CRISIS OR OPPORTUNITY:

Climate Change and Thailand

GREENPEACE

CONTENTS

Executive Summary

Climate change, global warming and the greenhouse effect refer to the same global environmental problem. It will have significant impacts on every nation on the planet. Increasing climate-related catastrophes such as drought, floods, storm surges, heat waves and wild fires were frequently experienced by many countries during the past few decades. These events may be largely attributed to climate change and could possibly lead to irreversible changes in the Earth's ecosystems. It is thus important to understand several aspects of climate change in order to minimize its causes and effects and cope with its impacts. Sustainable development and a self-sufficient economy can be achieved. This report gathers the information from the Intergovernmental Panel on Climate Change (IPCC) assessment together with studies conducted in Thailand in order to enhance the understanding and awareness of climate change impacts of which is not as high among the local people.

CAUSES OF CLIMATE CHANGE

Increasing greenhouse gases in the atmosphere is the main cause of climate change. Greenhouse gases include carbon dioxide, methane and nitrous oxide. The combustion of fossil fuels along with deforestation emit massive amounts of carbon dioxide into the atmosphere. Rice cultivation, live stock production and waste treatment release methane. Using nitrogen fertilizer emits nitrous oxide. In addition, few hydrocarbons that substitute ozone depleting substances such as CFC are also potent greenhouse gases. These gases absorb solar heat energy and cause the warming of the atmosphere and the Earth's surface. It is estimated that greenhouse gases will be double its present concentration by the end of this century.

CLIMATE CHANGE SCENARIOS

The Intergovernmental Panel on Climate Change (IPCC) assessment reveals that mean global temperatures will increase about 1.4 - 5.8 °C and that sea level would rise by 0.09-0.88 meters by the end of this century. The higher magnitude of change reflects the result of business-as-usual policies concerning intensive use of fossil fuels along with the lack of concerted global cooperation.

Few General Circulation Models (GCM) have shown that the average temperature in Thailand may increase from 21.5-27.5 to 25-32 °C, while the amount of rain fall changes spatially. A single Regional Climate Model was used to construct climate change scenarios of the Mekong river basin, which includes Thailand and neighboring countries.

EVIDENCES OF CLIMATE CHANGE

Instrumental records show that the global mean surface temperature has increased by 0.6 °C during the past century. Thinner mountainous glaciers and the breaking of polar sea-ice have been observed. In addition, poleward shifts and upward shift in the elevation of plants, insects, birds and fish have been observed. Earlier plant flowering, bird migration, breeding season changes and the emergence of insects has occurred in the Northern Hemisphere.

IMPACT OF CLIMATE CHANGE

The IPCC has stated clearly that developing countries will be affected hardest by climate change. Climate change will have tremendous impacts on natural resources and the environment by which development depends upon. The IPCC reveals that climate related catastrophes during the past four decades (1950-1992) have increased about five fold from the first to the last decade, and damages to economies increased 10 fold during the same period. These changes include:

Water resources:

Thailand has twenty five watersheds which store and supply water for domestic, agricultural and industrial use as well as for regeneration of wildlife in natural ecosystems. Changes in rainfall patterns and the frequency and intensity of rainfall due to climate change can affect the quantity and quality of water resources from the watershed areas down to the estuaries. Prolonged droughts and intense floods have frequently occurred, damaging vast tracts of agriculture areas and the commercial sector. During the period 1991-2000, damage to agricultural areas caused by drought, floods and storms cost up to fifty billion Thai Baht. During 2004-2005, the industrial estates of the eastern seaboard experienced severe shortage of water due to unprecedented prolonged drought.

Food Security

Thailand exports food to the world market. The country is the top global rice exporter. Rice is not only a main product of Thailand but is also central to the culture of the Thai people. Rain-fed agriculture is a common practice among the rural Thai. Floods, heat waves and shortage of water as a result of climate change greatly diminishes agricultural production, which consequently affects social practices and economic well-being of the majority of the people.

Coastal areas, oceans and fisheries

Thailand's coastline is about 2,600 kilometers, which is economically important in terms of commerce, recreation and tourism. More importantly, it provides habitats for numerous coastal flora and marine fauna that live in mangrove and other coastal ecosystems. Coastal areas are presently under threat due to severe erosion and sea-water encroachment in several areas. Sea-

Evidence of climate change is becoming more and more clear. Millions of human lives and the economic development of developing countries such as Thailand are increasingly threatened by climate-related catastrophes, heat waves, more intense droughts, floods and storm surges. These are only the warning signals of Mother Nature as she responds to human interference with climatic systems.

level rise may cause the extinction of coastal species and ecosystems that are unable to shift upland due to human infrastructures. In addition, more intense storm surges may damage commercial and recreational areas. Ocean currents and the chemical composition of sea water are also expected to change and affect marine ecosystems and fisheries. Coral bleaching world wide including Thailand is largely related to the warming of sea water.

Forest and biodiversity

It is expected that climate change may cause irreversible changes among ecosystems along with the extinction of many species. Thai forests consist of tropical rain forests and deciduous forests. The latter are under the influence of wet and dry cycles of a monsoon climate. The areas are habitats of numerous diverse species. Preliminary Thai studies on spatial distribution of forest ecosystems under climate change, based on one GCM, show that about thirty-two national parks and wild life sanctuaries are at risk due to climate change. Forests in these areas may change from one type to another and can consequently create changes in species composition.

Health

Increased average temperatures, precipitation patterns, storms, floods, droughts and more hot days and heat waves have direct and indirect impacts on health. These involve, for example, heat stress, contagious diseases due to lack of clean water, poor hygiene during and after the catastrophes, which increase the spread of cases of food and water-borne diseases. Moreover, changes in habitats of insects and pests, which carry diseases such as mosquitoes, increase the risk of outbreaks of malaria and dengue fever. In urban areas, higher temperatures due to global warming may impose additional impacts on the health of city dwellers who are already exposed to air pollution.

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Time to take Action

Evidence of climate change is becoming more and more clear. Millions of human lives and the economic development of developing countries such as Thailand are increasingly threatened by climate-related catastrophes, heat waves, more intense droughts, floods and storm surges. These are only the warning signals of Mother Nature as she responds to human interference with climatic systems. Because of the complexity of the climate system and the size of the consequent impacts, the action required to solve the problem needs the continuous cooperation of all sectors, especially among developing countries which lag far behind in knowledge, technology and the adaptation capabilities of their institutions. The context of climate change is less known in Thailand. It is necessary to increase the information available to the public regarding the impacts of climate change. Action that can and should be taken for adaptation and mitigation of climate change cannot be delayed.

It is strategic for Thailand to prepare for adaptation and to undertake mitigation measures that work hand in hand with the country's development goals. Developing countries are more vulnerable to changing climates.

Adaptation requires long term studies of climate change impacts on natural resources such as water, forests, biodiversity coastal areas, health as well as food production and socioeconomic activities. It is a win-win strategy. **Action taken to reduce the cause of climate change benefits the world. Reducing greenhouse gas emissions must prioritize mitigation measures in the energy sector, which includes less dependence on fossil fuels and moving increasingly towards renewable energy alternatives as well as more efficient energy utilization.**

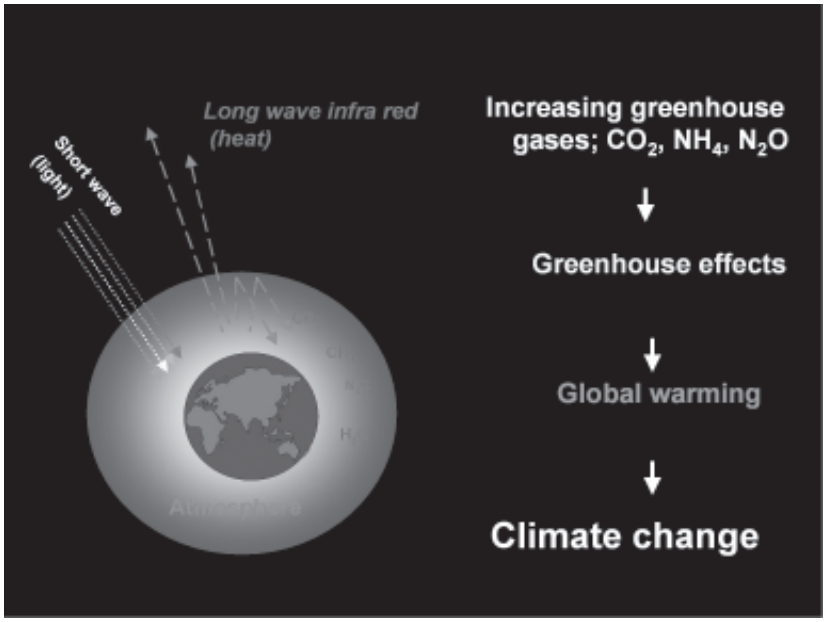

Figure 1.

Greenhouse effect

1 INTRODUCTION

1.1 Climate Change, Global warming and the Greenhouse effect

Climate change, also known as global warming and the greenhouse effect, is caused by man-made or anthropogenic emissions of greenhouse gases. Increasing greenhouse gases in the atmosphere leads to an increase in the mean global temperature with consequent changes in weather patterns and climate elements such as precipitation, and wind circulation, atmospheric pressure and ocean circulation.

1.2 Greenhouse gases, Climate Change and its impacts

Greenhouses gases include carbon dioxide, methane and nitrous oxide. They are naturally occurring in the atmosphere in small quantities, absorbing and preventing heat energy from radiating out. They keep the Earth warm and habitable. The burning of fossil fuels and deforestation releases massive amounts of carbon dioxide, the main greenhouse gas. Rice cultivation and livestock production release methane and the intensive use of nitrogen fertilizer causes increasing nitrous oxide levels in the atmosphere. Consequently, more heat is trapped which causes the warming of the world.

It is estimated that the concentration of greenhouse gases will be double from its present concentration by the end of this century (Figure 2). The Earth's atmosphere never reached this amount during the past 400,000 years (Figure 3) (IPCC 2001).

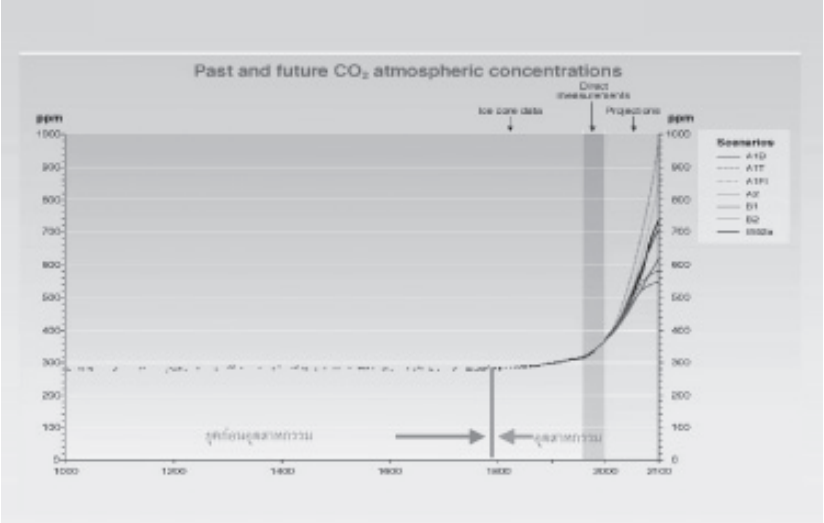

Figure 2.

Increasing concentration of green house gases in the atmosphere (from IPCC 2001)

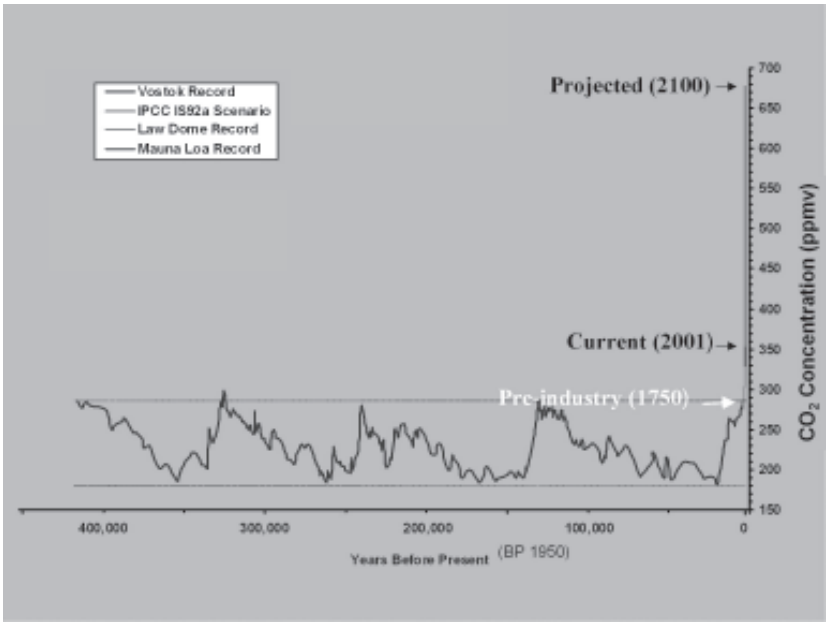

Figure 3.

Atmospheric green house gas concentration from past to present and future scenario (IPCC 2001)

EXPECTED IMPACTS FROM PROJECTED CHANGES IN EXTREME CLIMATE EVENTS RELATED TO CLIMATE CHANGE (IPCC, 2001)

Projected changes during 21st century	Examples of impact
More hot days & heat waves	Increasing * Serious illness and death * Heat stress in livestock & wildlife * Crop damages
More intense precipitation events	Increasing * Flood, landslide, mudslide damage * Soil erosion * Disaster relief
Increased tropical cyclones	Increasing: * Risk to human life * Infectious disease epidemics * Damage to coastal ecosystems
Intensified droughts and floods associated with El Ninio events	Decreasing: * Agriculture and range productivity * Hydro-power potential
Increased Asian summer monsoon precipitation variability	* Increased flood and drought magnitude and damages in Asia & temperate lands

From IPCC 2001

1.3 Purpose of Report

This report aims to present the causes and effects of climate change in a simple way by gathering information from IPCC Third Assessment Report (IPCC, 2001) and incorporating this with available local studies. The enhancement of the understanding of Thais and people in the Southeast Asian region regarding climate change issues is of primary consideration..

2 CLIMATE CHANGE SCENARIOS FOR THAILAND

2.1 Climate Change scenarios

Knowing future climate change is necessary to understand its impacts and to prepare for necessary adaptation.

GCMs

General Circulation Models (GCMs) have been used to construct future climate change scenarios. GCMs are mathematical models based on physical laws that simulate heat exchange among the main components of the Earth's climatic systems. The model is complicated and requires sub-models of extensive information of the Earth's climates. Some institutes in developed countries possess GCMs. Climate change scenarios from these models vary depending on the input data, the hypotheses, and the assumptions used. Therefore, it is important to utilize a number of GCMs to explore and evaluate the trends in future climate changes and to study the impacts and the adaptations that need to be made.

It is estimated that average global temperatures will increase between 1.4 and 5.8 °C, and sea levels will rise at least 0.09 meters and up to 0.88 meters because of the melting of polar ice and the thermal expansion of ocean waters (IPCC, 2001). The consequences of these changes are tremendous and affect precipitation patterns, increasing maximum and minimum temperatures as well as causing droughts and floods. These in turn will impact upon the equilibrium of natural ecosystems, food production, health and other systems, which finally have a negative effect on the socioeconomic development of the country.

RCMs

GCMs are global models, which work on a large spatial scale. Downscaling the output to a smaller country's area may not capture enough information to carry on impact studies. Regional Climate Models (RCMs) have been developed to construct climatic change scenarios for smaller areas of the regions, which are more appropriate for impact studies. However, developing countries have limited access to GCMs and RCMs because of inadequate technical experts and funding.

In 1997 Thailand selected three GCMs to develop climate change scenarios to study the impact of climate change on forest distribution. One RCM was used to construct a climate change scenario for the Mae Khong river basin. It is necessary to use at least three more RCMs to construct climate change scenarios for studying the effects of future climate change and the adaptations needed.

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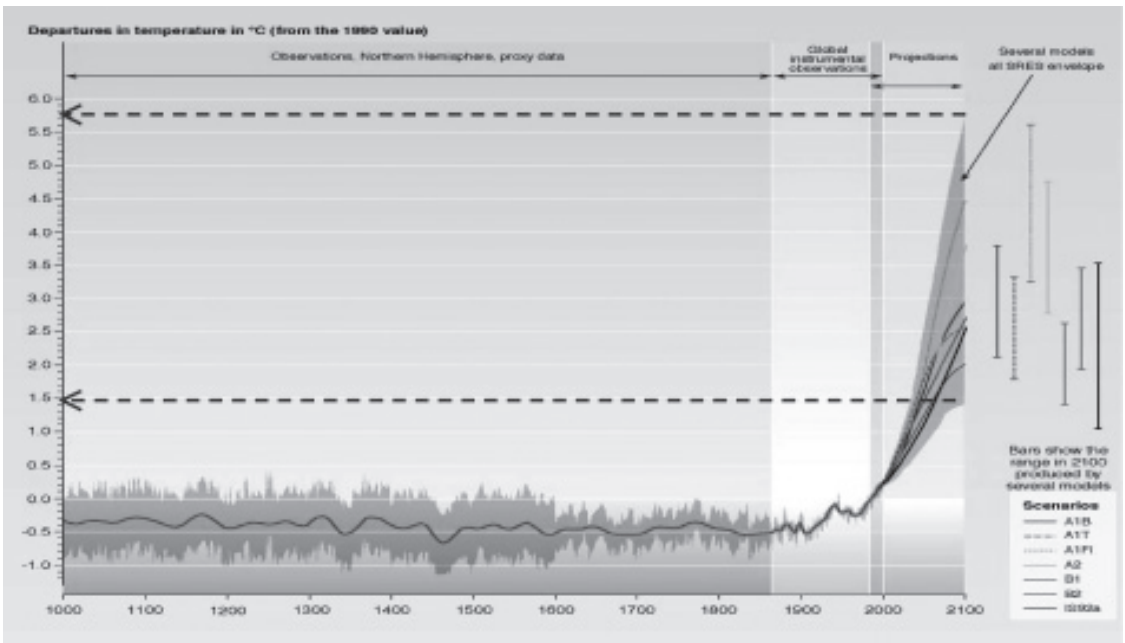
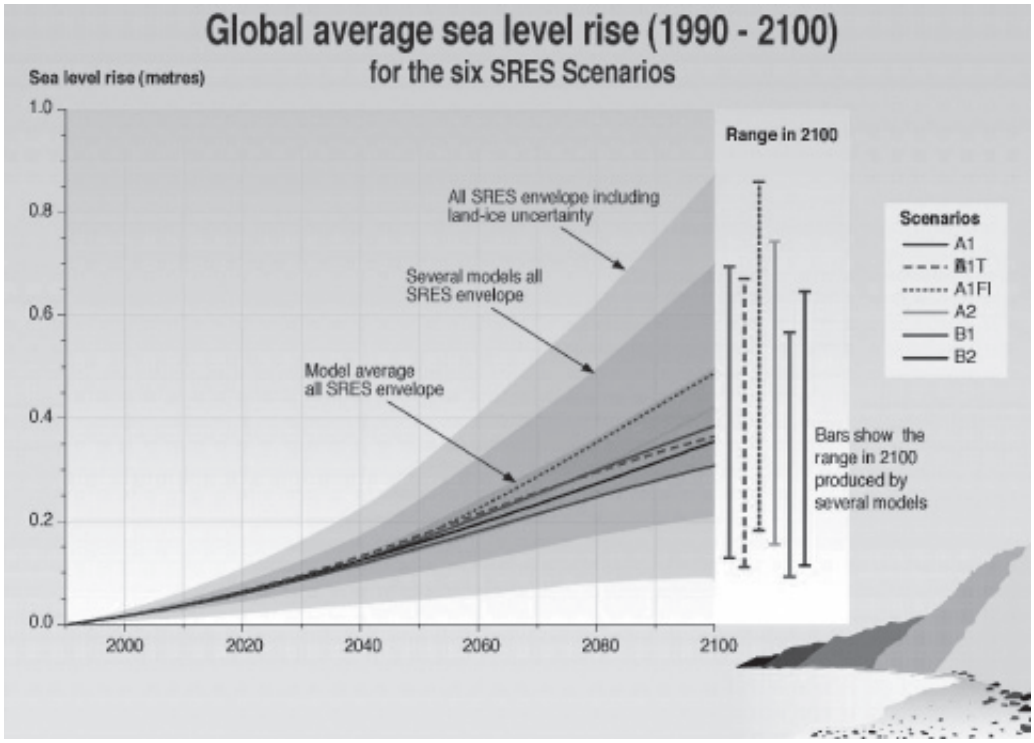


Figure 4

Temperature scenarios (IPCC 2001

Figure 5

Sea level rise scenarios (IPCC 2001)



It is estimated that average global temperatures will increase between 1.4 and 5.8 °C, and sea levels will rise at least 0.09 meters and up to 0.88 meters because of the melting of polar ice and the thermal expansion of ocean waters (IPCC, 2001).

2.2 Current climate

Measuring and recording climatic parameters in real time is necessary for weather forecasting of natural disasters and climate related catastrophes. It is also a source of input data needed to simulate climate change scenarios. The climate is a large continuous system; changes in one place affect others. The World Meteorological Organization (WMO) recommends a distance of 150 km between each climate station for efficient data uses. Thailand has 90 climate stations that meet WMO standards. The country needs to establish a network of climate stations to strengthen weather forecasting capabilities and to use for assessing climate change scenarios.

2.3 Paleoclimate

Paleoclimate is the study of ancient climatic patterns, which can be traced by tree rings, the pollen deposited in sediments and the air bubbles trapped in glaciers that have not melted for several thousand years as in the Antarctic. Paleoclimatic data provides information about the Earth's climate by centuries and millennia before the present. This information is necessary for the validation of climate models used to construct scenarios of future climatic change. Climate models that accurately simulate past climates would be used to construct climate change scenarios that are close to real events.

2.4 Thailand's Climate change scenarios

Three GCMs were chosen to construct precipitation and temperature scenarios over Thailand (TEI, 1999). The three GCMs used in the study were UK 89, UKMO and GISS as shown in Figure 6-9. Every model shows the increase in average temperature from 21.5-27.5°C to 25-32°C approximately (Figure 6). The temperature increases by 2.5°C in the northeast region and by 3-3.5°C in the central, north, and west regions (Figure 8). The amount of rainfall is dispersed differently from the base year, as shown in Figure 7. The amount of rainfall in the northeast is constant while it increases by 40% in the south. The amount of rainfall in other parts of the country increases by 20% (Figure 9).

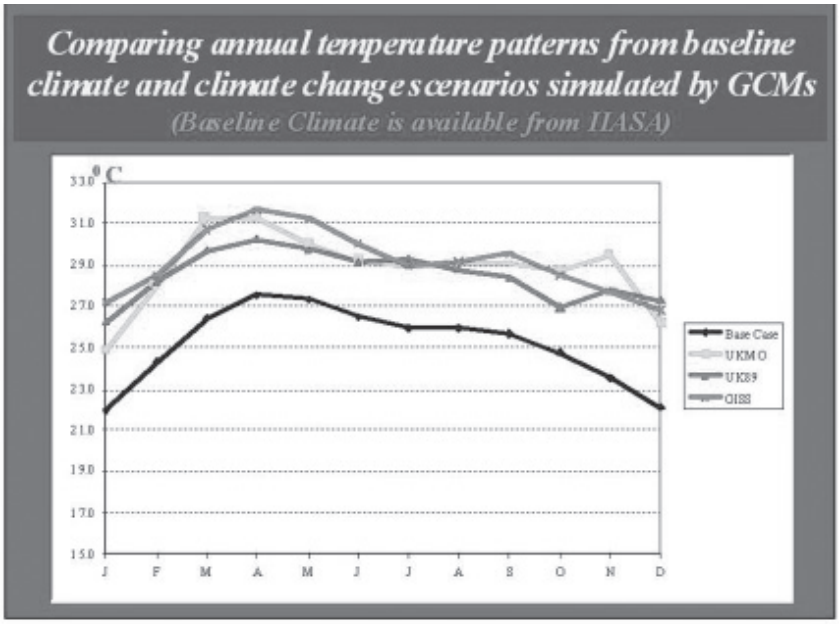


Figure 6

The results from 3 GCMs: UK 89, UKMO and GISS showing an increase in temperature
Source: TEI, 1999

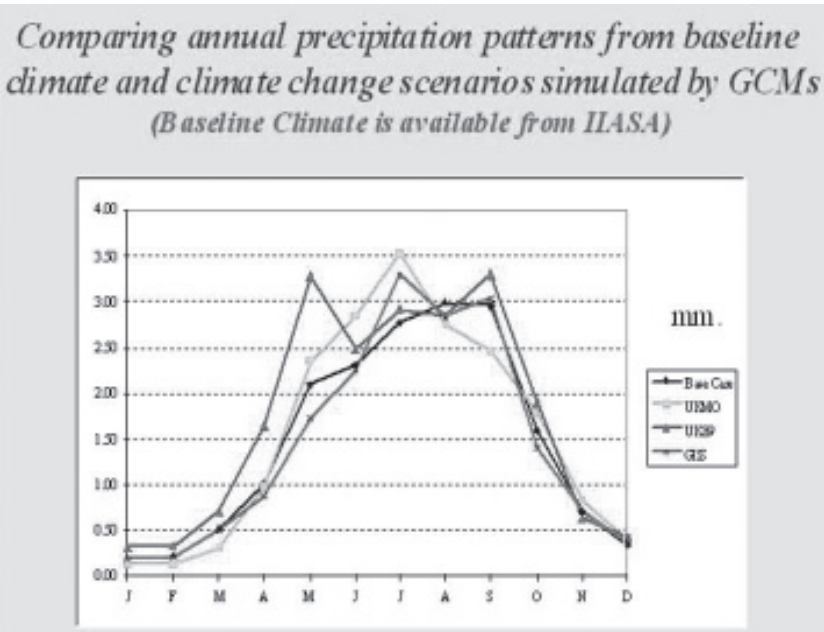


Figure 7

The results from 3 GCMs: UK 89, UKMO and GISS comparing patterns of rainfalls annually.

Source: TEI, 1999

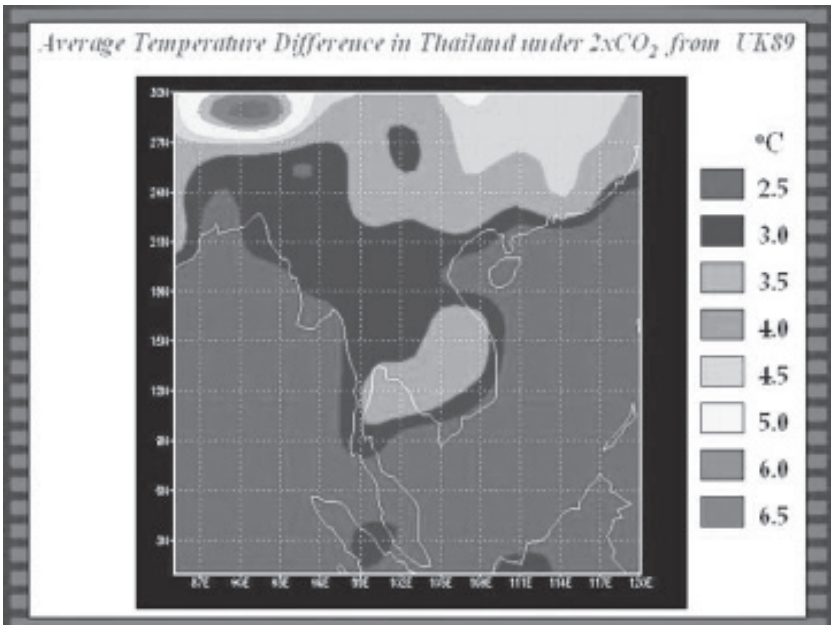


Figure 8

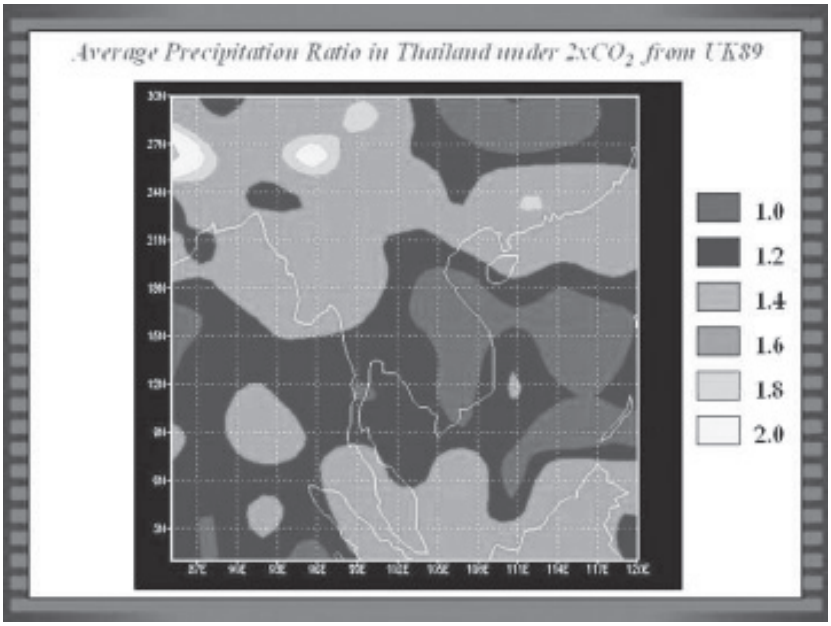
Showing the increase in temperature in Thailand. The results from UK89

Source: TEI, 1999

Figure 9

Altered rainfall patterns, the results from UK89

Source: TEI, 1999



Recent Prolonged drought in Thailand

From 2004 to 2005, Thailand was caught in the grip of a catastrophic drought. Thailand's rice yield in 2005 "is expected to fall below 11 percent to 14 percent from last year's harvests while sugar cane production is also expected to drop drastically."

One of the main causes of the current prolonged drought in Thailand can be attributed to global warming

During the same period the Eastern Seaboard of Thailand, which is prime industrial estates that include the largest petrochemical industry in the country, faced severe water shortage. Water levels in the main reservoirs dropped below minimum storage levels. Industries and residences in the region were requested to take long-term measures to cope with water shortages and reduce water consumption. According to the Irrigation Department, the region has experienced two consecutive dry years and droughts instead of alternating with a wet year that usually refills the reservoirs with enough supply of water to meet the demand of the following year.

Despite a massive government effort to divert water to replenish the main sources of water supplies in the region in particular in the Map Ta Phut area, several manufacturers have adjusted their production plans in order to survive the dry spell. It is the first time in over 20 years that the industrial estate has been faced with such a serious water crisis.

To help ease the water shortage, the Thai cabinet approved a large budget for projects, including water diversion between existing reservoirs and from rivers in the area to the reservoirs. The government plan has placed local communities and farmers in a fighting mood to stop the government from "stealing" their water to feed the region's water-starved industrial sector.

Average temperature and amount of rainfall recorded in Thailand

According to the Meteorological Department of Thailand, there has been a decrease in rainfall trends in Thailand and an increase in maximum and minimum temperature during 1951-2002 (B.E. 2494-2545), as shown in Figure 10, 11 and 12.

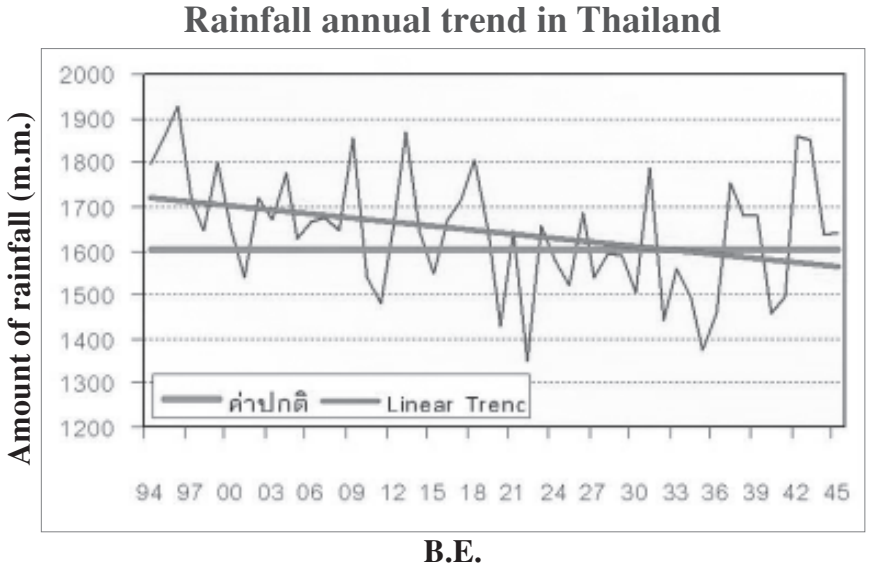


Figure 10

A decreasing trend in amount of annual rainfall in Thailand during 2494-2545 B.E.

Source: Chamnong Keawchada ,B.E. 2546

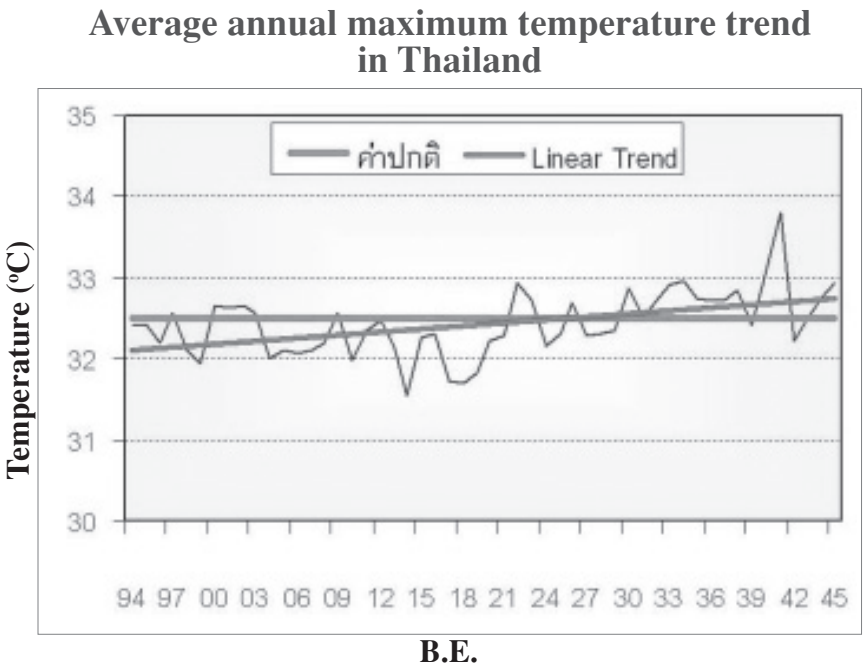


Figure 11

Increasing trend in Thailandís average annual maximum temperature during 2494-2545 B.E.

Source: Chamnong Keawchada, B.E. 2546

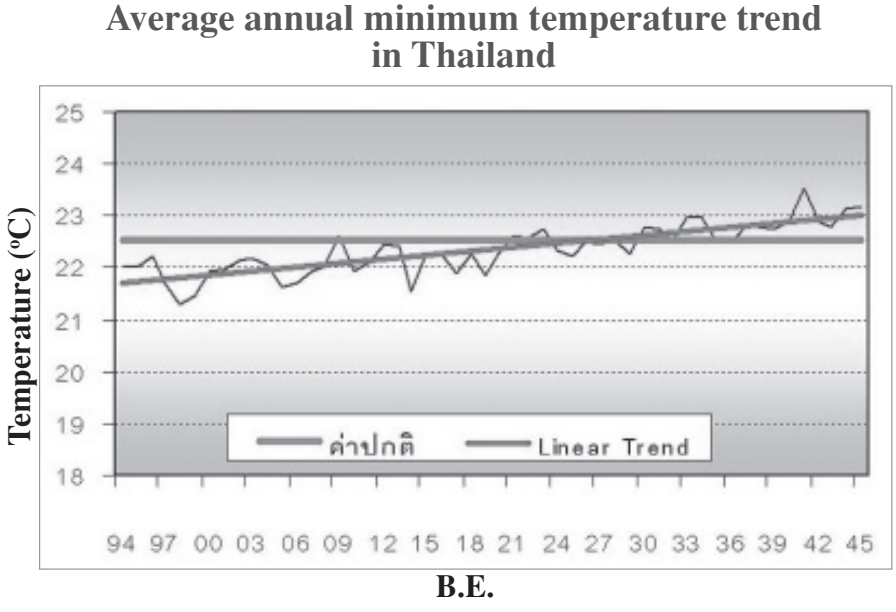


Figure 12

Increasing trend in Thailand's average annual minimum temperature during 2494-2545 B.E.

Source: Chamnong Keawchada, B.E. 2546

3 IMPACTS OF CLIMATE CHANGE IN THAILAND

3.1 Water Resources and fresh water ecosystems

The increase in solar radiation and mean global surface temperatures could alter the amount of precipitation and evapotranspiration, leading to changes in river flows, ground water recharge, catchments, soil moisture, water temperature, and water quality. Alteration in water resources and water ecosystem could result in changes in land uses and vice versa. All of these prospects would eventually change water balance in regional watershed areas. Annual stream flow, for instance, could decrease as much as 21-31% in some areas of the world (Moore, M.V. et al., 1997).

Most importantly, there would be changes in precipitation patterns. Despite the same amount of rain measured, the precipitation patterns, rainfall frequency and intensity, as well as the situation could be widely distinct in two places, as shown in Figure 13.

Thailand is an agricultural country that depends largely on natural water resources and unfortunately global climate change has serious implications upon these water resources. This could cause prolonged droughts, intense flooding and storm surges to occur more frequently. The supplies from fresh water reservoirs, rivers and streams are expected to change.

Thailand has 25 watersheds, which store rain water and supply fresh water. A study on climate change in the Mekong river basin, which included the Chee watershed area in northeastern Thailand, was performed using one Regional Climate Scenario. There is an urgent need to study changes in the rainfall pattern in all the watershed areas by using more than three climate change scenarios. The results from these studies will be useful to incorporate in the government's water management plans to maximize their efficiency, and to ensure future water availability.

Climate change would also affect the balance of fresh water ecosystems, causing changes in biogeochemical and hydrological cycles. The impacts will be different depending on previous settings of the watershed areas. Thailand has yet to investigate its regional areas to be able to indicate the impacts likely to occur in various localities.

The impacts of climate change on fresh water ecosystem are likely to be more pronounced in the littoral zones of lakes than the pelagic zones. Emergent vegetation such as aquatic macrophytes will benefit from higher CO_2 concentration while high temperatures and rich nutrients in littoral sediments result in lush growth. (Kankaala et al., 1996).

Small lakes and reservoirs could fluctuate rapidly in response to changes in precipitation and evapotranspiration. Where water levels decline, particularly in shallow lakes and reservoirs, surrounding wetlands would decrease in area causing the absence of some aquatic vegetation. As a result, this causes changed habitats for aquatic biota, reduction of productivity, and even extinction of fish and invertebrate species that are dependent on these types of habitats.

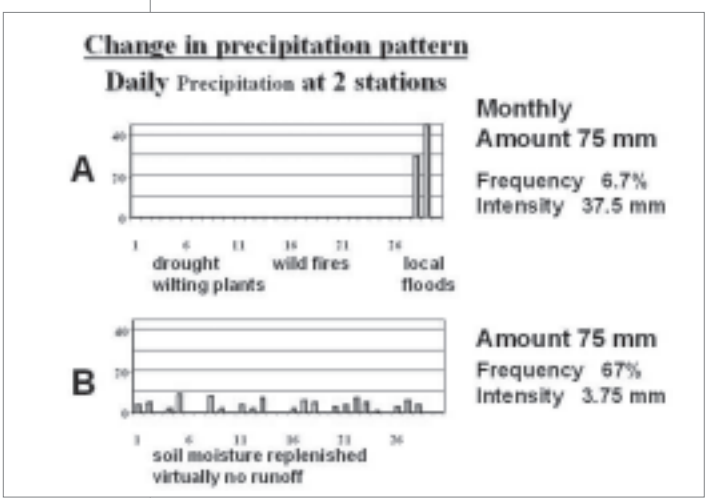
Decreasing lake volumes and areas could also result in increased loading of nutrients (nitrogen, phosphorus, and others) from catchments per unit lake area or volume. This could correspond to increased eutrophication, the phenomenon that results in high production of aquatic biomass, decreasing species diversity, deterioration of oxygen conditions, and adverse effects on water quality. In regions where most drinking water comes from surface sources, decreasing lake volumes and lower water quality may cause serious problems for human use.

Presently, there are few studies in Thailand which use mathematical models to assess physical property of water resource: water

Figure 13

Change in precipitation pattern

Source: Trenberth, 2003



Climate Change Hot Spots in Thailand

Climate change hot spots are the areas that will be severely impacted from climate change due to the extreme altering of temperatures and amount of rainfall. The ecosystems within the areas may change their types. Even as information related to climate change hot spot was identified. The impact, vulnerability and adaptation to climate change will be focused in these areas.

National parks and wildlife sanctuaries expected to be affected by climate change (from UK 89 Model)

1. Doi Suthep - Pui
2. Doi Khun Tan
3. Mai Yom
4. Srisatchanalai
5. Phu Rua
6. Ramkumhaeng
7. Phu Kardueng
8. Phu Kao - Phu Pankum
9. Phu Jong - Nayor
10. Kaeng Tana
11. Chalermrattanagosin
12. Kitchagoot
13. Laem Son
14. Kao Sok
15. Kao Luang
16. Kao Panombenja
17. Chieng Dao
18. Doi Pameung
19. Doi Leung
20. Phu Mieng - Phu Tong
21. Phu Leung
22. Phu Wa
23. Oom Pang
24. Tung Yai Naraesuan
25. Panom Dong Rak
26. Yod Dome
27. Kao Keaw - Kao Chomphu
28. Kao Soidao
29. Krommaleuang Choomporn
30. Klong Nak
31. Klong Saeng
32. Klong Phaya

Impacts of climate change on national parks and wildlife sanctuaries

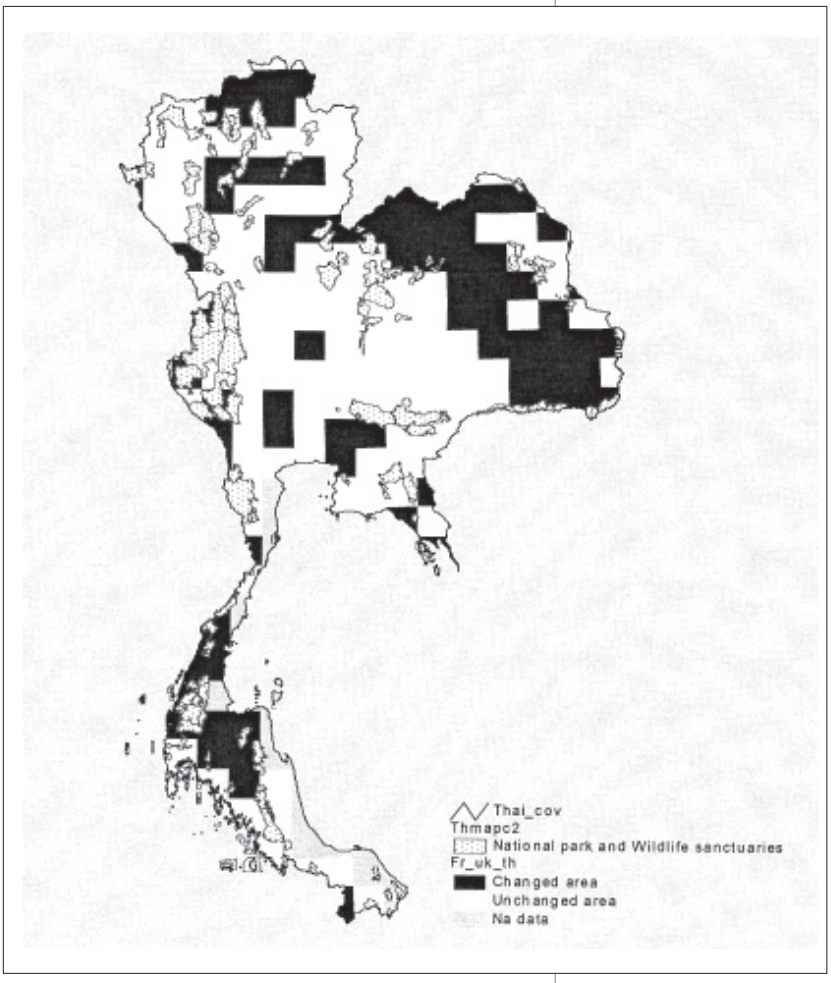
The preservation of natural habitat plays a crucial role in species conservation. In fragmented habitats due to roads and urban expansions, species in stress would be incapable of moving into new habitats, cooler areas up north will be affected by global warming. The species that cannot adapt to the new conditions may be threatened with extinction.

Of the national parks and wildlife sanctuaries distributed all over Thailand, 32 are situated in climate change hotspots.

Figure 14

Climate change hot spots in Thailand according to UK 89 showing national parks and wildlife sanctuaries at risk

Source: Boonpragob, unpublished



National parks and wildlife sanctuaries that are situated in climate change hot spots

Source: Boonpragob, Unpublished

flow conditions, element dispersion, sediment transfer and accumulation, for instance, to plan for water resource management. However, studies on biological diversity and the impacts of climate change on water resources and fresh water ecosystems using mathematical models need to be included.

3.2 Forest Resources

Plant communities are highly sensitive to changes in climate conditions, increase in CO_2 concentration, amount of rainfall, light intensity and exposure period; all impact their growth and development. Climate change, preceding forest fires, disease and pest outbreaks, could tremendously affect timber production and the existence of forests. For instance, after a severe drought in Panama in 1983, the loss of plant life in a 50 hectare ecological permanent plot in Barro Colorado Island (BCI) was as high as 50%, compared to normal years. (Condit et al. 1996, Hubbell and Foster 1983 cited from Sarayut Bunyavetcheewin B.E. 2545). It is expected that unrestrained climate change will cause irreversible changes in forest ecosystems

Furthermore, changes in vegetation cover will have a major feedback on the climate system through evapotranspiration, which affects the water and carbon cycles. The interaction of the terrestrial carbon cycle and the climatic processes has been simulated by Dynamic Global Vegetation Models (DGVMs). These mathematical models incorporate intensive vegetation data into the climate change scenarios generated by GCMs. Thus, the impact of climate change on forest production and wild life can be assessed. It is important to note that the existing models have been developed for temperate regions, whereas the environment in tropical regions is different. Climate-vegetation models that are appropriate for local conditions of the tropical regions need to be developed.

3.3 Biodiversity

The Indo-Burma region, including Thailand, is identified as a biological hot spot as it is rich in biodiversity while the management requires more attention (Myers et.al, 2000). Given the synergistic threats of climate change, however, deforestation, forest encroachment and habitat fragmentation would intensify the problem.

There are rich and diverse flora and fauna in tropical rain forests, such as the forests in Thailand, compared to other forest types. Ten square kilometers could contain up to 750 species of trees and 1500 species of higher plants, numbers higher than the total tree and plant diversity of North America (Raintree Nutrition, Inc., 1996). These plants have prospect novel products especially for pharmaceutical uses . For example, 70% of the plants that could fight against cancer grow in tropical rain forests, and yet less than 1% of this figure has been systematically studied. Deforestation is also limiting human chances in fighting against diseases. Some of the plants that could have been used became extinct before research and studies were performed.

Ecosystems tend to migrate up in elevation or northward in response to global warming. This phenomenon is already observed on the summits of a few mountainous areas. Plants and animals that are unable to move upward and are incapable of adapting to the warmer climates are threatened with extinction. The impact and adaptation of biological resources can be observed by: 1) field observations of species distribution on long-term permanent plots along altitudinal and latitudinal gradients. 2) Studies of species response in controlled environments under climate change conditions. 3) Model ecosystems changes under climate change scenarios to predict the spatial distribution of ecosystems.

Most existing studies on biodiversity cover inventories of species without incorporating climatic factors. A few long-term permanent plots with species inventories are ongoing. Long-term permanent plots along environmental gradients like mountain slopes, to monitor changes in climatic factors and species migration are necessary for the application of appropriate measures to conserve biodiversity.

Permanent plots are used to study forest dynamics in Thailand (Sarayut Bunyavetcheewin B.E. 2545). The examples are the dry evergreen forest at Huay Kha Khaeng Wildlife Sanctuary (50 hectares), a Lower Montane forest founded at Doi Indranon National Park (15 hectares), and mixed deciduous and dry dipterocarp forests at Huay Kha Khaeng Wildlife Sanctuary (100 hectares each) (Sarayut Bunyavetcheewin B.E. 2545). Furthermore, in 1998-2001, In-situ Conservation of Forest Genetics Resources in Thailand was founded under the responsibility of the Royal Forest Department (prior to the

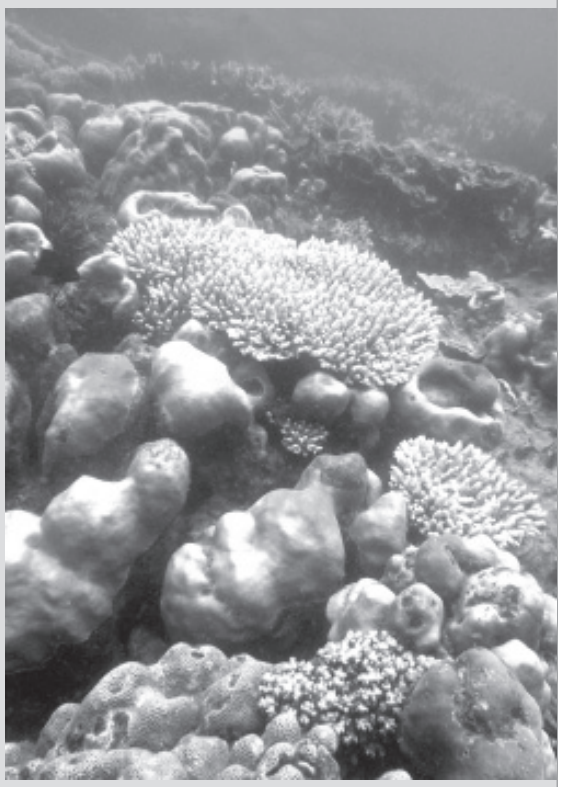
Thailand'sCoral Bleaching Episodes

Coral bleaching occurred in Thailand for the first time in 1979 but all the affected corals recovered. As reported by Dr. Suraphol Sudara, a well-respected marine scientist from Chulalongkorn University in Thailand and his team, warm water temperatures in April 1998 caused widespread coral bleaching in the Gulf of Thailand from Narathivat province (South) and Trat province (far east), up to Chonburi province (the inner part of the Gulf). But there was no bleaching on the other side in the Andaman Sea. Water temperatures in the Gulf increased from the normal of 28-29°C to above 32°C, such that on Ko Samui was 35°C.

It was first noticed in the tourist centres of Chumphon and Surat Thani. Then bleaching spread north to reefs in the inner part of the Gulf (Koh Samet, off Samaesan) and off Pattaya. In some places, bleaching has affected 100% of Acropora, 80% of Pocillopora damicornis, and about 60 to 70% of massive Porites, especially in shallow water. Around Chumphon (Ko Kai, Ko Samet and Ko Tao), 30-50 % of coral is bleached. Around Sichang Island (inner part of the Gulf) and Mun Islands (Rayong), the impact was 50-60% of coral being bleached, with mortality of about half those affected. This is the first report of widespread bleaching in the Gulf of Thailand. (Australian Institute of Marine Science : Status of Coral Reef of the World 1998)

The severe bleaching in the Andaman Sea was reported off Phuket, Phangnga and Krabi in the summer of 1991. Coral bleaching can occur when the water temperature rises by as little as 1°C above the average temperature of the warmest month of the year for several weeks, but in 1991 the water temperature was 1 to 3°C higher than normal and remained so for two-and-a-half months.

In fact 1998 proved to be a disastrous year for coral reefs all over the world. Apart from Thailand, some 32 countries in the Pacific and Indian oceans, the Mediterranean and the Caribbean as well as the Gulf of Mexico and the Red Sea suffered the most extensive and severe bleaching and subsequent loss of coral in modern times.



© Nalinee Thongtham

In 2005 Anchalee Chankong, a researcher from the Marine and Coastal Resources research centre in Chumphon, reported that many shallow water reefs on the Gulf of Thailand, such as those in the waters off Surat Thani and Chumphon provinces, are also suffering from bleaching.

Professors Richard P. Dunne and Barbara E. Brown, visiting researchers from the Department of Marine Science and Coastal Management at the University of Newcastle-upon-Tyne in England, predicted bleaching of coral in Phuket's waters in 2005, having witnessed weather conditions in Phuket that contribute to coral bleaching. Both scientists have been monitoring coral reefs in the Andaman Sea over the last 26 years, and their studies showed that coral bleaching directly corresponds to a rise in water temperature and solar irradiance. (quoted from Nalinee Thongtham, Phuket Marine Biological Centre)

reorganization of governmental departments). The program selects the zones that are rich in biodiversity from conservation areas of all forest types nationwide, being able to plan systematic studies on 15 forest zones-1-4 zones from each type of forest, of 100-6.25 rai (16-1 ha) (Boonchum Boontawee B.E. 2545).

Thailand's forest distribution expected to change from the impacts of climate change

According to the first and the only study on the impact of climate change on forest distribution, a few GCMs, UK 89, UKMO and GISS, and Holdridge Life Zone Classification of forest distribution based on climate were employed. The study revealed that, the forests in Thailand will be changed under climate change scenarios of doubling carbon dioxide concentration of the atmosphere. Most of them will become increasingly arid (Boonpragob and Santisirisomboon, 1997).

3.4 Coastal Resources, Ocean and Fisheries

Rising sea levels, high waves and severe storm surges are the expected result of changing climates. Thailand has about 2600 km of coastline. The economic value of these natural resources varies geographically. Coastal ecosystems would be expected to adapt naturally to rising sea levels by migrating landward, but human development with its infrastructures, e.g. roads, are major obstacles for migration. Therefore, the deterioration of the natural coastal resources may occur. For example, mangroves, which are the nursery grounds and refuge of juvenile sea animals, are expected to deteriorate. This would affect fish production as well as ruin the protection of the coastal zones from waves and storm surges.

It is expected that there will be an increase in coastal erosion, deterioration in natural resources and a reduction in the number of tourists. Changes in ocean currents salinity, temperatures, wind directions, as well as the vertical circulation of ocean water will all affect nutrients, the species composition and the population dynamics of the ocean ecosystems and fish production. Because of its importance to the economy of the country, the impact of climate change on food harvested from the ocean should receive more attention.

Modeling sea-level rise to identify hot spots along Thailand's coastline needs to be accomplished by incorporating current regional climate models to enhance the accuracy and trends of the changes. From these, adaptation measures to protect particularly threatened ecosystem could be developed.

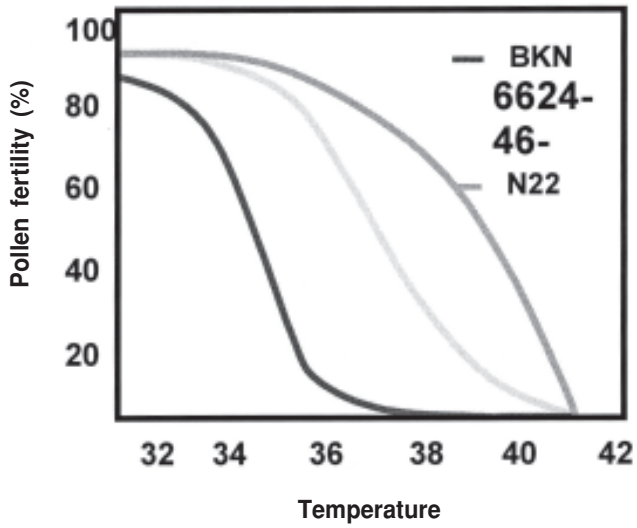
3.5 Food security

Agricultural products share major income among those exports from Thailand. However, crop productions are mostly from rain fed agriculture, which would become fluctuated due to the influence of climate change. During 1991-2000 loss of crop yields related to climatic events such as droughts, floods and storms amounted to over 50 billion Baht. It is predicted that climate related catastrophes will increase and intensify under climate change. This will cause reductions in agricultural production, and consequently retarded economic development and increasing social problems.

Figure 15

Comparing pollen fertility of different rice varieties in high temperature

Source: Sheehy, 2002



Rice
Satake & Yoshida (1978) and Horie (1993)

Pollen is among the most sensitive plant part to changes in temperature. Increasing temperatures for a short period during the flowering and pollination process greatly reduces fertility of pollen, Different plant species react to temperature differently, for example pollen of some rice species lost its fertility in a temperature higher than 34 °C, whilst others can tolerate to heat up to 38°C (Figure 15). Exposed to high temperatures, even for short periods, sensitive rice would lose their productivity by failing to fill the grain, while the plant still grow.

Extreme rainfall variability leads to declining rice, corn and sugar cane productions (Teerasak B.E.2541, สถาบันวิจัยพืชไร่, 2539). Furthermore, inundation in some areas could lead to plant diseases and insect infestation (Benchaphun et al., 2002).

Crop yield responds to growing temperature, by which high production generally occur at the optimum temperature range of 22-27 °C. Exceeding this range causes decline in plant production This has crucial implications on tropical crops, which normally grow at the high end of the optimum temperature, whereas temperate crops could benefit from increasing global temperatures. Tropical crop yields might decrease, and temperate yields may increase (Figure 16).

The fact that different species have a unique capacity to endure heat means that it is essential to study individual species to find those that can best accommodate themselves to a changing climate. Furthermore, it is most important to conserve genes of wild species as they possess characteristics that can overcome stress and enemies.

On-going studies in Thailand on the impact of climate change on the Mekong river basin utilize one regional climate model incorporated with CERES crop model to predict the yields of a single variety of economically important crops such as rice, corn, sugar cane and cassava. Other climate change scenarios are necessary for such studies in order to apply appropriate adaptation strategies to minimize the impact of climate change.

Animal production in Thailand primarily depends on grazing systems and mixed farming systems, which depend on climatic conditions, precipitation, natural pasture, and left overs from agriculture. Climate change could have crucial impact on livestock production. Drought and flooding would eventually lead to shortage in food and new disease outbreak. More importantly, most of the farmers in Thailand are small holders who lack understanding in the prospect of climate change and would be very much affected from the events.

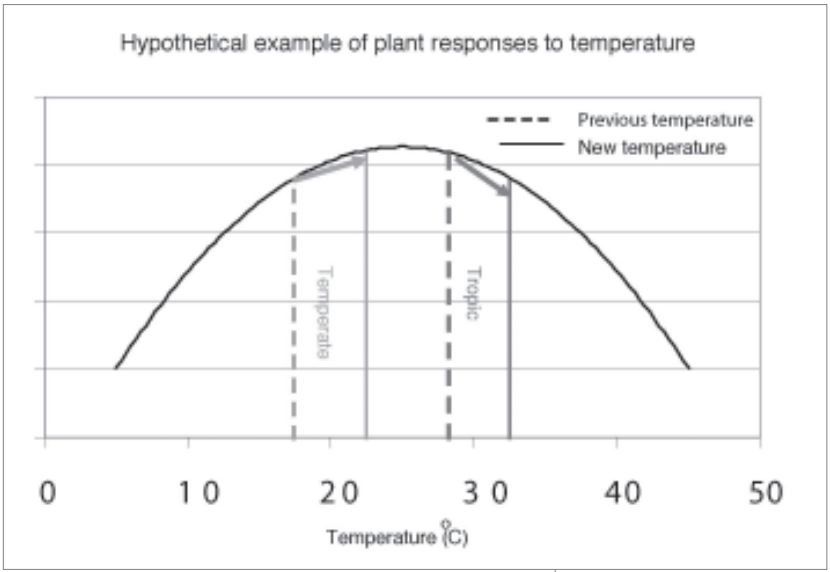


Figure 16

Influence of temperature on crop yield.

Source: modified from Nobel, 2002

Temperature and humidity are associated with livestock production. Different types of animals have varied Thermo Neutral Zone (TNZ), which is the range of temperature considered comfortable for the animal (McDowell, 1972). For example, if the bovine have to be in a temperature warmer than their TNZ, they would be under stress, leading to changes in physiological processes that impede growth and reproductive system (Charnwit, 2539, Yousef, 1985).

In addition, high temperatures could also affect the microbe in a bovine's stomach and cause mutation. Epidemic diseases carried by flies, might increase in number with changes in climatic condition, and that weakens the animals and their products, as well as the efficiency of vaccines.

In conclusion, livestock production could decline in changing climates due to heat stress, poorer food quality or disease outbreaks related to climatic conditions. The ability of livestock producers to adapt their herds to the physiological stresses associated with climate change is less known. Management to enhance understanding and to predict the future production of meat and dairy products under climate change conditions are needed.

3.6 Health

Extreme temperature and heat waves have negative effect on human health, especially in young and senior citizens and those who suffer from respiration and cardiovascular diseases. In the past, there have been many death caused by heat wave in urban areas. For example, the heat wave that struck Chicago in June 1995 killed more than a thousand people. Latest incidence of heat waves in 2003 in Europe took a lot of lives, especially in France in which the temperature was as high as 40°C and had the death toll up to 12,000.

The harmful effects from heat waves are intensified by humidity, which is the case of Thailand as it is situated in a tropical zone. Perspiration could dissipate body heat. However, in highly humid conditions organisms will perspire less as the sweat can not evaporate.

High temperature in urban areas can enhance the reaction rates of air pollutant, which are already detrimental. The polluted gases irritate respiration systems and optical tissues. In the long run, it causes chronic symptoms on respiration system and allergies.

Vector-born diseases such as malaria and dengue fever may shift their outbreak zones. High temperature accelerates the life cycle in insects which are intermediate hosts and shortens the parasite incubation period. The outbreak would therefore occur more frequently. Furthermore, the life style of Thai people increases the chance that people would come in contact with the diseases. Despite its controllable situation, malaria has been reported more frequently around Thai borders.

Climate change could increase the risk of food and water-born diseases such as Salmonellosis, the disease that causes diarrhea, if the amount of rainfalls increases and leads to inundation of surface water and floods. This case could be serious for areas where sanitation is below acceptable standards.

Psychological stress could also be affected by increasing incidences of natural disasters, changes in surroundings and settlements, and insufficient natural sources such as fresh water. This could eventually lead to social problems, changes in social structure, and insecure living.

Most of the operations concerning environmental health in Thailand emphasize on disease density, epidemic conditions, protection and prevention. An understanding of epidemics in relation to climate change, and climate related factors receive less attention. Management strategies should be primarily performed using mathematical models to predict disease outbreak, and other factors relating to climate so that warning systems and adaptation to climate change could be established .

3.7 Settlements

The direct effects of climate change on human settlements are floods and landslides caused by increases in rainfall intensity, rises in sea levels and coastal storm surges. Settlements along rivers and coastal zones are particularly at risk. Damage to infrastructures, transportation systems, water supply systems and public services are expected results from changing climate. Increased energy demands for infrastructure cooling and damage repairs are also expected.

Flooding in the Bangkok metropolitan area was infrequent during the last ten years because flood prevention programs were implemented. However, floods in other urban and rural areas have tended to increase during the past thirty years.

3.8 Insurance

Global economic losses related to extreme weather events have increased about ten fold during the past decades, from 3.9 billion US$ in the 1950s to 40 billion US$ in the 1990s (all in 1999 US$, unadjusted for purchasing power parity) (Figure 17), with approximately one-quarter of the losses occurring in developing countries. Between 1989 and 2002 the economic losses related to floods, storms and droughts in Thailand amounted to over 70 billion Baht. In developed countries, weather related losses are insured by financial service sectors. This minimizes the burden on governments as it reduces their compensation payments, whilst the economy and the livelihood of the farmers remain intact. In developing countries, including Thailand, such programs rarely exist. Governments may subsidize part of the weather related losses.

The possibilities to develop insurance systems, or other appropriate strategies, to compensate the loss of agriculture products caused by extreme climate events should be developed. Losses are expected to increase as a result of changing climate.

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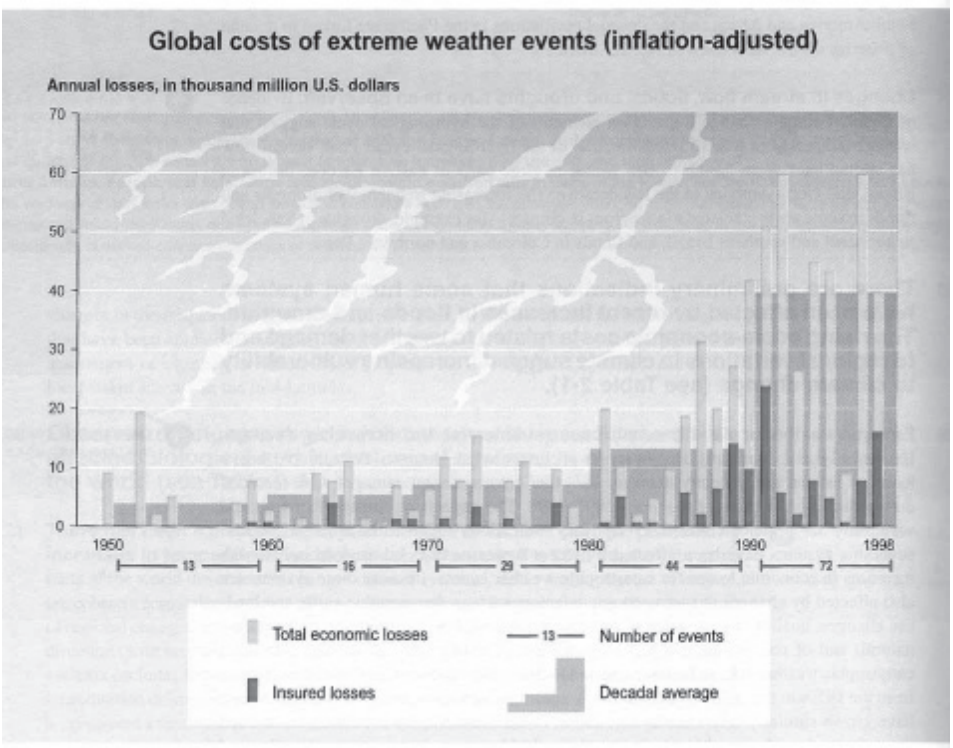

Figure 17

Global cost of extreme weather events

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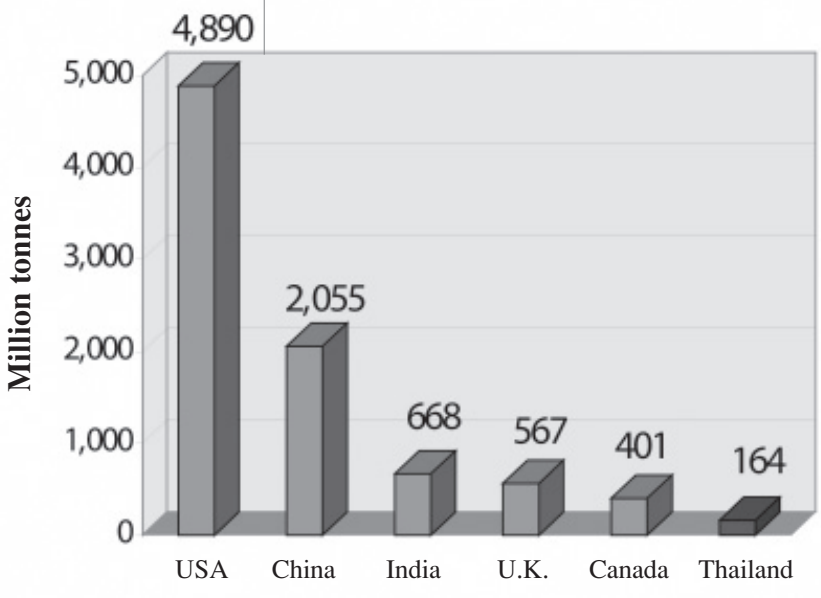
Figure 18

Comparing emission of carbon dioxide (CO_2) in Thailand and some other countries

Source: Thailand's information from TEI, 1997; Other countries information from World Resource Institute - WRI, 1994



4

THAILAND AND THE CLIMATE CHANGE CONVENTION

Assessment of Intergovernmental Panel on Climate Change (IPCC)

The Intergovernmental Panel on Climate Change (IPCC), supported by UNEP and WMO, consists of experts in areas of climate change from every region. They are responsible for assessing and distributing current knowledge and appropriate technology in three areas including the science of climate, impacts, adaptations and vulnerability, and lastly mitigation of greenhouse gases. It also includes a Task Force Group on greenhouse gas inventory. The IPCC philosophy is "Policy relevant, not policy descriptive".

Political Framework and Negotiation United Nations Framework Convention on Climate Change (UNFCCC), and Conference of the Parties (COP)

The United Nations Framework Convention on Climate Change (UNFCCC) was initiated during the June 1992 Earth Summit in Rio de Janeiro, Brazil. It is a global commitment. The ultimate objective of the convention is to stabilize GHG concentration in the atmosphere sufficient to allow ecosystem to adapt naturally, to ensure food production, and enable economic development to proceed in a sustainable manner. However, this commitment is obligated by Annex I developed countries. Thailand belongs to Non- Annex countries, which includes developing countries.

Thailand and climate change

Thailand ratified the UNFCCC without a commitment to reduce GHG emissions. The country released only 0.6 % of the global emission in 1990; per capita emission was also below world average.

5

CALL FOR ACTION

Evidence of climate change has become more and more obvious. Millions of lives are at risk and the economic development of Thailand is increasingly threatened by climate-related catastrophes, heat waves, intense droughts, floods and storm surges. These are only the opening warning signals of Mother Nature as she responds to human interference with the planet's climate system. Because of the complexity of the climate system and the large consequential effects of global warming, required actions to solve climate change need the sustained cooperation of all sectors of society, especially among developing countries where awareness, knowledge, technologies and institutional capacity is still lagging. More importantly, the context of climate change is less known in Thailand or perceived only as a portion of the story. It is important to raise the awareness of the public regarding climate change in order to impress the urgency of the issue. Mitigation and adaptation measures equal to the urgency posed by climate change can not be delayed.

Taking into account the globally agreed principle of common but differentiated responsibilities, Thailand must combine both adaptation and mitigation efforts in order to minimize the impacts of and to cope with the consequences of climate change. Developing countries are more vulnerable to changing climate than those that are equipped with know-how, technology and institution. Adaptation requires the long- term study of the impacts of climate change on natural resources such as water, forests, biodiversity, coastal and human health as well as food production and socioeconomic activities. This strategy is a win win option for Thailand.

Actions taken to minimize the cause of climate change benefit the world. Reducing greenhouse gas emissions must prioritize mitigation measures in the energy sector, which includes less dependence on fossil fuels and moving increasingly towards renewable energy alternatives as well as more efficient energy utilization.

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CRISIS OR OPPORTUNITY: Climate Change and Thailand

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April 2006

Front Cover Photo: ***Drought in Thailand © Greenpeace/Sataporn Thongma***
Front Cover Photo(inside): ***Coral Bleaching near Phuket © Nalinee Thongtham***

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Greenpeace is a global organization that uses non-violent direct action to tackle the most crucial threats to our planet's biodiversity and environment.

Greenpeace regional presence in Southeast Asia was formally established in 2000. Through its campaigns, Greenpeace aim to protect the region from further ecological ruin and serve as beacon of awareness and action in the interest of environmental protection and sustainable development. To date, its work in the region has include stopping hazardous waste imports, opposing radioactive shipments, campaigning against destructive logging, stopping dirty and polluting technologies like waste incinerators and coal power plants, halting the spread of GMOs, promoting renewable energy and sustainable solution to key environmental problems. Often working with local groups, Greenpeace has been leading successful campaign in Thailand, the Philippines and Indonesia.

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