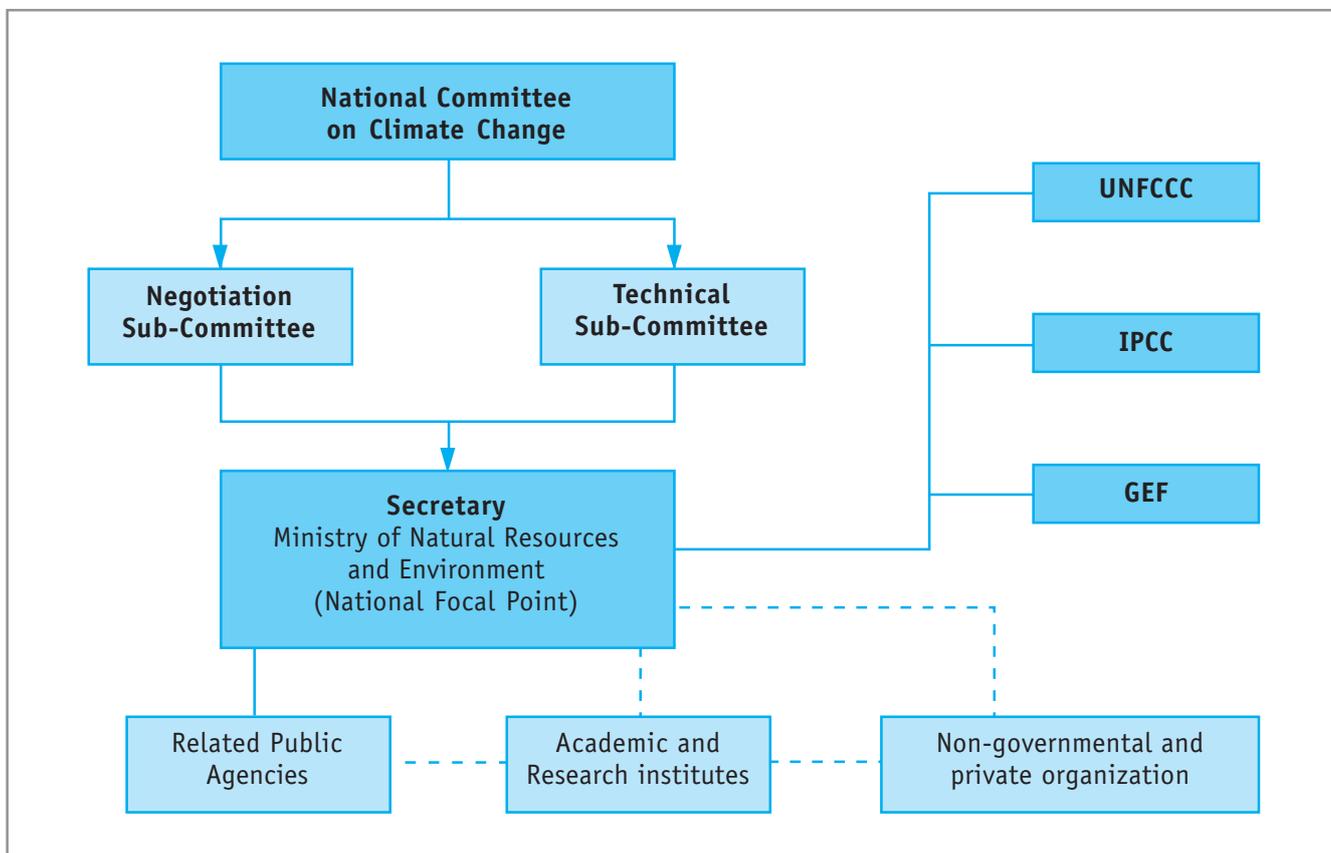
Thailand has not established a good database for vulnerability and adaptation to climate change. Available databases are scattered in research institutions that have conducted relevant studies, such as the Thailand Research Fund, Office of Natural Resource and Environmental Policy and Planning, and various academic institutions. Nevertheless, the Department of Meteorology has the responsibility for handling the country's climate data. Other research organizations have also collected climate scenarios derived from different climate models. It would be useful to collect scattered information and develop a systematic V&A database for Thailand. This will streamline research activities to supplement or complement each other in research and development on V&A.

## ✿ Adaptation mainstreaming

Mainstreaming vulnerability and adaptation is a fundamental process to institutionalize climate change issues. There are two levels of mainstreaming, that is, domestic and international.

The international aspect of climate change management in Thailand relates to the UNFCCC, IPCC and GEF. The Office of Natural Resource and Environmental Policy and Planning in the Ministry of Natural Resources and Environment is the designated national focal point for climate change. At the national level, the Ministry of Natural Resources and Environment is directly responsible for issues related to climate change. Various departments, particularly the Office of Natural Resources and Environmental Policy and Planning, are supporting the Ministry in handling the issues.

Diagram 3-1 shows the organizational structure handling climate change, with the National Committee on Climate Change chaired by the Prime Minister being the highest climate change policy making body. Three sub-committees handle technical, negotiation and public relations functions. The Ministry of Natural Resources and Environment serves as secretariat for all the committees. It also coordinates operations with other public agencies, academic and research institutes, as well as non-governmental and private organizations.



**Diagram 3-1** Thailand's climate change organizational structure

The ultimate goal of research and development on vulnerability and adaptation to climate change and climate variability and extreme events is to formulate national policies and measures on adaptation and to integrate these into the country's sustainable development efforts. The organizational structure for climate change is an institutional mechanism that facilitates such integration.

Progress of research on vulnerability and adaptation to climate change is constrained by scientific and technical limitations, especially with regards scenario uncertainties and the lack of clear vulnerability assessments. This restricts the integration of climate change adaptation into national development. A plan to address the problem has been drawn up in the National Strategy on Climate Change (2008-2012).

The National Strategy on Climate Change has been linked to and is consistent with the country's key strategic plans<sup>15</sup>. Six strategies have been identified<sup>16</sup>. Adaptive capacity enhancement is the first strategy and it is critically linked to the third, fourth and fifth strategies.

The key factors in determining the strength of the linkages between scientific knowledge on V&A and policy development are, as follows:

- ❖ Uncertainties
- ❖ Period covered
- ❖ Local conditions

High uncertainties of climate scenarios from GCMs cause the main bottleneck to research and development on V&A in Thailand. Despite more than two decades of research on impacts and vulnerability to climate change, various research works<sup>17</sup>, including those recently supported by Thailand Research Fund, are still seeking to understand the extent of uncertainties in downscaling global scenarios, while only one regional climate model, PRECIS, is available for the region<sup>18</sup>.

The period covered in the analysis is another constraint encountered in V&A studies. Climate scenarios covering several decades are difficult to use in developing socio-economic scenarios. At most, the available socio-economic development vision for Thailand covers two decades<sup>19</sup>. As V&A is sector-based, socio-economic scenarios should capture plausible economic structural change at the sector level. This further complicates the development of scenarios.

Earlier studies have suggested that crop diversification in Asia and the Pacific offers high potential for crop substitution. This is important for the development of adaptation options. A comprehensive analysis is required. So far, the issue has not been dealt with.

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<sup>15</sup> Those strategic plans include National Economic and Social Development Plan, 2007-2011; Environmental Quality Management Plan, 2007-2011; Strategy to Prevent and Remedy Coastal Erosion; Strategy to Resolve Energy Problem; The First National Strategic Plan on Environmental Sanitation, 2009-2011; Global Warming Mitigation in Agriculture Plan, 2008-2011; Strategic Scientific and Technology Plan to Address Global Warming and Climate change.

<sup>16</sup> The six strategies are:

- ❖ Enhancement of Adaptive capacity to cope with the vulnerability and reduce the impacts of climate change
- ❖ Support of GHG emission reduction from sources and enhancement of GHG storage by sink on the basis of sustainable development
- ❖ Support of research and development to enhance knowledge and understanding on climate change
- ❖ Development of public awareness and cooperation in addressing climate change

<sup>17</sup> For instance, *Socio-economic impact of Climate Change and Policy Response*, a UNEP support project to Ministry of Science, Technology and Energy, 1990; Office of Environmental Policy and Planning, 2000, *Sectoral Impacts of Climate Change*; Attachai Chintawech, 2005, *A Preliminary Study on Impact of Global Atmospheric Change on Food Security in Thailand*, a project supported by Thailand Research Fund

<sup>18</sup> To address uncertainties, IPCC recommends to use several models that allowed for reliable ranges of the results.

<sup>19</sup> Office of National Economic and Social Development Board has developed a Thai vision for the next two decades as a framework for national economic and social development planning.

## Climate Change Impacts and Thailand

Research on climate change started at the end of the 1980s. The early version of climate scenarios from the GCMs assumed double CO<sub>2</sub> with limited grid points<sup>20</sup>. Statistical downscaling was commonly used to develop scenarios at the national level. The results were rather crude. Refinements were introduced and substantial improvements in the development of various emission scenarios were made in the past two decades. Dynamic downscaling techniques were introduced. Refined climate models took into account different feedback effects and so on. Thailand used PRECIS (Providing Regional Climate Indicator System) to derive climate scenarios and analyzed potential impacts on certain sectors in the country.

### Potential climate change in Thailand

Potential climate change in Thailand is seen in downscaled scenarios based on IPCC's emission scenarios. Previous studies in Thailand suggested high uncertainties among different GCMs, requiring urgent improvement in this regard<sup>21</sup>. Over the past decade, several research studies on climate change have contributed to the understanding of climate change and its potential effects, as summarized below:

**Climate change trends**<sup>22</sup> Studies on climate change in Thailand have so far emphasized the understanding of downscaled scenarios from global to national levels. Various models have been used, including RegCM 3, to study temperature and rainfall variables during the 2031-2070 period, the application of statistical downscaling from GFDL-R30 to analyze climate trends for the period 2010-2029 and 2040- 2059, testing and development of WRF to forecast climate change for Thailand, the application of MM5 to study climate change in Thailand over the next 30 years, and the use of PRECIS to study climate change in Thailand and neighboring countries<sup>23</sup>.

The most recent work used a regional climate model called PRECIS, which applies dynamic downscaling technique to derive climate scenarios at the national and regional levels<sup>24</sup>.

Based on the emission scenario that reflects a growth-oriented global economy in the next century, results from the PRECIS model indicate that Thailand tends to have higher rainfalls by 10-20% in all regions, although the number of days with rainfall and heavy rainfall is not expected to change much. In contrast, all regions will be warmer as maximum temperature increases by 2 degrees Celsius and minimum temperature increases by 1 to 2 degrees Celsius. The duration of the cold season will be shortened as well.

In the scenario with less GHG emissions (that is, a more environment-conscious global economic development), the extent of higher rainfall will be less, while the frequency of rainfalls and heavy rainfalls will remain the same. Similarly, changes in maximum and minimum temperatures will be fewer and not every region will experience the same trends.

<sup>20</sup> In the early batch (such as GFDL, GISS, UKMO or CSRIO), resolution (grid point) was mostly less than 200 points across the world. Downscaling would be meaningful at most only at national level but not for regions or provinces of the country.

<sup>21</sup> Office of Environmental Policy and Planning, 1999, *Impacts of climate change on different sectors*; Office for international Environmental Cooperation, 2002, *Technology needs assessment*, Enabling Activity II project, UNFCCC.

<sup>22</sup> Center for technical service, Chulalongkorn University, 2010, *Study on impact of climate change and climate variability and extreme events in the future and adaptation of key sectors*, a draft final report submitted to Office of Natural Resource and Environmental Policy and Planning, (in Thai).

<sup>23</sup> Many of these projects used the same emission scenario of IPCC. Comparing the simulated values from PRECIS model with the actual climate data indicated that the model estimated rainfall lower and the temperature higher than the actual values. The results suggest the need to use more than one model in order to address the uncertainties issue. The Meteorology Department also compared results from the model with actual data from the stations in the country. It was found that most maximum and minimum temperatures from the model were higher than actual values while amount of rainfalls lower than actual values (<http://www.tmd.go.th/programs/uploads/intranet/DOCS/ncct-0008.pdf>).

<sup>24</sup> For instance, climate scenarios by provinces for 1980-2100 were studied in Center for technical service, Chulalongkorn University, 2010, *Study on impact of climate change and climate variability and extreme events in the future and adaptation of key sectors*, a draft final report submitted to Office of Natural Resource and Environmental Policy and Planning, (in Thai).

When the same model was used to derive climate change in Krabi province, it was found that over the next three decades, the temperature in Krabi province will increase by 1 degree Celsius, the amount of rainfall will drop by 10%, the rainy season will be shorter, and rainfall intensity will be lower<sup>25</sup>. The results indicate that climate change is locality-specific and can deviate substantially from the overall picture.

In addition to changing climate factors, increase in greenhouse gases will cause changes in the direction and speed of wind in Thailand. Specifically, it was found that the northeast monsoon will be slightly stronger, while the Southwest monsoon is not expected to change.

**Agriculture** Despite the declining ratio of agriculture to the gross national product, more than half of the population is engaged in agriculture, where incomes are relatively low. Agriculture remains as one of the key sectors in the country's economic and social development and is also the source of raw materials for various downstream industries. During the economic crisis in 2000 and 2007, agriculture provided food security and was an important source of employment.

Climate change affects agriculture in different ways depending on the direction and magnitude of change. Early studies on the impact of climate change on rice and maize yields, using different models in selected areas, found that crop yields varied substantially. The uncertainties were too high to be used in policy formulation<sup>26</sup>. Although climate models have been refined continuously, problems of high uncertainties remain in the analysis of climate change impacts on agriculture<sup>27</sup>.

A recent study on the impacts of climate change on agriculture applied scenarios generated using a regional climate model. The results indicated moderate, if not minimal, potential impacts on rice, maize, sugarcane and cassava production. The potential impacts on yield fluctuation or variability tend to be substantial, however. The north of Thailand tends to have higher production risks in the rainy season compared with other regions. Potential impacts during the hot season are similar across Thailand. Because only one model was used, uncertainties remained as an issue.

In addition to the issue of uncertainties, another key weakness of earlier studies is the lack of socio-economic scenarios. The latest study attempted to develop socio-economic scenarios based on Thailand's development vision for the next 20 years. Three possible scenarios were developed:

- ❖ Emphasis on food production (World Kitchen)
- ❖ Emphasis on renewable energy
- ❖ Emphasis on integration of 1 and 2 and the demand for eco-balanced development

Each scenario will have different land uses for agriculture and other activities. Under the natural resource constraints, emphasis on food production will enhance rice production by 23%. Under the renewable energy policy, sugarcane and cassava areas will double. Under the integration policy, conserved forest areas will increase, and the agricultural system will take into consideration soil and water conservation.

**Water resource** Climate change affects two aspects of water resources, that is, surface water flow and water storage. The key determinants are the amount and intensity of rainfalls and the rate of evaporation.

<sup>25</sup> Southeast Asia START Regional Center and World Wildlife Fund, 2008, *Climate change impacts in Krabi province, Thailand: A study of environmental, social and economic challenge*, December 2008.

<sup>26</sup> Office of Environmental Policy and Planning, 1999, *Impacts of climate change on different sectors*; Chitnucha Buddhaboon, Sahasachai Kongton and Attachai Jintrawet, *Climate Scenario Verification and Impact on Rain-fed Rice Production*; Sahasachai Kongton, Vinai Sorawat and Sukij Rattnasriwong, 2002, *Impact of climate change on maize, sugarcane and cassava in Khon Kaen province, Northeastern Thailand*; Wichian Kerdsuk, Sahasachai Kongton and Attachai Jintrawet, *Impact on climate change on rice production in Tung Kula Ronghai*.

<sup>27</sup> For instance, rainfed rice yield ranged from -12% to +10% (Matthews *et.al*, 1997) or an analysis that concluded that the increases in CO<sub>2</sub> concentration from 380 ppm to 540 ppm and 720 ppm had no effects on rice productivity in some provinces (Buddhaboon *et.al*, 2004). In contrast, a study in Ubon Ratchathani province found that climate change increases rice yield between 1-15% or reduce by as much as 24% but could increase up to 17%.

Studies on the impact of climate change on surface water flow into the Bhumibhol and Sirikit dams, based on climate scenarios from CCAM and a hydrological model called VIC (Variable Infiltration Capacity), found that climate change could reduce water flow into the Bhumibhol dam by the middle of the century. However, there were no impacts on the Sirikit dam. By the end of the century, water flow into the two dams is expected to increase substantially due to the impact of climate change.

Studies on water resources in the Mekong River based on several climate models found that surface water flow tends to increase due to increased rainfall. The higher the CO<sub>2</sub> concentration, the heavier is the rainfall. However, during the dry season, water flow will be lower than normal<sup>28</sup>. It is notable that the models used in this study indicated the same positive impacts on water resources, including potential flash floods in the eastern region.

**Health** The first study on climate change impacts on health in Thailand was in the Initial National Communication. A technical relationship between temperature and the growth rate of mosquitoes was used. It was concluded that global warming will enhance the potential spread of malaria within the first half of the century.

There has been no follow-up study over the past decade. A recent study on risks of malaria and dengue diseases and climate factors in various provinces failed to establish a clear relationship<sup>29</sup>. This area needs further study. Climate change has been integrated into the first National Strategic Plan on Environmental Health (2008-2011)<sup>30</sup>. The strategy emphasizes enhancement of a warning system to effectively control and prevent climate change-related airborne diseases from becoming an epidemic. It is envisaged that the development of an adaptive capacity concerning environmental health, including research and development, will encourage cooperation with other countries in the region in the foreseeable future.

**Forest and wildlife** There has been no study on climate change impacts on forests since the study covered in the Initial National Communication. The main potential impacts are expected to affect the type and structure of the forest, forest ecosystem, and biological diversity of fauna and flora. Biological diversity of fauna and flora is vital to the development of agricultural genetic resources. These issues are addressed in strategies contained in the National Strategic Plan on Climate Change (2008-2012), to adapt to climate vulnerability.

**Marine and coastal resources** Thailand's coastline is more than 2,600 kilometers long and is blessed with an ecosystem that is highly important to the social and economic development of the southern and eastern regions. Studies on the potential impacts of sea level rise due to global warming have been limited. A small study in Krabi province using DIVA (Dynamic Interactive Vulnerability Assessment) shows that the sea level along the coast of Krabi will rise by 11 to 22 cms. in 25 to 30 years due to global warming. About 10 to 35 meters of the coastline will be inundated<sup>31</sup>.

On the other hand, a study on sea level rise in the Gulf of Thailand over the past 56 years indicated a reverse trend, that is, a decline by 35 cms. per century, potentially due to geological change<sup>32</sup>.

Thus, vulnerability to sea level rise needs to integrate the potential impacts into socio-economic scenarios, in addition to other physical and biological changes over the same period.

<sup>28</sup> Southeast Asia START Regional Center, 2006, Final technical report AIACC AS07: *Southeast Asia Regional Vulnerability to Changing Water Resource and Extreme Hydrological Events due to Climate Change*, Southeast Asia START Regional Center Technical Report No.15, Bangkok, Thailand

<sup>29</sup> Center for technical service, Chulalongkorn University, 2010, *Study on impact of climate change and climate variability and extreme events in the future and adaptation of key sectors*, a draft final report submitted to Office of Natural Resource and Environmental Policy and Planning, (in Thai).

<sup>30</sup> This strategic plan is a result of cooperative efforts of key environmental agencies and those of public health. It was based on the concepts and proposals in the Charter of Environment and Health agreed by the Ministers of 14 nations in the South East and East Asia in 2007. The strategic plan was approved by the cabinet on the 8<sup>th</sup> December 2009. It comprises of 6 strategies, including measures and approaches related to climate change

<sup>31</sup> Southeast Asia START Regional Center and World Wildlife Fund, 2008, *Climate change impacts in Krabi province, Thailand: A study of environmental, social and economic challenge*, December 2008

<sup>32</sup> Vongvisessomjai, S. 2006, *Will sea-level really fall in the Gulf of Thailand?*, Songklanakarin Journal of Science and Technology, 28(2): 227-248



## ✿ Climate variability and extreme events

Climate variability and extreme events, especially droughts, floods and storms, have intensified due to global warming. Such natural disasters have caused substantial damage to food production and rural livelihoods, as well as to the country's national economic and social development (Table 3-2). Several studies have analyzed past events and have provided a forecast for the future.

Recognizing the importance of adaptation to increasing climate change variability and extreme events, Thailand has conducted a pilot study in Kor Tao (Tao Island), Surat Thani province. Historical data and 30-year scenarios using a climate model indicated that a slight increase in the number of monsoon days. Using the historical data to forecast future trends, it was found that the frequency of depressions is likely to decrease, typhoons are likely to increase, and monsoon storms will see no change (Table 3-3).

**Table 3-2** Disaster and damages in Thailand, 2001-2006

Year		2001	2002	2003	2004	2005	2006
Storm	Frequency (times)	1,061	594	3,213	3,834	1,313	1,883
	Provinces (number)	70	67	76	76	57	65
	Household (number)	32,100	23,070	146,024	70,818	32,449	30,296
	Public utility loss (mil.baht)	501.0	213.3	457.4	398.4	148.9	92.4
Drought	Provinces (number)	51	68	63	64	71	61
	Household (number)	7,334,816	2,939,139	1,399,936	1,970,516	2,768,919	2,960,824
	Loss (mil. Baht)	72.0	508.8	174.3	190.7	7,565.9	495.3
Flood	Provinces (number)	60	72	66	59	63	58
	Household (number)	919,699	1,373,942	485,436	619,797	763,847	1,673,822
	Loss (mil.baht)	3,666.3	13,385.3	2,050.3	850.7	5,982.3	9,627.4

**Source:** Department of Disaster Prevention and Mitigation, Ministry of Interior

**Table 3-3** Potential trends in the intensity of depressions, monsoons and typhoons over the next 30 years

Storm	1963-1982		1983-1997		2013-2542	
	Number	%	Number	%	Number	%
Depression	8	54	6	46	6	40
Monsoon	5	33	4	31	5	33
Typhoon	2	13	3	23	4	27
Total	15	100	13	100	15	100

**Note:** Those for 2013-2043 are forecasted from historical values



An estimated 20 cm. rise in the sea level around the island will affect the stability of coastal areas by 5-20 meters. Based on the potential effects of storms and the rise in the sea level, researchers carried out consultations with the local community and together drew up community development scenarios over the next 30 years. After a series of consultations, different adaptations were considered and evaluated. The meeting concluded that green development will be the best option to enable the community to respond positively to global agreements on the environment. The option will also enable the community to effectively cope with risks due to global warming and to pursue the path towards sustainable development.

## Technical and Management Issues on Vulnerability and Adaptation

The above provides a broad picture of progress concerning vulnerability and adaptation studies over the past decade. In general, V&A studies in Thailand are still at an early stage of development, in the midst of increasing impacts and vulnerability to climate change and climate vulnerability and extreme events. The main issues that need to be addressed are, as follows:

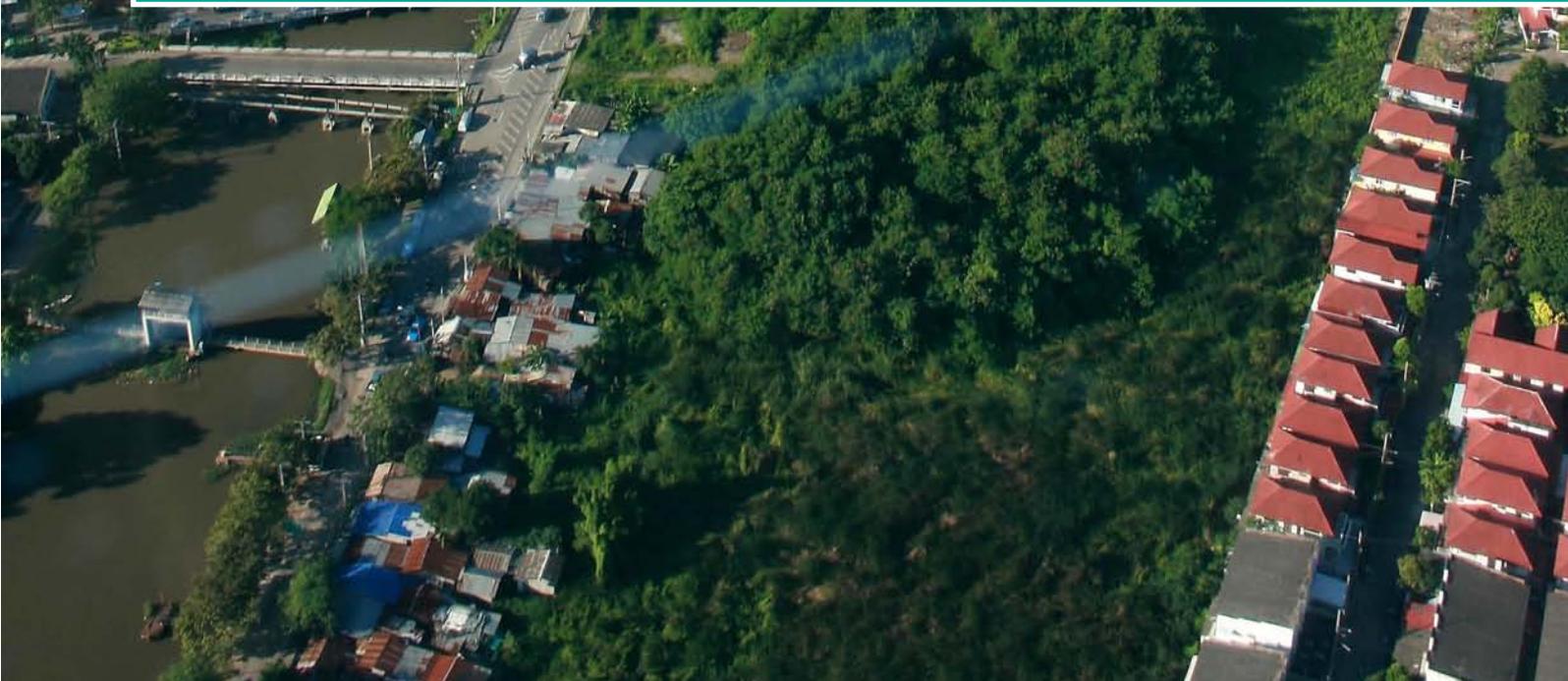
- ❖ Uncertainties in downscaling the global climate change scenarios to national and regional scenarios
- ❖ Meaningful behavioral linkages between climate factors and key sectors of the economy, such as climate change and cash crops, paddy and fruit trees
- ❖ Socio-economic scenarios for vulnerability analysis in all sectors
- ❖ Integration of vulnerability and adaptation strategies into different sectors and stakeholders

Innovative technical approaches that rapidly and meaningfully respond to policy needs, in order to address increasingly severe effects of climate change and climate vulnerability and extreme events.



# 4

## Greenhouse Gas Mitigation in Thailand



# 4

## Greenhouse Gas Mitigation in Thailand

### Introduction

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One of the main objectives of the UNFCCC is to control the atmospheric concentration of greenhouse gases (GHG) to a level that would not affect the climate system. GHG mitigation is a commitment by all Parties to the Convention, as stated in Article 4.1(b). This commitment is based on common as well as individual responsibilities of Annex I Parties (developed countries) and Non-annex I Parties (developing countries).

As a Non-annex I Party, Thailand has been actively involved in greenhouse gas mitigation, following its win-win policy which is described in Thailand's Initial National Communication (INC). Policies and measures pertaining to investment in energy efficiency, energy switching from fossil fuel and coal to natural gas, improvements in the public transportation network, and promotion of energy savings and use of renewable energy, have contributed to global efforts to mitigate greenhouse gases.

Since 2000, implementation of greenhouse gas mitigation measures includes provisions in the Kyoto Protocol. Clean development mechanisms provide flexibility to developing countries to cooperate with developed countries in fulfilling the latter's obligations. This chapter summarizes Thailand's mitigation efforts since submission of the INC.

### Thailand's Greenhouse Gas Mitigation

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Together with other Parties, Thailand has fulfilled its obligations and commitments under the UNFCCC to address climate change. Key policies of the Thai Government that have greatly contributed to GHG mitigation include mandated and voluntary energy auditing system for factories and buildings, energy efficiency labeling, demand side management, and logging ban. In addition, the framework for Thailand's sustainable development policy has consistently and continuously guided its development policy towards an environment-friendly direction.

In the past decade, Thailand faced economic and social difficulties arising from problems at the national and global levels. Trade competition and fluctuations in the global economy demanded greater efforts from Thailand, in order to build national resilience to the changing world. Thailand has shifted its development focus to emphasize people as the center of development and to apply the philosophy of sufficiency economy as core principle to strengthen sustainable development. Thailand remains committed to these policies to promote GHG reduction in all sectors.

## ✿ Energy sector

Energy management is vital to Thailand and thus has been given top priority. As shown in the INC, Thailand has been implementing demand side management of energy since the 1990s up to the present. Energy conservation has been implemented and related laws have been revised regularly to enhance their effectiveness.

Since 2000, energy management in Thailand has been supportive of national economic and social development. The 8<sup>th</sup> National Economic and Social Development Plan (1997-2001) was systematically put into action. The Ministry of Energy pursued specific targets following the direction set for the country's sustainable development and the national energy strategy.

Under the 8<sup>th</sup> Plan, a strategy for energy development was prepared on the basis of a stable economic and social development. The objectives were, as follows:

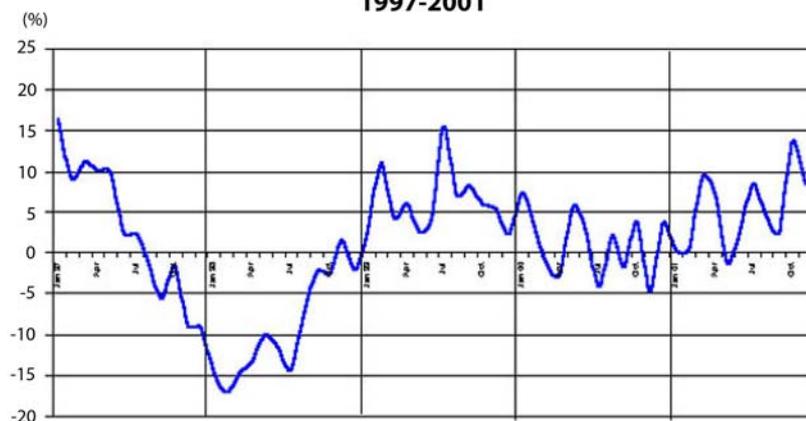
- ✿ To supply high quality, stable energy that satisfies demand at appropriate prices
- ✿ To promote energy efficiency and energy conservation
- ✿ To promote the role of the private sector and competition in the energy business
- ✿ To prevent and mitigate the environmental impacts of energy use and energy development, including enhancing safety in the operation of energy enterprises

Based on the above strategy, the 8<sup>th</sup> Plan provided for power management measures that would reduce electricity power consumption by 1,400 megawatts, while the promotion of energy conservation should lead to a reduction in energy use equivalent to one million tons of crude oil. Such targets certainly contributed to GHG mitigation by the global community.

### Energy and economic change

Energy is vital to economic and social development. Similarly, changes in economic development also affect energy utilization and development. In the 8<sup>th</sup> Plan (1997-2001) and the 9<sup>th</sup> Plan (2002-2006), Thailand adopted a development concept that focused on people as the center of development and applied the concept of "happiness in the society" as a framework for drawing up a development vision, objectives and principal targets. One of the key development components was to develop renewable energy and energy substitution to reduce dependency on imported oil and coal. However, the economic crisis and recession during 1997-1999 subsequently and substantially reduced energy demand. In the first two years of the 8<sup>th</sup> Plan, during which economic growth hit bottom level and registered a negative growth of more than 10%, energy consumption dropped by as much as 15%. Energy consumption picked up following the economic recovery in the latter period of the Plan (Figures 4-1 to 4-3).

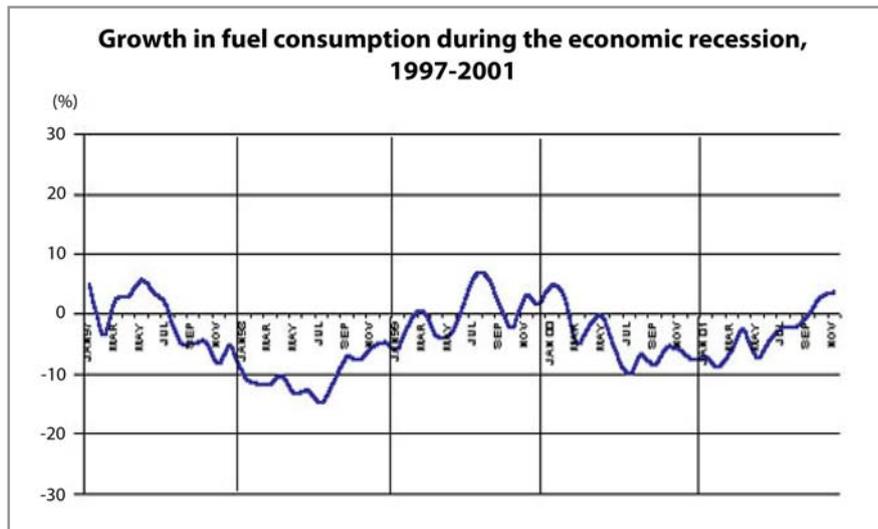
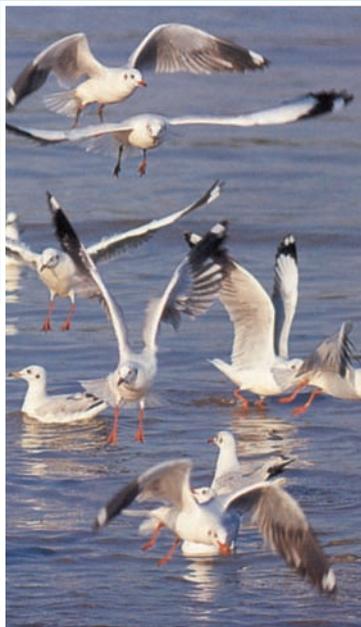
**Commercial energy consumption growth during the economic crisis, 1997-2001**



**Figure 4-1** Commercial energy consumption growth during the economic crisis, 1997-2001

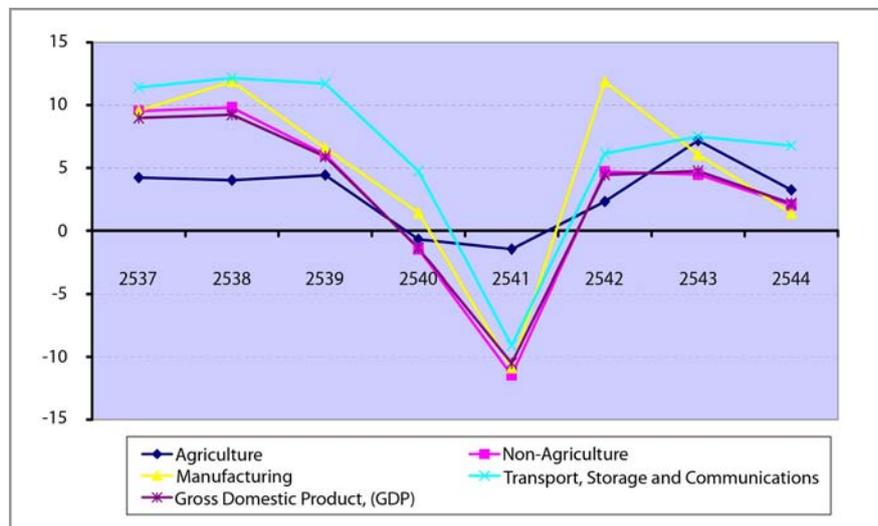
Source: Status and energy policy of Thailand, 2001 (<http://www.eppo.go.th/doc/report-2544/04-thaienergy.html>)





**Figure 4-2** Growth in fuel consumption during the economic recession, 1997-2001

Source: Status and energy policy of Thailand, 2001 (<http://www.eppo.go.th/doc/report-2544/04-thaienergy.html>)

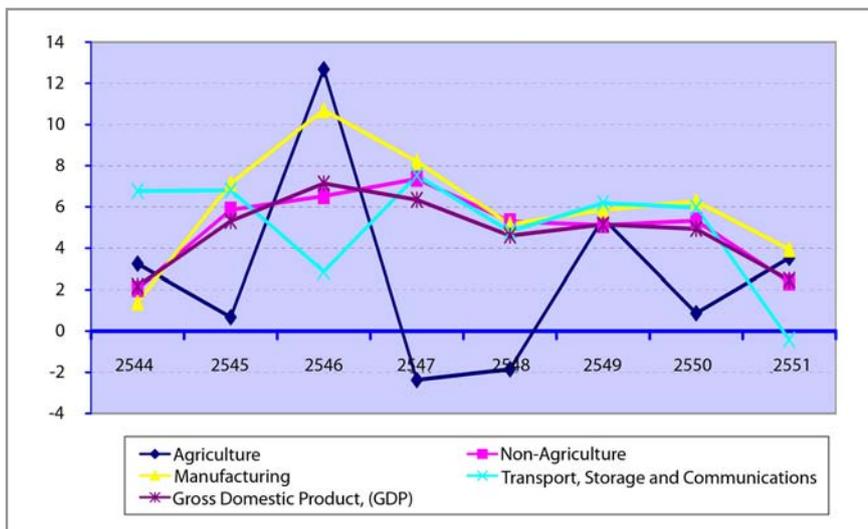


**Figure 4-3** GDP growth at constant prices, by key sector, 1994-2001

Source: Office of National Economic and Social Development Board

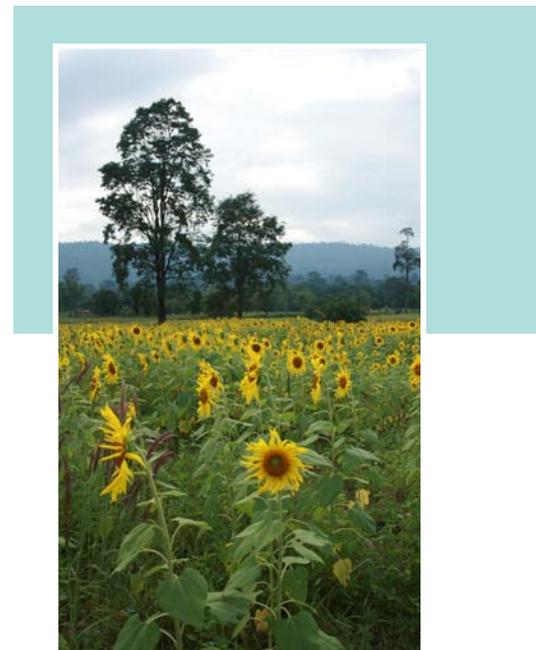
Such a close relationship reflects the fact that energy is closely related to economic change, as a prime factor contributing to growth as well as to the consumption of goods to satisfy demand as a result of income growth. Hence, GHG mitigation policies and strategies in the energy sector that do not compromise clean energy in order to advance economic growth and social welfare are very challenging.

Based on the concept that people constitute the center of economic development, Thailand changed the main objective of the 9<sup>th</sup> Plan (2002-2006) from a conventional economic growth orientation to strengthening the economic foundation and ensuring its stability and quality. This was to ensure equitable distribution of economic benefits and incomes, in order to alleviate poverty, increase self-sufficiency and income levels, and improve the quality of life of the people. During the first half of the 9<sup>th</sup> Plan, the economy expanded overall and the major sectors improved, but did not perform as well in the second half of the Plan, with the exception of agriculture which saw high fluctuations over the period. The trends continued up to the 10<sup>th</sup> Plan (2007-2011). (Figure 4-4).



**Figure 4-4** GDP growth in total and by sector at constant prices, 2001-2008

Source: Office of National Economic and Social Development Board



On energy, the 10<sup>th</sup> Plan identified climate change as a component that Thailand needs to adapt to, that is, "... global warming aggravates climate variability and potentially causes droughts and floods and affects ecosystem balance and biodiversity. Demand for energy in Thailand will increase and affect the environment, **Hence, Thailand needs to improve energy efficiency and develop renewable energy, taking into account environmental impacts and national energy security**" This policy has been transformed into energy action plans at the operational level.

### Energy conservation plan

Thailand has consistently emphasized energy conservation and implemented various measures following the Energy Conservation Promotion Act, 1992. Implementation of energy conservation has been divided into three phases: Phase I (1995-1999), Phase II (2000-2004), and Phase III (2005-2011). Implementation of the first two phases was funded by the Energy Conservation Promotion Fund to the amount of 23.8 billion Baht or more than US\$730 million. Under these two phases, electricity consumption was reduced by 883 megawatts, alternative energy for electricity was developed by more than 5.4 billion Gwh per year and for fuels by 430 million litres of crude oil equivalent per year. It was estimated that energy valued at more than 20 billion Baht was conserved during the period<sup>1</sup>.

In the third phase of energy conservation, the overall target followed the national energy policy of Thailand. It is planned that by 2011, the proportion of renewable energy to total will increase from 0.5 to 8%, and by 2017, energy intensity measured by energy per GDP will be reduced from 1.4:1 to 1:1<sup>2</sup>.

There are three important implementation plans in the Energy Conservation Plan, Phase III. These are implementation plans for renewable energy development, energy efficiency enhancement, and strategic administration. The targets of the three implementation plans are summarized below.

**1. Energy efficiency enhancement** Under this plan, by 2011, the commercial energy consumption will be reduced from a total of 91.9 million tons of crude oil equivalent to 81.5 million tons of crude oil equivalent. This is equivalent to reduction of energy consumption by 12.7% or about 10.3 million tons of crude oil equivalent. These are distributed as follows: 21% in the transportation sector, 9% in the industrial sector, and 4% in the residential sector.

<sup>1</sup> Office of Energy Policy and Plan, *Status of Energy Policy and Measures of Thailand, 2004*, Ministry of Energy, Thailand

<sup>2</sup> Office of Energy Policy and Plan, *Status of Energy Policy and Measures of Thailand, 2004*, Ministry of Energy, Thailand

**2. Renewable energy development** By 2011, the proportion of other types of energy will increase by 9.2% of the total demand, or will replace the use of commercial energy by about 7.5 million tons in crude oil equivalent. The transportation, industrial and residential sectors, with targets of 8%, 14% and 2%, respectively, will be emphasized. Renewable energy sources being considered are bio-diesel, ethanol, biomass, hydropower, solar, wind, and other renewable sources to produce electricity and heat.

**3. Human resource development** Four hundred additional graduates at the bachelor's and graduate levels will be employed in the energy sector. Energy education is proposed in the curricula of at least 30,000 primary and secondary schools. Bachelor's program to support industrial demand will be developed. Up to 1,400 persons with qualifications in industrial energy and 500 specialists in different energy areas at the local level will be produced.

### Renewable energy development plan

In the past few years, problems of high/fluctuating energy prices have increased. Thailand has developed a long-term renewable energy plan that covers a 15-year period and sets an important turning point in the country's energy policy by developing renewable energy as a substitute for imported fuels. The important target is to increase the share of renewable energy to total energy demand to 20% by 2022, compared with the present share of 6.4%. Three five-year development phases have been drawn up.

- ❖ Promotion of renewable energy-proven technologies with comprehensive fiscal measures. This will increase the share to 9%.

- ❖ Promotion of industries dealing with renewable energy technologies and development of innovative renewable energy technologies, as well as development of green city prototypes to expand the adoption of renewable energy at the community level. This will add another 3.5% to the proportion of renewable energy to total energy.

- ❖ Promotion of economically feasible renewable technologies and expansion of the green city prototype as well as export of renewable energy. This will increase the proportion of renewable to total energy by another 1%

In addition to contributing to the economy, these measures will generate benefits from CDM projects by about 14 billion Baht (over US\$ 430 million). Nevertheless, more comprehensive and in-depth analysis of social costs and the benefits of these measures will be required to fully assess the effects of GHG reduction.

### Greenhouse gas reduction from transportation

Besides energy efficiency and renewable energy development in the power sector, a mass transit development plan is being implemented in the Bangkok Metropolitan Region and other provincial capital cities<sup>3</sup>. The plan follows the revised master plan, which consists of three development phases, in 2008<sup>4</sup>. The revised plan is more responsive to changes and priorities in the socio-economic system.

The first phase covers a mass transit system consisting of seven routes running a total distance of 291 kilometers, with 44 kilometers now in operation. The system is expected to reduce economic losses by almost six billion Baht and to reduce fuel cost by more than 1.5 billion Baht, in addition to time saving and pollution reduction. The mass transit system in the Bangkok Metropolitan Region is expected to run 12 routes with a total distance of 495 kilometers within two decades.

To assess the contribution to greenhouse gas mitigation, the Office of Transport and Traffic Policy and Planning has developed a baseline using both top-down and bottom-up approaches recommended by the Thailand Greenhouse Gas Management Organization. This would further be developed as CDM projects. A preliminary study indicates that one of the lines could reduce CO<sub>2</sub> by more than 25,000 tons, valued between 12 and 14 million Baht per year. Other social and environmental benefits, such as reduction of local pollution, traffic accidents, and so on, are expected.

<sup>3</sup> Details of network system and development plan could be viewed at <http://www.otp.go.th/th/index.php/project.html>

<sup>4</sup> Phase 1 (2002-2011) for the comprehensive development of urban transit system; Phase II (2012-2021) for sustainable development of transport to ring system for accessibility in all urban areas and; Phase III (beyond 2021) for long term development for transportation link between urban and sub-urban areas.

## ✿ Mitigation due to energy conservation and renewable energy

Thailand's National Energy Policy Committee is responsible for the national energy policy and plan. The Energy Conservation Promotion Act, 1992 provides the legal framework for the establishment of the Energy Conservation Promotion Fund, which provides support to various projects, such as energy audits and tax privileges from energy conservation, energy services, and investment promotion.

### Historical contribution to GHG mitigation

Energy conservation reduces energy consumption by enhancing energy efficiency. Renewable energy from biomass and biogas and other substitute energy from fossil fuels and coals are used. Thailand's energy conservation and renewable energy plans contribute to GHG mitigation by reducing energy consumption and substituting energy from fossils and coal. Previous energy conservation plans (1995-1999, 2000-2004, 2005-2007) consisted of four main components, as follows: energy efficiency, renewable energy, human resources, and public relations. Contributions to CO<sub>2</sub> reduction in the past are shown in Table 4-1. In the past 13 years, Thailand has invested greatly on energy efficiency and renewable energy, resulting in a total CO<sub>2</sub> reduction of nearly 170 tons. Further reductions were made gradually, from less than 13 million tons in the first five years and exceeding 110 million tons by the end of the second five years. In 2007 the reduction reached 170 million tons.

**Table 4-1** Carbon dioxide reduction due to energy conservation during 1995-2007

Plan Period	Reduction of crude oil (in Ktoe)			CO <sub>2</sub> (mil.tons)	
	Energy efficiency (per year)	Renewable energy (per year)	Total reduction per year	Total reduction	Total reduction
1995-1999	48.48	37.89	86.37	431.85	12.76
2000-2004	48.48	702.53	751.01	3,755.05	110.92
2005-2007	1,554.00	3,586.00	5,140.00	15,420.00	45.55
Total					169.23

**Note:** CO<sub>2</sub>/Ktoe of crude oil = 2.954 thousand tons

**Source:** Adapted from Office of Energy Policy and Planning, Annual Report 2005 and Ministry of Energy, Energy Conservation Plan and Approach, Criteria, Conditions and Priority in Use of Energy Conservation Promotion Fund for 2008-2011

### Future contribution to GHG mitigation

Thailand is implementing Phase III of the Promotion of Energy Conservation and Renewable Energy Plan (2008-2012). The main objectives of the Plan are to intensify measures to conserve energy and to use renewable energy. The measures include innovative energy technology development and various incentive mechanisms to promote effective energy management in the private and public sectors. The Plan aims to reduce energy demand by 7.8 million tons of crude oil equivalent (approximately 10.8% of demand in 2011). Renewable energy and CNG will be used to substitute commercial energy by 8.6 million tons of crude oil equivalent or 12.2% of commercial energy in 2011<sup>5</sup>.

If the Plan is successful, energy consumption in 2011 will be reduced by 16.7 million tons of

<sup>5</sup> Ministry of Energy, *Energy Conservation Plan and Approach, Criteria, Conditions and Priority in Use of Energy Conservation Promotion Fund for 2008-2011*

<sup>6</sup> From the 2009 statistics of Ministry of Energy, CO<sub>2</sub> emission was estimated as 196.02 million tons as a result of final energy consumption of 66,339 ktoe. Hence, CO<sub>2</sub>/1 ktoe is 2.954 thousand tons

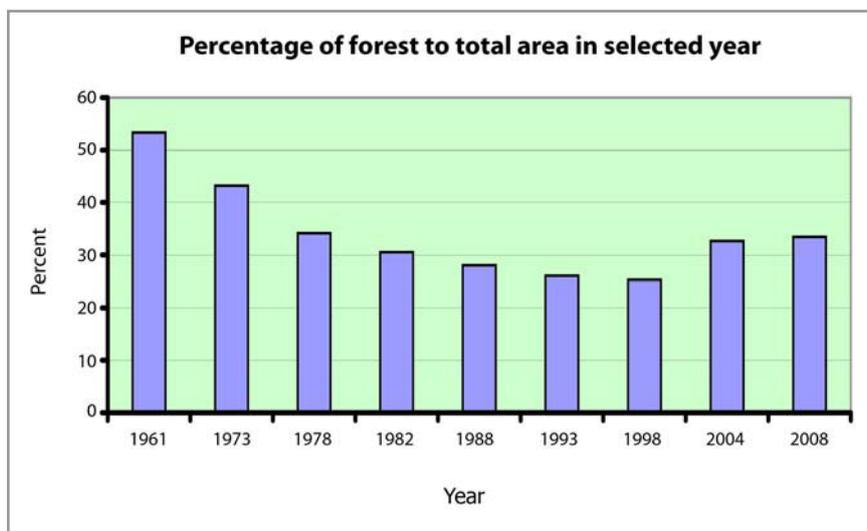
<sup>7</sup> Ministry of Energy, *Energy Conservation Plan and Approach, Criteria, Conditions and Priority in Use of Energy Conservation Promotion Fund for 2008-2011*

oil equivalent and CO<sub>2</sub> emission will be reduced by nearly 50 million tons<sup>6</sup>. To achieve this, about 88 billion Baht (over US\$ 2.7 billion) will have to be invested over the five-year period<sup>7</sup>.

## Forestry

The forestry sector is an important source of GHG sink. Policies to conserve forest and expand forest areas are important to GHG mitigation. Since change in forest land means change in land use, forest conservation or forest area expansion are inevitably and closely related to economic and social development. Optimization of land for forest, food and energy is the main principle underlying the development of sustainable livelihoods in the future.

Figure 4-5 shows changes in forest areas in the past 50 years. Forest land declined to the lowest level of about one-fourth of total land area in 1998. Since then, Thailand has conserved and expanded forest areas and community forests, and promoted reforestation in watershed areas. As a result, forest land in Thailand increased to about one-third of the total land area in 2008<sup>8</sup>.



**Figure 4-5** Proportion of forest land to total land in Thailand, 1961-2008

Source: Royal Forest Department

These strong efforts to expand forest land resulted in a net sink for the forest sector since 1998. If Thailand can continuously maintain or expand the proportion of forest to total land, the forest sector will eventually be a net GHG sink and will contribute positively to the country's GHG inventory.



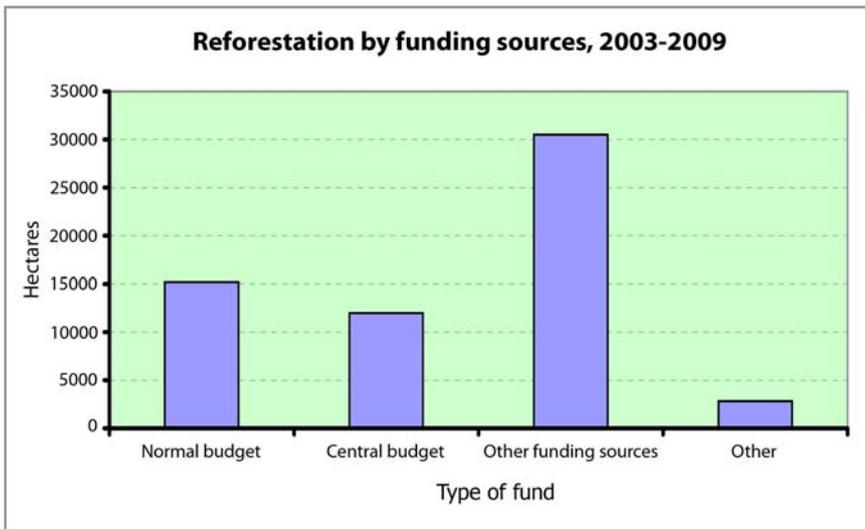
### Reforestation

Forest management can be roughly divided between management of conserved areas and management of other areas, such as reserved forests, national parks and wildlife sanctuaries, and public areas. The expansion of forest areas other than conserved forests has been carried out in many ways, such as reforestation by the private sector or by agencies or through public participation, community forest management, and promotion of commercial forests.

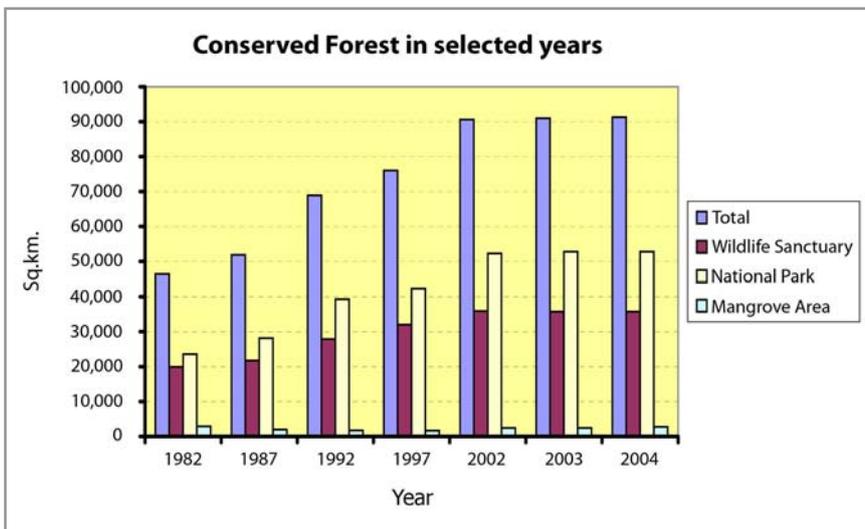
Commissioning the private sector to reforest is normally done in the first three years of a reforestation project. Since 2000, about 7,520 hectares have been planted using this method<sup>9</sup>. In 2006, Thailand had about 20,000 hectares of forest land with 2- to 10-year old trees, of which half was planted and maintained by local communities. It is noted that local community participation in reforestation activities has been in practice since 2003. The Royal Forest Department reforested about 64,000 hectares. Nearly half of the land was planted using

<sup>8</sup> Change in forest area is due partly to the change in definitions and estimation technique used. For instance, in 2000, increase in forest areas was partly due to the improvement of technique and higher resolution of the maps. Although backward revision is technically possible, this can not be done with the old maps of low resolution.

<sup>9</sup> Planting cost is 2,500 baht/rai and maintenance cost is 680 baht/rai/year (Royal Forest Department, Annual report, 2006)



**Figure 4-6** Reforested land, by source of fund, 2003-2009



**Figure 4-7** Conserved forests, by type, 1982-2004

Source: Department of National Parks, Wildlife and Plant Conservation

non-public budget. About two-fifths of the total was planted using the public budget, while less than 10% was planted through other projects. In summary, it can be said that reforestation by the Royal Forest Department has so far been supported from the public budget or from funds collected based on forestry regulations (Figure 4-6).

### Conserved forest

Conserved forest is also vital to GHG mitigation, especially under the UNFCCC campaign, Reducing Emission from Deforestation and Forest Degradation (REDD). There are two main types of conserved forest in Thailand:

- ❖ Conserved forest as defined by law and Cabinet resolutions. This includes forest reserves that have been declared as conserved forest, wildlife sanctuaries, national parks, class 1 watershed areas, and conserved mangrove forests.

- ❖ Additional forests for conservation, including national forest reserves that are in good conditions or have a good potential to be naturally conserved, forest areas that are suitable for research, border areas with special characteristics, and forest areas that should be conserved, according to environmental quality acts or for the purpose of preserving natural heritage.

Conserved forest in Thailand expanded from about 31,000 sq km in 1979 to about 90,000 sq km in 2004. Of this, approximately 60% are national parks and 35% are wildlife sanctuaries. The rest contains



mangrove forests (Figure 4-7). The expansion of conserved forest areas is another win-win policy of Thailand. While conserved forests help to maintain ecological balance and to protect the environment, they also reduce emissions by preventing encroachment and deforestation.

## Natural Resource Management and Greenhouse Gas Mitigation

The demand for energy, land use, and forest products affects greenhouse gas emissions. Increasing energy demand in the past few years has caused soaring prices for petroleum and its products. As with other countries, Thailand has taken measures to address economic difficulties and the energy crisis, in order to ensure energy security at the lowest possible costs. Thailand has pursued renewable energy policies, especially concerning energy from biomass and crop residue. The food crisis in 2007 placed the issue of food security high in the political agenda and in international trade negotiations.

With the energy problem and food crisis happening simultaneously, policy makers were alerted to the complexity of energy, food and global warming issues. Their linkages can be viewed in general as being the relationship among demand for energy, utilization of natural resources (land and water), and global warming.

The relationship between natural resource and environmental management and greenhouse gases can be synthesized from the National Strategy on Management of Climate Change and the four-year operational plan of the Ministry of Natural Resources and Environment<sup>10</sup>. They are summarized in the following section.

To achieve the target concerning **greenhouse gas mitigation and effective improvement of conventional production technologies as clean technologies**, Thailand supports the reduction of GHG emission from various sources and through sinks, and integrates this into the national sustainable development process. The national GHG inventory forms the basis for the design of approaches to mitigate GHGs in different sectors, as follows:

- ❖ Increasing efficiency in transportation, energy production and consumption, in general, and increasing the use of renewable energy
- ❖ Reducing the amount of waste generated and improving the efficiency of management and administration
- ❖ Reducing emissions from industrial production processes
- ❖ Reducing emissions from agriculture
- ❖ Increasing sinks from forest areas

The four-year operational plan of the Ministry of Natural Resources and Environment identifies strategies to address climate change and environmental quality by setting the following key targets.

- ❖ Creating new forest and reforested areas, covering 3.18 million hectares
- ❖ Rehabilitating watershed forest areas, covering 160,000 hectares
- ❖ Planting trees in commercial forest areas, covering 448,00 hectares
- ❖ Establishing 20 CDM projects for water reuse or recycling
- ❖ Supporting 120 research and development projects in GHG management at the national level
- ❖ Promoting 120 communities that surround research and development projects on community health and social development

<sup>10</sup> Office of Natural Resource and Environmental Policy and Planning, *National Strategy on Management of Climate Change, 2008-2012*, Ministry of Natural Resources and Environment, January, 2008; Ministry of Natural Resources and Environment, *4-year Operation plan, 2008-2011*

- ❖ Generating CDM projects with a value of at least 2,000 million Baht (US\$320 million) to reduce GHG emissions up to 2 million tons of CO<sub>2</sub> equivalent

In addition, there are strategies for the management and administration of natural resources which are consistent with sustainable development and are related to GHG mitigation. These are, as follows:

- ❖ Protection of 17 million hectares of conserved forest
- ❖ Rehabilitation of 240,000 hectares of forest land
- ❖ Conservation and rehabilitation of 2,150 hectares of watershed areas and deteriorated forest areas with a survival rate of 90% or more
- ❖ Maintenance of 3,000 hectares of forest gardens in conserved areas with a survival rate of 80% or more
- ❖ Maintenance of the biological richness of 256,000 hectares of marine and coastal resources

## Agriculture and Greenhouse Gas Mitigation

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Agriculture is an emission source and a possible way to reduce emission is through changes in rice cultivation, raising livestock, and land use techniques. While being a source of emission, rice is a basic staple food for more than half of the world's population. Because food security is the objective of the UNFCCC, any option to reduce emissions from rice, livestock, or land use should not hamper food security or bring poverty to rural farmers. Developing GHG mitigation options in agriculture requires thorough and comprehensive analysis of the social and economic pros and cons of such options. Thailand's win-win policy is along this line.

The Ministry of Agriculture and Cooperatives defines the mitigation strategy for agriculture, as follows:

- ❖ Campaign to plough 20,000 thousand hectares of land for rice planting
- ❖ Plant 72,000 hectares with permanent trees
- ❖ Reduce agricultural field burning by 24,000 hectares, particularly in northern Thailand

It should be noted that the campaign to reduce agricultural or rice field burning is a tactic to reduce local environmental impacts due to smoke from the burning of agricultural residue. Rice stock or agricultural wastes are basically CO<sub>2</sub> neutral. Planting permanent trees in abandoned land is a net sink due to the accumulation of carbon stock. It will become carbon neutral when the trees are cut and start to decompose.

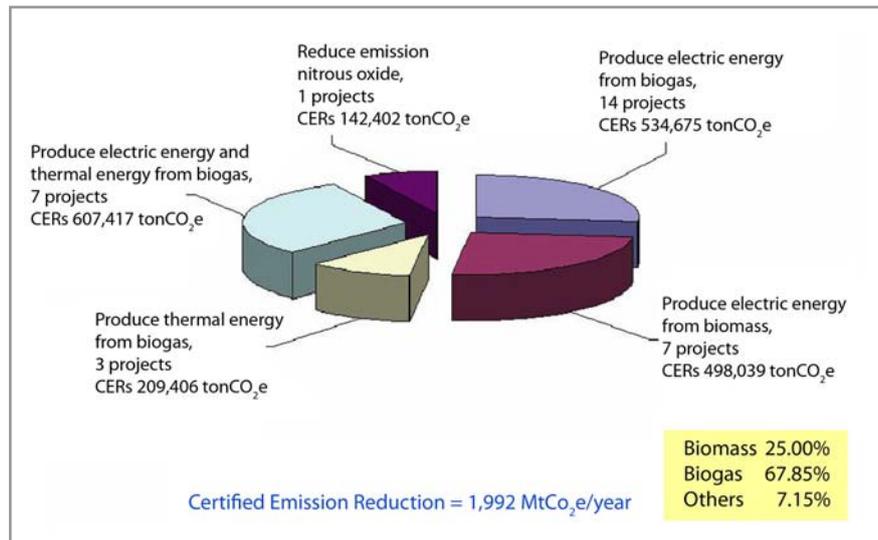
## Clean Development Mechanism

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Clean development mechanism has contributed to GHG mitigation, following Thailand's ratification of the Kyoto Protocol. The national capacity for CDM has been enhanced with the cooperation and support of developed countries, including projects funded by Australia and Denmark.

Greenhouse gas mitigation using CDM mechanism was initiated after Thailand established the national criteria for CDM projects. Thailand's Greenhouse Gas Management Organization, a public organization, was established to act as DNA for CDM projects.

As of 5 March 2010, Thailand had 100 CDM projects, each backed by a Letter of Approval (LoA) and with the capacity to reduce GHG emissions by 6.3 million tons of CO<sub>2</sub> equivalent per year. Of these, about 69% are biogas projects and 22% are biomass projects (Figure 4-8). These projects will have to be approved by the CDM Executive Board to qualify as CDM projects. At present, 32 CDM projects with a CO<sub>2</sub> reduction capacity of about 2 million tons/year have been approved. CERs have been issued to two CDM projects with a capacity to reduce 800,000 tons of CO<sub>2</sub> per year.



**Figure 4-8** CDM projects approved by the CDM Executive Board, by type

**Source:** Thailand's Greenhouse Gas Management Organization (public organization)

## Others

Over the past decade, various public agencies and private organizations have promoted environmental conservation and greenhouse gas mitigation. Some of these are summarized below.

### Green procurement

Thailand has implemented green marketing for more than a decade to promote both sustainable production and consumption. As public agencies account for 11-17% of the total national product, the Pollution Control Department initiated a green procurement pilot project to promote and develop an environment-friendly procurement system. The Public Procurement of Environment-Friendly Product and Service Pilot Project (2008-2011) aims to have participating public agencies procure environment-friendly products and services at the following rates: 25% of all procured products and services in the first year, increasing to 50%, 75%, and finally 100% by the end of the project.

### Public health and global warming

The Department of Health in the Ministry of Public Health has introduced a project to promote global warming mitigation through sustainable sanitary health and environmental services. The project encourages all public health service offices in the Ministry of Public Health to implement activities that contribute to greenhouse gas mitigation. Under the GREEN and CLEAN<sup>11</sup> strategies/activities, all public health service offices will demonstrate activities to address global warming and promote awareness of global warming and health among all personnel. The target areas include central hospitals, general hospitals, community hospitals, hospitals under the Technical Department, sanitation stations, and community health centers. The project period is 2010-2012. By 2010, 692 hospitals have participated in the project and more are expected in the near future.

### Global warming and cities

Global warming alerts major cities around the world, including Bangkok and other major cities in Thailand, to implement projects and activities to reduce greenhouse gas emissions. The Bangkok Metropolitan Administration (BMA) together with 35 agencies adopted the Bangkok Declaration to mitigate global warming. Five measures that have been agreed upon are, as follows:

<sup>11</sup> GREEN stands for G=garbage, R=rest room, E=energy, E=environment, N=nutrition,; CLEAN stands for C=communication, L=leader, E=effectiveness, A=activity and N=networking

- ❖ Reduce energy use and maximize the benefits from production activities and consumption, and cause the least impacts associated with global warming
- ❖ Promote and support the participation of youth, community, business, public agencies and individuals in reducing greenhouse gases and global warming
- ❖ Support and promote livelihoods based on the sufficiency economy philosophy, in order to mitigate global warming and build the people's resilience and ability to adapt to global warming
- ❖ Support, promote and participate in activities to enhance carbon sinks through widespread tree planting and by ensuring that these trees are maintained
- ❖ Promote activities to continuously reduce and prevent global warming in a sustainable manner, including information and knowledge dissemination and practices.

The BMA has implemented operational plans during the period 2007-2012 to reduce global warming. The aim is to reduce greenhouse gases from business operations by 15%. There are five strategies, as follows: mass transit system development, promotion of alternative energy, improvement of electrical appliances in buildings, management of solid waste and wastewater, and enhancement of green areas. There are regular public campaigns for public participation to enhance greenhouse gas mitigation, including campaigns for 15-minute stops in Bangkok; switching to energy-saving light bulbs; biking to mitigate global warming; stopping and turning off engines; planting trees; car-free days in Bangkok, and so on.<sup>12</sup>

In early 2010, the city of Khon Kaen in Khon Kaen province in northeast Thailand adopted the Global Warming Mitigation Declaration with the aim to become an eco-city. The major objectives of Khon Kaen's Operational Plan on Global Warming Mitigation, 2010-2019<sup>13</sup> are, as follows:

- ❖ By 2012, 5% reduction of greenhouse gases emitted in 2010, and 10% reduction in 2019
- ❖ By 2012 expansion of green areas in urban communities by 5% of the total area in 2009 and by 10% in 2019
- ❖ Participation by all parties in readiness preparation for adaptation to global warming
- ❖ In 2012 reduction of damage from natural disasters by 5% and by 10% in 2019

To achieve these objectives, the operational plan will apply the following four strategies.

- ❖ Reduction of emission sources and enhancement of sinks
- ❖ Promotion of public awareness and participation in addressing global warming
- ❖ Development of management and administration to make these more efficient
- ❖ Capacity enhancement to address global warming

In addition to the implementation of specific plans to address global warming in the major cities of Bangkok and Khon Kaen, other cities in various provinces have also initiated and implemented natural resource and environmental conservation activities, thus contributing to greenhouse gas mitigation and adaptation to climate change impacts.

## Greenhouse Gas Mitigation and National Development

The national greenhouse gas inventory clearly identifies the energy and forestry sectors as major contributors to GHG emissions. Hence, options to reduce GHG emissions will naturally focus on these two main sources. Under the win-win policy, activities that support GHG mitigation will contribute positively to the achievement of national development objectives. The extent to which these win-win options can continue and how they relate to the evolving negotiation process are questions that are critical to Thailand's climate change policy and planning.

<sup>12</sup> Implementation plan of Office of Environment, BMA (<http://203.155.220.174/modules.php?name=News&file=article&sid=19>)

<sup>13</sup> Regional 10 Environmental Office and Khon Kaen province, *Operational Plan to Address Global Warming, Khon Kaen Province, 2010-2019*, in cooperation with GTZ, 2010.

The preparation of the 11<sup>th</sup> Plan (2012-2016) is looking into the status of national and international development and the trends therein, as well as their interactions. Changing conditions in five key areas are being considered: post-global crisis opportunities, creative economy as an option, development of a new society, mechanism to balance social and economic change, and global warming.

As far as economic and social development is concerned, global warming over the past decade has affected Thailand in different ways. One of the most important effects concerns the long-term competitiveness of Thailand. Thailand must be well prepared to adapt to the impacts of global warming. National development will have to be directed towards a low carbon economy. Production has to adopt a low carbon system. Economic gains from the biological resource base have to be accelerated, while conservation and rehabilitation of natural resources and protection of the environment will need to be intensified. At the same time, Thailand will have to maintain food and energy security and will need to enhance knowledge, research and development, as well as improve its information system to support national capacity and technological needs.

In gearing its vision towards 2027, Thailand should recognize increasing threats from global warming, together with changing national economic and social structures. Several factors contribute to emerging complexities. These are the following:

- ❖ *Global warming and climate change* Increasing greenhouse gas emissions and their consequences threaten the environment and quality of life. It is expected that countries will have to spend 0.05-0.5% of their GDP to address the potential impacts of global warming

- ❖ *Global demographic change* The world's aging society will affect overall labor capacity and efficiency, while global investments in machines and technologies will tend to drop.

- ❖ *Energy demand and food security* The global demand for renewable energy is increasing. This will further affect the demand and pricing for energy crops, including cassava, maize and oil palm, consequently affecting food security.

- ❖ *Technology* New technological developments with multi-dimensional and innovative applications will change the people's way of life, as well as consumption, production and marketing patterns. Consumers will respond to stimulants that deviate from present consumption and marketing patterns.

- ❖ *Global financial system* The global financial system will tend to fluctuate and will be increasingly fragile. Countries will tend to form specific regional groupings and to reach agreements on trade, finance, and investment in the long-term.

- ❖ *Regional economic grouping and cooperation* More emphasis at the regional level will expand trade, investment and economic growth. New markets will be developed and global economic centers will change in the future.

- ❖ *Urban, rural and economic zone development* As more than 50% of the population will be living in urban areas in the near future and considering the rapid growth of the Asian region, urbanization in the region will expand rapidly, and hence there will be various structural changes and adjustments to support the urbanization process.

The main factors linking greenhouse gas mitigation and economic development in Thailand are those related to energy, land use change and forestry, agriculture and livestock. Other potential factors are those related to industrial production processes and waste management. Factors related to energy are those associated with fossil fuels and coal, while those related to land use are mainly associated with increasing green areas and reducing methane emission from rice and livestock, particularly dairy cows and cattle.

Reducing greenhouse gas is one type of investment venture. The economic and social costs and returns must be fully assessed. As seen in the UNFCCC process, at issue is not the need to mitigate GHGs as such. At the root of contradictions is the allocation of costs and returns among the parties concerned. Based on the national inventory of Thailand, energy is the top priority sector to be considered in GHG mitigation. As the price elasticity of energy demand is generally low, price changes tend to have minimal impacts on consumption demand. These phenomena have been frequently demonstrated in energy statistics. This further suggests that measures to reduce GHG mitigation in the energy sector tend to be costly, due to the inelasticity of demand. Hence, it is critically important to search for low cost and environment-friendly technologies as substitute for existing primary sources of energy.



5

Other  
Information

# 5

## Other Information

### Development and Transfer of Technology

#### ✿ Introduction

It cannot be denied that the prime mover for global warming as we face it today is technology development, which gave rise to the industrial revolution two centuries ago. Energy demand and relatively cheap fossil fuel and coal have resulted in heavy dependence to-date on these primary energy sources. This has been consistently demonstrated by the impacts of fuel supply and price shocks on national economic and social development. Effective GHG emission mitigation can only be met by reducing dependence on fossil fuels. Unless appropriately developed, actions to reduce emissions from fossil fuels could be counterproductive to national development. The same is true for other emission sources. Reducing emissions from forestry and agriculture certainly requires changes in land use, yielding consequences on the livelihood of the poor. Technology development is a key factor to enhance mitigation and adaptation to climate change. This is true for all countries in the world, although at different levels.



The development of GHG mitigation technologies, such as 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. Under Article 4.5 of the UNFCCC, developed countries have an obligation to help developing countries in addressing climate change by promoting, supporting and facilitating the development and transfer of technology and capacity.

This section reviews the progress of technology development and transfer in Thailand, in the context of the UNFCCC.



## ❁ Thailand and technology development and transfer

The development and transfer of technology or technology cooperation constitute a natural development process at the national and/or international levels, among or between developed and developing countries. Similarly, these countries also engage in technology competition in the world's free market. Technology has become an important driver for trade competition and the export of goods in international trade.

Thailand has been systematically promoting its technological development since 1991, with the implementation of the Scientific and Technological Development Act. The Act established the National Scientific and Technological Development Policy Committee and the National Scientific and Technological Development Office. The first five-year strategic plan (1992-1996) was adopted in 1992. Technology development during the early period followed the National Economic and Social Development Plan and was distributed across ministries. After the economic crisis in 1997, science and technology development in Thailand was streamlined to make it more systematic and responsive, as reflected in the National Scientific and Technological Development Plan (1997-2006), Vision and National Strategy on Scientific and Technology (2000-2020) and the Sixth National Research Policy and Approach (2002-2006)<sup>1</sup>. Thailand also streamlined the preparation of a decadal strategic plan for science and technology development and the national economic and social development strategy<sup>2</sup>. Thailand is now implementing the Fourth Five-Year Scientific and Technological Strategic Plan (2007-2011), which is in parallel with the 10<sup>th</sup> National Economic and Social Development Plan. This strategic plan recognizes the importance of the country's economic and social foundation insofar as food and agriculture, energy and the environment are concerned. It also emphasizes the transfer of appropriate technologies to rural communities.

The following summarizes technology development and transfer related to climate change, particularly mitigation and adaptation, and the status of international cooperation in technology, especially in natural resource and environmental management.

## ❁ Implementation under the UNFCCC and Kyoto Protocol

As a developing country Party to the UNFCCC and Kyoto Protocol, Thailand is a potential recipient country for technology development and transfer from developed country Parties. At the same time, Thailand contributes to technology development and transfer, as well as to capacity building of scientists and social scientists in least developed and developing countries.

**Response to the UNFCCC** Since submission of the INC, Thailand has conducted a study to preliminarily assess its technology and national capacity needs concerning climate change<sup>3</sup>. The technology needs are, as follows:

<sup>1</sup> The Committee on National Scientific and Technological Development Policy, 2004

<sup>2</sup> National scientific and technological development strategy, 2004-2013

<sup>3</sup> Technology needs assessment was one of the topics given under the Enabling Activity II project. The project was designed to maintain the continuity of national communication preparation process. It was not responding to the article 4.5 per se. Hence the assessment was only preliminary.

- ❖ Development of local emission factors for agriculture (rice, livestock, and agricultural soil), forestry, and waste management

- ❖ Development of technologies for mitigation, especially technologies and know-how on energy conservation, biomass, and solar energy

- ❖ Development of technologies and know-how on impact, vulnerability, and adaptation. These include (1) technologies and analytical techniques related to climate change at sub-regional scale, particularly on the development of climate scenarios, (2) development of capacity to assess impacts on and vulnerability of the agricultural sector, particularly cash crops in different regions, (3) research capacity to analyze impacts on water resources, surface water, and water storage, (4) analytical techniques to analyze impacts on coastal areas, especially impacts on the ecological system and land use, and (5) analytical techniques to analyze impacts on health, especially airborne diseases.

The report on the technology needs assessment was submitted to the UNFCCC for further consideration, taking into account the context of the framework to facilitate implementation of Article 4.5 of the Convention. However, technology transfer activities implemented under Article 4.5, particularly the enabling environment, have not been sufficiently responsive to such needs. Most activities were focused on capacity building through various workshops and training.

In summary, Thailand has carried out a preliminary needs assessment of climate-friendly technology in the country. Due to limited action-oriented activities under Article 4.5 of the Convention, climate change technology has not been effectively transferred. Increasing threat from climate change and the lack of active technology transfer have worsened Thailand's vulnerability of to climate change.

**Response to the Kyoto Protocol** In addition to technology transfer under the Convention, the Kyoto Protocol has encouraged voluntary participation of developing country members under the Clean Development Mechanism. The CDM, in principle, will accelerate technology transfer for sustainable development, rather than the business-as-usual or existing market system, which is referred to as the "additionality" condition. More than 100 CDM projects have been approved by the Designated National Authority (DNA) of Thailand (Table 5-1). These projects emphasize renewable energy technologies, especially biomass and solar. It would be very useful to see how the CDM has facilitated the transfer of climate-friendly technology to Thailand.

**Technology Plan** In addition to activities related to technology development and transfer under the UNFCCC and Kyoto Protocol, the national strategic plan on climate change has also given top priority to technology development related to GHG mitigation. The important ones are the following.

- ❖ Development plan for renewable energy, especially biomass and solar energy
- ❖ Plan for the improvement of a technology foundation for clean technology development
- ❖ Energy efficiency plan



**Table 5-1** CDM projects approved by Thailand's DNA, as of March 2010

Type of project	Number
Energy from biogas	6
Energy from biomass	2
Electricity and energy from biogas	19
Electricity and energy from biomass	1
Energy efficiency	2
Organic fertilizer	1
Reduction of Nitrous Oxide	1
Electricity from biogas	44
Electricity from biomass	15
Electricity from heat transfer	9
Electricity from solar energy	2
Hydroelectricity	5
Total	107

**Source:** Thailand's Greenhouse Gas Management Organization (Public Organization)

Other agencies have also prepared specific plans to support the development of climate-friendly technology in Thailand. These include a strategy by the Ministry of Science and Technology to cope with global warming and climate change using science and technology and the Energy Conservation Plan of the Ministry of Energy.

The development of climate change technology in Thailand indicates the need for appropriate integration of technology development and transfer under the UNFCCC and the Kyoto Protocol, in order to accelerate the development of clean technologies in the country. Unfortunately, slow and limited support and facilities under the Convention and the Kyoto Protocol have not effectively enhanced Thailand's efforts to combat climate change through technology development and innovation.

### International cooperation in technological development

Thailand has continuously cooperated with other countries at the sub-regional, regional and global levels, such as ASEAN, APEC and other bilateral and multilateral cooperation groups. Technical cooperation includes the development of technologies and capacities, training, and so on.

TICA (Thailand International Development Cooperation Agency) is the key agency for coordinating international cooperation. Its main objective is to handle technical cooperation at the bilateral and multilateral levels with development agencies in the public sector as well as with international organizations. Thailand's approach to the development of technical cooperation is consistent with the cooperation principle of the Convention. Because of its strategic location and level of development, Thailand has positioned itself as a gateway and linkage to facilitate and support technological transfer from developed to least developed countries. Thailand's advantages will enhance technical cooperation to its full capacity in the form of north-south-south cooperation.

In accordance with the TICA (south-south cooperation), Thailand has expanded the framework for cooperation among developing countries, from neighboring countries to sub-regions and South Asia, the Middle East, Commonwealth countries, Africa, Latin America and the Caribbean.

Tables 5-2 and 5-3 show Thailand's increasing support to various countries, amounting to 380 million Baht (more than US\$11 million) in 2008 and mostly in the form of multilateral cooperation, covering basic infrastructure, training, and scholarship. It is noted that external support to Thailand has gradually decreased from about US\$113 million in 1997 to less than US\$50 million in 2007. Most of the support was in the form of expert secondment and grants.

In addition, various agencies in Thailand have cooperated with international organizations in the development of a climate change strategy. For instance, the Ministry of Science and Technology has participated in the APEC Center for Technology Foresight's Research on the Future of Low Carbon Society: Climate Change and Adaptation Strategy for Economies in APEC Beyond 2050. The project aims to develop a strategy for a low carbon society in the APEC region beyond 2050. This project has been endorsed by APEC's Industrial Science and Technology Working Group (ISTWG). Thailand has also contributed to the project through the FMIP of the Ministry of Foreign Affairs.

**Table 5-2** Thailand's support to international cooperation under TICA, 1997-2008 (thousand Baht)

Year	bilateral	AITC	TIPP	TCDC	Trilater	Fr.work	Total
1997	300,601	6,891.0	-	7,849.0	8,332.0	-	385,673.0
1998							
1999	105,569	11,204.0	-	3,295.0	2,991.0		123,059.0
2000	100,569	6,159.0	-	1,439.0	5,016.0		113,183.0
2001	94,544	13,435.0	-	1,793.0	3,264.0		113,036.0
2002	93,807	13,338.0	-	993.0	9,402.0		117,540.0
2003	139,591	19,677.0	19,356.0	313.0	13,168.0		192,105.0
2004	112,664	23,977.0	22,124.0	-	11,709.0		170,474.0
2005	140,212	34,762.0	17,810.0	-	16,224.0		209,008.0
2006	143,701	38,325.0	23,605.0	9,207.0	19,146.0	86,258.0	320,242.0
2007	191,017	59,015.0	24,859.0	11,934.0	26,909.0	11,573.0	325,307.0
2008	220,940	72,938.0	23,632.0	4,873.0	23,357.0	29,018.0	374,758.0

Source: Thailand International Development Cooperation Agency

**Table 5-3** International cooperation support to Thailand (thousand US\$)

	Experts	Mission	Volunteer	Fellow	Equipment	Grants	Others	Total
1997	46,301		4,731.7	79,308.0	19,783.2	15,362.1	117,220.4	112,796.5
1998	48,928		4,205.3	10,731.7	13,082.2	11,000.6	18,130.2	16,078.8
1999	50,703		1,988.6	19,772.8	7,876.3	15,259.8	23,911.0	119,511.8
2001	34,965	2,175.1	4,704.7	13,397.0	4,553.7	14,734.5	13,300.9	87,831.5
2002	27,927	1,305.9	4,233.4	10,575.3	8,405.3	10,822.5	9,063.6	72,333.2
2003	25,245.0	535.7	4,432.2	8,539.8	8,672.9	9,156.5	10,527.6	67,109.7
2004	22,288.6	703.7	4,447.3	6,102.0	5,119.4	11,491.3	5,796.9	55,949.2
2005	20,566.6	344.1	4,515.7	3,245.5	1,903.9	10,807.3	14,121.5	55,504.6
2006	17,780.5	274.8	4,436.1	2,441.3	1,886.2	11,124.1	15,620.6	53,563.6
2007	16,025.2	407.6	4,447.1	2,070.9	1,455.3	15,996.6	7,218.0	47,620.7

Source: Thailand International Development Cooperation Agency

The ASEAN Energy Action Plan (2010-2015) is another important step taken by ASEAN member countries following the concept of economic integration as the ASEAN Economic Community. Energy has been identified as a key indispensable factor in the region's sustainable economic development. There is a need to integrate economic development, energy needs, environmental protection and adaptation to global warming into ASEAN's regional development. The key energy plans being proposed are the establishment of the ASEAN Biomass Energy Center, energy source allocation for electricity grids, development of infrastructure for ASEAN transboundary energy trading system, and ASEAN CDM projects.

## Systematic Observation Network

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### Introduction

Research and systematic observation are contained in Article 5 of the Convention. The UNFCCC has included research and systematic observation network in its agenda since COP3. The Parties are encouraged to exchange their experiences concerning developments in their climate systems and to participate in research and development on the climate, atmospheric and oceanic observation systems.

The Global Climate Observation System (GCOS) is the key international organization responsible for the systematic observation network that supports the Convention. The UNFCCC has requested the Parties to support the implementation of the climate observation system network. Regional workshops have been organized to exchange views and information related to GCOS, as well as regional needs for the development of climate observation systems. The Parties have also been encouraged to communicate their national activities in this regard.

### Regional development of climate observation system

Since 2000, activities carried out in Asia through the research and systematic observation network were limited to exchanges of information and experiences among climate change experts on capacity building needs in the region<sup>4</sup>. Key issues concerning the region's systematic observation network have been identified.

The regional GCOS workshop called for regional coordination to support the global climate observation system and to harmonize global, regional and national needs. The need for national capacity development, a regional information centre and information exchange, and a communication system has been highlighted. A sense of ownership of information from the countries is important, in order to sustain participation. Hence, it is important to encourage the use of climate information at the national level, such as for climate change forecasting or warning system. The workshop's outcomes were reported to the UNFCCC, but no concrete actions were taken.

### Implementation in Thailand

Thailand's Meteorological Department has been actively engaged in WMO activities, especially in climate data collection and exchange with WMO countries in the region. The Department is the national focal point for GCOS.

Several public agencies and organizations are involved in monitoring and observing climate variables in Thailand. Among them are the Meteorological Department, Royal Irrigation Department, and Geographical Information and Space Development Authority. Their weather stations have been established to support their operations, some of which are consistent with standards required by GCOS and WMO. Following WMO standards, weather stations must be registered and regularly reviewed. Weather stations other than those of the Meteorological Department need to register with the Department, in order to receive its approval as a national grid for the WMO system.

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<sup>4</sup> Capacity Building for Observing Systems for Climate GCOS Regional workshop for East and Southeast Asia, Singapore, 16-18 September 2002.



**Table 5-5** Terrestrial observation network in Thailand

	GTN-P	GTN-G	FLUXNET	Other
Number of sites in Thailand	-	34	3	*
Number of sites are operating	-	34	3	-
Number in operation in 2005	-	34	3	-

**Note:** These are preliminary assessment from Enabling Activity II project.  
 \* Thailand has the most hydrological measuring stations in the ASEAN region

*Note* GTN-P : Global Terrestrial Network-Glaciers  
 GTN-G : Global Terrestrial Network-Permafrost  
 FLUXNET : Global Terrestrial Network-Carbon

the global air watch system has yet to be assessed. The same is true for the terrestrial system. Thailand has some observation stations to support permafrost and carbon observation. Parameters and data quality and sufficiency to support the global observation system need to be assessed. As Thailand has no ocean observation network, the development of such a network will enhance the country's capacity.

In summary, Thailand's national systematic observation network supports national needs and the global meteorological network. However, the system has yet to be streamlined with the GCOS planned system. Thailand urgently needs an ocean observation system to support marine and coastal disaster management. The global climate system recognized by the UNFCCC and GCOS is important for climate analysis at the global, regional, and national levels. Thailand strongly supports the UNFCCC process to enhance the systematic observation network and urges the Convention to implement the Asian action plan submitted sometime ago.

Reviewing past developments has called attention to the need for technical and financial support to enhance research and development of a systematic observation network in Thailand. The following needs have been identified.

- ❖ Network expansion to monitor climate factors in key areas
- ❖ Verification and standardization of climate data in the region
- ❖ Establishment of a communication system for data exchange
- ❖ Regular capacity enhancement with regards data development
- ❖ Training in atmospheric observation for meteorologists and weather volunteers
- ❖ Development of an ocean observation network

The following areas require international financial and technical support to enhance the global observation system.

- ❖ Development of a systematic operational plan for a systematic observation network
- ❖ Research and development and the application of climate data from a global systematic observation network
- ❖ Training and study tours in developed countries to look into short- and long-term climate change impacts
- ❖ Exchange of researchers and joint research in climate observation system

## Climate systematic observation system and disaster management

The tsunami disaster in December 2004 was Thailand's most devastating natural disaster. It prompted Thai authorities to review the situation and to develop more efficient disaster monitoring and mitigation systems. Had Thailand been better prepared for the occurrence of a tsunami, especially having an early warning and public awareness system, the resulting damage would have been much less.

Natural disasters, like the tsunami and climate change, have their specific characteristics. While the occurrence of a tsunami is unpredictable and rapid, its movement, scale and direction are traceable. Climate change is gradual, its magnitude and areas of impacts are wider and varied across sectors and regions. However, in dealing with natural disasters, there is one thing in common, that is, the need to be aware and to be prepared for their impacts. Preparing for a tsunami raises the need for a monitoring and early warning system. Preparing for climate change, however, covers more sectors and requires much more integrated approaches ranging from public awareness to adoption of adaptation technologies that are appropriate to local conditions and circumstances.

The tsunami experience triggered Thailand's comprehensive development of its disaster management system. Training in the use of meteorological information and disaster management was conducted for local communities. An early warning system and evacuation plan were introduced in risk-prone areas. Community emergency volunteers were formed and trained to deal with emergency situations when disasters occur. The Meteorological Department has developed the Climate Data Management System (CDMS) for weather forecasts to be disseminated to rural communities, including coastal and fishing communities in southern Thailand. Some 367 CDMS members participated in monitoring and verifying climate information and actual events to strengthen forecasting reliability<sup>5</sup>.

Thailand has also improved its disaster management institutions. Local communities play a greater role in building their resilience to disaster risks. The Department of Disaster Prevention and Mitigation, Thai Red Cross Society, and Department of Marine and Coastal Resources have worked together to strengthen local capacities to cope with natural risks. Community volunteers have been organized and trained. Warning systems have been established and demonstrated. A disaster volunteer network has been set up. To strengthen community resilience to respond to disasters, Thailand has introduced a pilot project to enhance the capacity of coastal communities to adapt to climate variability and extreme events<sup>6</sup>.

The integration of disaster risk management and vulnerability to climate change and climate variation and extreme events at the community level is an important step towards developing the capacity of local communities to integrate climate change into the community development process. Going by lessons learned from the tsunami disaster and disaster management experiences in coastal areas, integrating climate risk into the community development process is a sure way to strengthen community resilience to environmental risks.

Thailand's revised public administration system also builds the resilience capacity building process. Local governments are now responsible for preparing economic, social and environmental development plans at the provincial level. Hence, local governments have the flexibility to select appropriate development paths for their respective provinces, as long as they are consistent with overall national policies and plans. It is hoped that the pilot project will provide a good experience in integrating climate change and the disaster management system into the planning process for local development.

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<sup>5</sup> Office of Monitoring and Warning of Weather, Meteorological Department

<sup>6</sup> Strengthening the Capacity of Vulnerable Coastal Communities to Address the Risk of Climate Change and Extreme Weather Events is a 3-year project under the Special Climate Change Fund. Three coastal provinces are selected as research sites. Project key implementers are Thai Red Cross Society, Department of Disaster Prevention and Mitigation and Sustainable Development Foundation. The project is expected to start by the end of 2010.

# Education, Training and Public Awareness

## ✿ Introduction

Addressing global warming requires collective and cooperative actions from all parties at all levels. Article 6 of the UNFCCC and Article 10(e) of the Kyoto Protocol require all parties to promote and facilitate, at the national, sub-regional and regional levels, the development and implementation of educational and public awareness programs, public access to information, and training for scientific, technical and managerial personnel with regards climate change and its effects.

According to an assessment of the implementation, the pace of progress varies in different regions. Promotion and facilitation are still needed to enhance capacity building and exchanges in climate change-related experiences. International cooperation, particularly towards building development partnerships at different levels, is important to enhance the implementation of Article 6 of the Convention and Article 10(e) of the Kyoto Protocol.

## ✿ Implementation in Thailand

Prior to ratification of the Convention, Thailand has been promoting education, training and public awareness concerning climate change. During the early period, only scientists and researchers had good knowledge of climate change. Climate change was taught merely as part of a subject offered in selected courses or as part of a university course. Thailand has since expanded the teaching of climate change and has prepared an action plan in response to Article 6 of the Convention<sup>7</sup>.

**Implementation at the regional level** The main activity in the implementation of Article 6 at the regional level is the exchange of information and experiences on climate change through education, training, and public awareness. Thailand participated in the Asian workshop on Article 6, which was organized in Japan<sup>8</sup>. The workshop was a platform to discuss and exchange views on issues related to the implementation of the New Delhi work program on Article 6 of the Convention. It was agreed that there were various challenges to the success of the work program. The key constraints were the promotion of participation among stakeholders through wide dissemination of information, enhancement of the participation among non-profit organizations, and development of incentives to encourage all parties to participate.

Cooperation concerning climate change is carried out in the Asian region. Some examples are the Asia-Pacific Network on Climate Change or the ASEAN cooperation on climate change. The region, however, has no specific cooperation program in response to Article 6. It is possible for ASEAN to expand its climate change forum to exchange information and experiences on issues related to education, training and public awareness on climate change.

Thailand has conducted training in climate change in the Asian region, as well as training in climate models and inventory for experts from other countries in the region. The Department of Environmental Quality Promotion has organized training workshops dealing with climate change for developing countries in Asia.

**Implementation at the national level** Enhancing knowledge through formal and informal education at all levels is a top priority of the Thai Government. Environmental education for the youths builds an important foundation for their ability to learn more complex environmental issues, especially those related to transboundary natural resources and the environment.

Thailand has made use of the basic education curriculum for 2001 as a framework or direction for the preparation of curricula for basic education, informal education management, and special/professional training. Curriculum development is based on specific core courses required by the Ministry of Education and educational institutes. The curriculum allows schools to organize integrated educational activities that respond to community needs and local development conditions.

<sup>7</sup> Ministry of Natural Resources and Environment, National Communication Project: A preparation study in responding to Article 6 of the UNFCCC, August, 2003

<sup>8</sup> Asia-Pacific regional workshop on article 6 of the Convention, 13-15 September 2005, Yokohama, Japan

In basic education, the curricula related to climate change are those for science, social studies, religion and culture, and health and physical education. The others are for specific areas of learning and are not directly related to climate change<sup>9</sup>.

Public campaigns play an important role in raising public awareness of climate change. The main objectives of these activities are to improve the understanding of climate change in the private and public sectors, to enhance their participation in implementing activities related to climate change, and to promote public acknowledgement and acceptance of policies on climate change. The youth is an important target group of public campaigns.

Access to information depends largely on information dissemination methods and information access system. Thailand has reviewed and improved its environmental information dissemination and public communication using climate change as a pilot case<sup>10</sup>. Among the key mechanisms that greatly influence effective communication among responsible agencies as well as stakeholders are public interactive discussion fora. Under the institutional structure for handling climate change, a public communication sub-committee was established to enhance public participation in addressing these issues.

### a) Education and Training

Climate change knowledge and experiences, during the first decade of Thailand's ratification of the UNFCCC, had been concentrated among academic and research institutes. Growing knowledge of the science of climate and sea level rise and awareness of these issues at the international level have gradually increased information flow and public awareness at the national level.

In general, the public education system provides general knowledge of sustainable development and different environmental perspectives. Training in climate change is often concentrated among researchers and public personnel. Public awareness of climate change relies mostly on the public sector, although increasingly other public organizations have played roles in raising public awareness of the environment in recent years.

Since 2000, Thailand has followed the New Delhi work program on Article 6 and implemented education, training and public awareness activities concerning climate change. An action framework for climate change education, training and public awareness has been prepared. Supplementary reading materials on climate change and Thailand's implementation of pertinent activities have been developed for students.

On climate change education, Thailand approaches the issue by enhancing knowledge through formal and informal education. The gradual expansion of climate change-related subjects has been observed in curricula or courses in general environmental studies in primary and secondary schools and in more specific fields in universities and colleges<sup>11</sup>. However, climate change education has yet to be developed as a specific study area/program. So far, informal education in Thailand has played a limited role in climate change education. Likewise, climate change campaigns among the youth have not been sufficient<sup>12</sup>.

Public awareness of climate change has changed greatly since the release of various key studies on climate change, particularly the AR4 of IPCC and the Stern Report, as well as the holding of events, such as the Nobel Prize awards. Partly due to the effects of international fora and media coverage and partly due to the participation of countries in global events, public awareness of climate change has increased dramatically. Information dissemination, public workshops and training have been organized by various public agencies and NGOs, as well as by international organizations. Information dissemination has benefited from the use of new information technologies, particularly the Internet. The continuous growth of climate change-related homepages and web pages in schools and private institutions has been dramatic.

<sup>9</sup> Ministry of Natural Resources and Environment, National Communication Project: A preparation study in responding to Article 6 of the UNFCCC, August, 2003

<sup>10</sup> This is part of the Strengthening Thailand's responsiveness on international environmental cooperation project, a UNDP supported project of Ministry of Natural Resources and Environment

<sup>11</sup> For instance courses offered at undergraduate and graduate levels are Introduction to climate change economics, Global warming: geographical perspectives or Biodiversity and climate change, Meteorology, satellite and global climate change, Changes in climate and ecosystem or Climate, energy and food security in Asia and the Pacific

<sup>12</sup> Ministry of Natural Resources and Environment, National communication project: preparation study for implementation of article 6 of the UNFCCC, 2004

Revision of the educational system following the educational reform has contributed to climate change education in Thailand. The new system allows schools to develop curricula and activities that are suitable to local or community conditions, characteristics and environment, and can be adapted to circumstances. Over the past few years, students have made use of the Internet to participate in climate change activities.

Training has been conducted under two broad categories. The first is specific technical training, such as inventory, mitigation and vulnerability and adaptation analysis, and the second is general knowledge concerning the characteristics and consequences of climate change. Besides training in inventory estimation, Thailand has not conducted other national level technical training in climate change. Nevertheless, a large part of capacity building has been implicitly incorporated in various national climate change seminars and workshops. Thai researchers and technicians have also participated regularly in climate change-related training organized for the public sector, NGOs or intergovernmental agencies at the regional or international levels over the past few years<sup>13</sup>.

## **b) Public awareness**

Public awareness is a process aimed at enhancing operational efficiency to meet environmental targets. Strong public awareness will reinforce social incentives to promote public participation in environmental management. In general, agencies under the Ministry of Natural Resources and Environment conduct public awareness activities concerning natural resource conservation and environmental protection. The main agency responsible for public awareness is the Department of Environmental Quality Promotion (DEQP). As mandated, DEQP promotes public awareness of climate change. Other agencies, including NGOs, and the private sector also play important roles in promoting public awareness of natural resource conservation and environmental protection, including climate change.

Over the past few years, climate change and global warming have been commonly referred to in public campaigns for environmental protection, covering waste reduction, energy saving, reforestation, the sufficiency economy philosophy, and so on. Similarly, private companies have made use of global warming campaigns in their sales and marketing strategies. Among these are campaigns for the use of non-plastic bags, dissemination of global warming leaflets, a variety of promotional activities, and so on. Various conferences and workshops have highlighted climate change and global warming on their agendas. Thailand has also participated in international environmental campaigns, such as the “one-hour power off to reduce global warming” campaign.

In addition to regular campaigns to promote awareness of global warming and climate change, Thailand has also encouraged public awareness through the sale and consumption of goods and services. For example, carbon labels have been placed on a number of products. Carbon footprint has been introduced by major manufacturers to develop a carbon auditing system. These voluntary activities are social instruments to enhance greenhouse gas mitigation as well as to raise public awareness through the market system.

In summary, Thailand has implemented education, training and public awareness activities following ratification of the UNFCCC. Climate change education has been expanded in and out of classrooms and at different levels. At present, students make use of modern information/communication systems, especially the Internet, to exchange information and promote public awareness.

As for training, Thailand has organized technical training in inventory and mitigation, with a special focus on CDM. However, vulnerability and adaptation have not yet been the focus of training.

The sub-committee on public communication will play a key role in developing and enhancing the efficiency of a public participation mechanism in education, training and awareness, in response to Article 6 of the UNFCCC.

<sup>13</sup> For instance, a seminar on climate change organized for BMA officials; conferences on climate change strategic plan in 4 regions, climate change seminar on World Environment Day, Green school project (Thailand Research Institute); Local energy conservation project (WWF); Exchange of view meeting on climate change under the strengthening Thailand's International Environmental Cooperation; Workshop on exchange of view under the SNC project.

# Capacity Building

## ✿ Introduction

Capacity building is one of the main items in the UNFCCC agenda. Capacity building encompasses all activities under the Convention. Due to the different capacities of the Parties, cooperation to enhance national capacities, particularly in the case of developing and least developed countries, to deal with climate change effectively is an issue in all negotiation agendas, particularly as they concern mitigation, vulnerability and adaptation, technology development and transfer, national communication, research, and systematic observation network. The capacity building obligation is described in Article 9 of the Convention and Article 10(e) of the Kyoto Protocol.

In practice, capacity building is embedded in the implementation of different aspects of climate change. In COP7, the Marrakesh Accords adopted a Framework for Capacity Building in Developing Countries. The main components are, as follows:

- ✿ Capacity building in national communication covering all aspects
- ✿ Capacity building covering activities under the Kyoto Protocol
- ✿ Information exchange and cooperation
- ✿ Support to least developed countries
- ✿ Call for financial and technical support from developed countries
- ✿ Call for support to relevant implementing agencies by all parties, particularly the public and private sectors in developed countries

The last review at COP10 concluded that implementation of the framework has progressed, but there is still room for improvement<sup>14</sup>, including sourcing for financial support.

## ✿ Implementation at the regional level

Other than those activities implemented in Asia under the Convention, there has been limited capacity building activities carried out at the regional level<sup>15</sup>. Most capacity building activities are part of, if not embedded, in other climate change activities, such as those under the Asia-Pacific Network for Global Change Research (APN) or the National Communication Support Program (NCSP)<sup>16</sup> of UNDP/UNEP.

Several capacity building activities in the region under the Kyoto Protocol are related to CDM. Developed countries have supported workshops, including training in the implementation of the mechanism. It is noted that capacity building under the Kyoto Protocol concentrated only on mitigation.

Capacity building has also been addressed through cooperative research and development concerning climate change. The AIACC (Assessment of Impacts and Adaptations to Climate Change in Multiple Regions and Sectors) and the Asia-Pacific Network are two examples of such cooperation in the region.

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<sup>14</sup> Among them are: Give priorities to capacity building for institution and its basic infrastructure

- ✿ Increase climate change awareness at all level and participation of public agencies in capacity building
- ✿ Develop and promote exchange in knowledge, experiences and information
- ✿ Increase financial and technical resources for the supports
- ✿ Use learning-by-doing approach at national and local level

<sup>15</sup> The US Country Studies program is a good example of capacity building activity, although it is not originated in the region.

<sup>16</sup> <http://www.apn.gr.jp/en/indexe.html>; NCSP organized capacity building activities for national communication preparation such as energy modeling, GHG mitigation and vulnerability and adaptation analysis

## ❁ Implementation at the national level

Enhancing national capacity for climate change has mostly focused on training national focal point personnel. This is mainly due to frequent reshuffling of staff responsible for climate change, since 2001. As negotiation and implementation of the UNFCCC are underway, personnel in charge of climate change need to follow-up and to learn more about the process before they can effectively participate in the negotiation process. The establishment of the Thailand Greenhouse Gas Organization to oversee the CDM further splits human resources trained in climate change in Thailand. The reshuffling of personnel has interrupted the process and has resulted in repeated capacity building exercises for human resources dealing with climate change.

Nevertheless, it can be said that the organizational structure handling climate change in Thailand has been firmly established. The office has implemented various climate change activities. It has also closely coordinated with climate change-related agencies to enhance their capacity building. Capacity building covers basic and technical knowledge of climate change mitigation and impacts and vulnerability. A series of workshops have been organized to discuss issues in the negotiation process. Technical cooperation among research institutes, research funding sources, and the national focal point has also been carried out to ensure that the common interest is attained.

Thailand recognizes the importance of capacity enhancement for all relevant personnel and agencies, as indicated in the fifth strategy of the National Strategy on Climate Change. Two key capacity building components are the following.

- ❁ Support personnel to receive technical training and know-how to carry out climate change duties and responsibilities effectively
- ❁ Develop mechanisms to transfer knowledge and to exchange experiences in intra- and inter-agency climate change planning and operations

As main activities and measures to carry out the above components, a network of specialists and related personnel, researchers and technicians will be developed; knowledge will be exchanged and technical development promoted among related personnel; guidelines and other documents will be developed; and a system to facilitate knowledge transfer and to ensure regular monitoring and evaluation of plans will be established.

Certain capacity building activities will be assigned to national personnel responsible for implementing domestic or international cooperation. Among these are the following.

- ❁ Projects under the National Strategy on Climate Change (2008-2012)<sup>17</sup>
- ❁ Thailand Research Fund support for research projects on greenhouse gas inventory, mitigation and adaptation to climate change
- ❁ Climate Change Knowledge Management Center under the Ministry of Science and Technology, serving as the center to collect, synthesize and promote climate change knowledge, particularly concerning adaptation
- ❁ Regional Climate Change Adaptation Knowledge Platform for Asia
- ❁ Cooperation with GTZ in climate change capacity enhancement in Thailand
- ❁ Organization and personnel potential development plan under the Global Warming Mitigation Plan of the Ministry of Agriculture and Cooperatives
- ❁ Projects under the National Environmental Health Strategy (2009-2011)
- ❁ Strategies to remedy energy problems

## Information and Networking

Information and networking are key mechanisms that link various components related to the national communication process and other activities related to climate change. In this regard, the UNFCCC has requested the Parties to share with the public their activities concerning climate change, as well as to develop an information network at the national and regional levels.

<sup>17</sup> <http://climate.onep.go.th/>

## Implementation at the regional level

There has not been any information networking on climate change under the UNFCCC at the regional level in Asia, except for the pilot phase of the information network on technology and education, training, and public awareness. However, there are other sources of climate change information in the region, such as databases on emission factors and climate change research studies<sup>18</sup>.

## Implementation at the national level

As the national focal point, the Office of Natural Resource and Environmental Policy and Planning is the core agency responsible for climate change activities in Thailand. Because global warming and climate change relate to nearly all sectors of the economy, the national focal point plays an important role as coordinating body for climate change activities, including information and networking. Many public agencies and other bodies disseminate information through the Internet. Below are some examples.

Agency	Website
Office of Natural Resource and Environmental Policy and Planning	<a href="http://www.onep.go.th/CDM/cmc.html">http://www.onep.go.th/CDM/cmc.html</a>
Department of Environmental Quality Promotion	<a href="http://www.deqp.go.th/main/">http://www.deqp.go.th/main/</a>
Thailand Environment Institute	<a href="http://www.environnet.in.th/">http://www.environnet.in.th/</a> , <a href="http://www.thai-sbc.org/Default.asp">http://www.thai-sbc.org/Default.asp</a>
Meteorological Department (Climatorological Center)	<a href="http://www.tmd.go.th">http://www.tmd.go.th</a>
Green Peace Southeast Asia	<a href="http://www.tmd.go.th/NCCT/climate_change.php">http://www.tmd.go.th/NCCT/climate_change.php</a>
Thailand Research Fund	<a href="http://www.greenpeace.org/seasia/th/campaigns/climate-and-energy">http://www.greenpeace.org/seasia/th/campaigns/climate-and-energy</a>
Thailand Research Fund	<a href="http://www.measwatch.org/">http://www.measwatch.org/</a>

In the past few years, climate change has been widely publicized in all countries. In Thailand, seminars and workshops have been held to exchange knowledge and to disseminate information on climate change. The Internet has also come into popular use as a means to transfer information to the public and to network among researchers.

A climate change information network has been developed. The Office of Natural Resource and Environmental Policy and Planning (ONEP) has been established. Its information portal (<http://www.onep.go.th/portal/>) supports the development of a climate change information database, including information concerning activities and projects of agencies under the National Strategy for Climate Change.

Networking on climate change has not been well developed. Most networks are related to research activities and are informal, as for example, networking among climate change researchers working in projects under the Thailand Research Fund or among technical experts under different climate change committees. However, notable improvements in networking have been observed recently. The Environmental Research and Training Center initiated a network called Thailand Climate Change Network (<http://www.ertc.deqp.go.th/ertc/000000.jpg>). With strong support from NGOs, networks among schools to enhance their participation in climate change have been developed. Another example is the establishment of a public information network on energy and the environment in Thailand by the Office of Energy Policy and Planning ([http://www.eppo.go.th/encon/teenet/index\\_Thai.html](http://www.eppo.go.th/encon/teenet/index_Thai.html)).

<sup>18</sup> See <http://www.ipcc-nggip.iges.or.jp/EFDB/main.php>; <http://www.apn-gcr.org/en/link/gcresearchdata.html>; <http://www.ap-net.org/>; <http://climate.start.or.th/>.



6

## Problems, Constraints and Needs

# 6

## Problems, Constraints and Needs



### Introduction

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Over the past decade, Thailand, as a developing country, has fully and actively participated in addressing climate change to fulfill its obligations. Economic difficulties and political instability during that period required policies and measures, which, if sufficiently supported by technical and financial resources, could have turned the crises into opportunities to harmonize economic and social development through the use of cleaner technologies. Nevertheless, Thailand has demonstrated its commitment and has fully mobilized national resources to combat climate change. Accumulated experiences in different areas of climate change, as summarized in the previous chapters, indicate Thailand's need for technical know-how and technologies in different areas of climate change, to enable it to effectively address climate change. These needs are in broad areas and fall under different categories and may require more detailed and systematic assessment, especially in the case of climate-friendly technologies. Below are some areas where technical and financial support is needed.

### Greenhouse Gas Inventory

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Thailand's greenhouse gas inventory (1994, 2000) followed the UNFCCC guidelines as well as the IPCC technical guidelines and handbooks and other supplementary materials. Experiences gained while working on the inventories have developed a

learning curve for Thailand, leading to its recognition of areas that need further technical support to improve inventory activities. Below are Thailand's priority needs concerning the greenhouse gas inventory.

- ❖ Develop local emission factors in major sectors and those sectors that are important to economic development. The priority sectors are agriculture and forestry.

- ❖ Develop appropriate activity data to support the estimation of greenhouse gas inventory. The priority sectors are energy, agriculture, forestry and waste management.

- ❖ Develop estimation method for key sectors to higher tier. These are the energy, agriculture, and forestry sectors.

- ❖ Train relevant officials and agencies to carry out the estimation regularly.

- ❖ Develop technical personnel in specific areas to develop appropriate estimation methodologies or techniques for Thailand.

- ❖ Develop techniques in greenhouse gas emission forecast.

## Impact, Vulnerability and Adaptation

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Studies on impact, vulnerability and adaptation to climate change and climate vulnerability and extreme events have evolved rapidly. Nevertheless, research has so far not been able to reach policy making level in a meaningful way. There are various constraints, problems, and gaps that need to adequately addressed, as described below.

### ❖ Climate Change

Problems in and constraints to research and development on climate change can be described as follows: (1) uncertainties of climate scenarios from GCMs. Despite recently refined regional models, some models remain problematic in assessing uncertainties in climate scenarios. High uncertainties are difficult to work with and to bring about meaningful policy development; (2) lack of comparable socio-economic scenarios; (3) lack of new impact assessment techniques in different sectors, e.g. annual and perennial crops, water resources and public health; (4) new and innovative approaches to adaptation analysis; and (5) integration of climate change factors into the development process.

The need for support is seen in the following.

- ❖ Development of more climate change scenarios at the sub-regional level to address uncertainties

- ❖ Development of techniques for preparing socio-economic scenarios that are consistent with climate change for use in the vulnerability analysis

- ❖ Development of advanced techniques to analyze impacts on major sectors, especially annual and perennial crops, water resources and public health

- ❖ Development of techniques to prioritize adaptation options within and across different sectors

- ❖ Development of public health warning systems in areas prone to the spread of diseases caused by climate change

Thailand needs to enhance the capacity of a large number of researchers, especially in applying new techniques to assess the vulnerability of cash crops and water resources. At present, international support to developing countries, including Thailand, has been very limited.

### ❖ Climate variability and extreme events

In Thailand, research on vulnerability and adaptation to climate variability and extreme events is in its early stage. The main problems and constraints are associated with the following: (1) research techniques to prioritize key sectors and analyze best alternatives for adaptation; (2) integration of adaptation options into the socio-economic development of risk-prone communities; and (3) technology options for villages in disaster-prone areas.

The need for support is seen in the following.

- ❖ Analytical techniques to prioritize selected adaptation options across different sectors and issues, and to meaningfully convey the message at policy making levels
- ❖ Technologies for warning systems for disaster-prone areas
- ❖ Technologies to cope with coastal erosions, and are appropriate for local conditions
- ❖ Technologies for agricultural climate forecast and warning system
- ❖ Technologies to develop plant species that are resistant to climate variation
- ❖ Public health and disease prevention management system in disaster-prone or climate change-risk areas

In addition to prioritization and integration into local development, financial support, insurance, and technology transfer are also highly important. As stated in Articles 4.8 and 4.9 of the Convention, capacity development to analyze the impacts and assistance needed from Annex I Parties is vital to the capacity of Non-annex I Parties, including Thailand, to meet their obligations.

## Greenhouse Gas Mitigation

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Thailand has adopted strategies to conserve energy and to use renewable energy, with a view to achieving ambitious targets. To meet such targets, advanced and economically sound technologies are vital. Under the existing market system, many technologies that contribute to greenhouse gas mitigation, such as solar and wind technologies, are technically possible but are not economically viable. Improving their economic viability is critical for Thailand, in order to effectively mitigate GHGs and to fulfill its commitments to the Convention. Obligations to support and facilitate technology transfer in the public sector of Annex I countries, as stated in Article 4.5 of the Convention, are key to the mitigation capacity of Thailand. Techniques, know-how and technologies to mitigate GHGs are needed, as follows:

- ❖ Analytical techniques to prioritize mitigation options for energy conservation and renewable energy
- ❖ Advanced technologies for energy conservation for electricity production and consumption
- ❖ Efficient technologies and systems for traffic and mass transport, especially for logistics
- ❖ Technologies for biomass and biogas energy production appropriate for local conditions
- ❖ Environment-friendly technologies for cement production
- ❖ Development of knowledge and infrastructure for innovation of clean technologies
- ❖ Technologies to mitigate GHG from rice paddy fields

## Others

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There are other areas concerning climate change that require international support, in order to enhance the national capacity. These are the following.

- ❖ Research in systematic observation of climate variables to support GCOS, particularly ocean observation in Asia and the Pacific
- ❖ Enhancement of climate observation stations and networks
- ❖ Development of regional information exchange and communication
- ❖ Capacity building for short- and medium-term weather forecasts
- ❖ Capacity enhancement of meteorologists
- ❖ Development of a center of excellence for Asia and the Pacific
- ❖ Capacity building for negotiators of the UNFCCC and the Kyoto Protocol

# Acronyms and Abbreviation

AIACC	Assessments of Impact and Adaptation to Climate Change	KP	Kyoto Protocol
APEC	Asia-Pacific Economic Cooperation	LULUCF	Land Use, Land Use Change and Forestry
APN	Asia-Pacific Network for Global Change Research	N <sub>2</sub> O	Nitrous Oxide
ASEAN	Association of Southeast Asian Nations	NAPA	National Adaptation Plan of Action
CBDRM	Community Based Disaster Resilience Management Program	NFP	National focal point
CCAM	Conformal-Cubic Atmospheric model	NGOs	Non-governmental Organizations
CDM	Clean Development Mechanism	NMVOCs	Non-methane Volatile Organic Compounds
CH <sub>4</sub>	Methane	NO <sub>x</sub>	Nitrogen Oxide
CO	Carbon Monoxide	NWP	Nairobi Work Program
CO <sub>2</sub>	Carbon Dioxide	ONEP	Office of Natural Resources and Environmental Policy and Planning
COP	Conference of the Parties	PRECIS	Providing Regional Climate Indicator System
DIVA	Dynamic Interactive Vulnerability Assessment	REDD	Reducing Emission from Deforestation and Forest Degradation
DNA	Designated National Authority	RegCM3	Regional Climate Model 3
EAI	Enabling Activities II	SARS	Severe Acute Respiratory Syndrome
GCMs	General Circulation Models	SCCF	Special Climate Change Fund
GCOS	Global Climate Observation System	SNC	Second National Communication
GDP	Gross Domestic Product	TICA	Thailand International Development Cooperation Agency
GEF	Global Environment Facility	UNFCCC	United Nations Framework Convention on Climate Change
GFDL	Geophysical Fluid Dynamics Laboratory	V&A	Vulnerability and Adaptation
GHGs	Greenhouse Gases	VIC	Variable Infiltration Capacity
GWP	Global Warming Potential	WMO	World Meteorological Organization
INC	Initial National Communication		
IPCC	Inter-governmental Panel on Climate Change		



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