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Social implications of climate change for land tenure and land policy

Case Studies from ASEAN, the European Union and NAFTA

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II. List of Acronyms

ABI	Association of British insurers
APEC	Asian Pacific Economic Cooperation
ASEAN	Association of Southeast Asian Nations
CAP	Common Agricultural Policy
CDM	Clean Development Mechanism
CFCOP	Community Forestry Carbon Offset Project
CFMC	Community Forestry Management Committee
DIVA	Dynamic Interactive Vulnerability Assessment
DNA	Designated National Authority
EC	European Commission
ECCP	European Climate Change Programme
EEC	European Economic Community
EIA	Environmental Impact Assessment
EU	European Union
EU ETS	*European Union Emissions Trading Scheme*
FAO	Food and Agriculture Organization of the United Nations
GDP	Gross Domestic Product
GHG	Greenhouse Gas
ICZM	Integrated Coastal Zone Management
ILUC	Indirect Land Use Changes
INC	Initial National Communication
IPCC	Intergovernmental Panel on Climate Change
KP	Kyoto Protocol
LECZ	Low Elevation Coastal Zone
LULUCF	Land use, land use change and forestry projects
MOE	Ministry of Environment
NGO	Non-governmental Organization
NAFTA	North American Free Trade Agreement
ONREP	Office of Natural Resources and Environmental Policy and Planning
PEER	Partnership for European Environmental Research
PESETA	Projection of Economic impacts of climate change in Sectors of the European Union based on bottom-up Analysis
RED	Reduced Emissions from Deforestation
REDD	Reduced Emissions from Deforestation and Degradation of forests
SEA	Single European Act
SLM	Sustainable land management
SLR	Sea level rise
SRES	(IPCC) Special report on emissions scenarios
TCI	Tourism Climate Index
TFEU	Treaty on the functioning of the European Union
TGO	Thailand Green Gas Management Organization
UN	United Nations

UNDP	United Nations Development Programme
UNFCC	United Nations Framework Convention on Climate Change
WTO	World Trade Organization

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Chapter 1

Introduction

1.1. Background of the problem

During the last decade, climate change has gained a fast recognition in the policy and economic world. Related discussions have infiltrated the media and more often than not, climate change has been named the culprit for many natural or man-made disasters. Numerous studies have become the focus of conferences, workshops, government circles and media. Economic liberalization has been significantly regulated – which in many areas (in a kind of late Manchester Capitalism) destroyed social cohesion as well as environmental living conditions. Subsequently, a politicizing of the climate change issues has hindered many useful political implementations or caused misunderstandings in the areas of affected peoples while business and industry tried to "paint everything green", i.e., many products were suddenly labeled "3 E": ecological, environmental friendly, expensive. Against this backdrop useful mitigation measures for climate change often remained unnoticed. Legal regulations were implemented without major participation of the affected populations and most significantly, the consequences of the effects as well as countermeasures (or mitigation efforts) were widely forgotten in relation to land issues.

According to the 1988 established United Nations *Intergovernmental Panel on Climate Change* (IPCC), which is comprised of the world's leading scientific experts in the field of climate change, the global climate is undergoing dramatic changes as a direct result of greenhouse gas emissions from human activity. Climate change outcomes are already evident in the form of higher temperatures, desertification, land degradation, rising sea levels, increased ocean acidity and melting polar ice caps. Additionally, natural disasters (e.g. flooding, landslides, storms) are occurring at a higher frequency than before. Global surface temperatures have increased by roughly 0.74 °C between the beginning and the end of the 20th century. According to the IPCC, these trends are set to continue to accelerate in the 21st century and will be accompanied by new effects such as an increase in extreme weather events like hurricanes. According to the IPCC's latest findings, global average temperatures will rise around another 1.8^{o}C to 6.4^{o}C during this century.

In this context, the *United Nations Framework Convention on Climate Change's* (UNFCCC) Kyoto Protocol is a key tool to reducing green house gasses and to take action against global warming. The *European Union* (EU) has long been at the forefront of international efforts to combat climate change and was instrumental in the development of the two United Nations climate treaties, the 1992 UN Framework Convention on Climate Change and the Kyoto Protocol (KP), agreed upon in 1997. Realizing the seriousness of climate change as a global challenge, Thailand has been contributing to

international efforts to address climate change issues. Consequently it signed the UNFCCC in June 1992 (ratified in March 1995) as well as in February 1999 the Kyoto Protocol (ratified on 28th August 2002).

Climate change has impacts on various parts of life: health, agriculture, forestry, water security, food security, coastal areas and species, and natural reserves. Most of these factors are closely connected to land tenure and land usage as they affect the conditions for agricultural land use or threaten the livelihood of people and economic assets in coastal areas exposed to sea level rise. Thailand will be particularly affected through land degradation with massive social implications in the long term, as Thailand is still highly dependent on agriculture and tourism. Another important aspect is that land use itself is, in turn, a source of climate change, since especially agriculture and – particularly in tropic regions – deforestation produce significant emissions of Greenhouse Gases (GHG).

Therefore, it is imperative that the issues of climate change adaption and mitigation are addressed and included in land policies to control long term costs and avoid negative social impacts. The challenges for policy are various. Adaption and mitigation needs have to be balanced with the economic costs and social risks since the protection of forests might be in conflict with the basic economic needs of local communities. The promotion of biofuel might help to avoid GHG emissions, but on the other hand it may strain food supplies. Examples from the EU and NAFTA prove that in many cases a one-sided prioritization of economic interests (e.g. biofuel) can be counterproductive for the local population. In Mexico, for instance, there were aggressive changes in the governmental policy related to the economic liberalization of agriculture (NAFTA implementation) in 1994. These policies caused an increase in production costs and led to a dramatic decrease of profits for maize producers. The maize producers then sold their products into the bio-fuel industry which led to a food shortage and subsequently the need to import maize. The rise in prices led to social tensions in several regions in the country.

Additionally, barriers exist to land ownership and secure tenures which complicate mitigation/compensation activities, as they are mostly based on the respective land title deeds. Furthermore, many of the land related policies are assmebled from a central government perspective without sufficient information or participation of the affected people. As a result, some of these policies are neither accepted nor fully implemented, especially in rural areas. Finally, another core issue is financing. Especially developing or least developed countries will be highly challenged through costs related to adaption and mitigation (e.g. for coastal protection). Local communities and individuals in these countries have nearly no capacity to adapt and are therefore highly vulnerable.

1.2. Hypothesis and Objectives

Against this backdrop, the research study is designed to deliver a contribution to the management of the land related climate change issues. Effective climate change counter measures will have a deep influence on land usage and land tenure in ASEAN and will cause significant social impacts. The key hypothesis is that there should be legal and implementation arrangements under which the contrary effects of climate change mitigation and social benefits for citizens can be balanced and negative impacts can be mitigated in a participatory approach, thus setting precedence for successful planning in the future. The key research questions referring to this are how climate change is affecting countries in general in land tenure and land usage and what lessons learned from other countries/ regions (Germany/EU and United States of America /NAFTA) can be drawn.

To answer the key research question, the study will focus on two objectives:

1. To analyze the existing situation in ASEAN, the EU, NAFTA, as well as selected national states referring to climate change impacts and respective social, economic, and legal mitigation measures.

2. Issue policy recommendations for coping with climate change and land tenure under consideration of social provisions

In order to achieve these objectives, the study will analyse potential climate change impacts, vulnerabilities as well as existing frameworks and policies of the named regions and countries. This analysis is designed to identify strength and weaknesses of the different approaches related to the institutional setting as well as the concrete policies. This will also be related to the questions of what issues are addressed on a supranational level and what this level can do. Therefore, in addition, selected states will be analyzed to get a clearer image of how their respective national policies are dealing with the climate change issues and who they are interlinked within the supranational policies. The findings of this analysis will allow it to identify lessons learned in the three different regions that form the basis for achieving objective 2, the issue of policy recommendations that can form the basis for a comprehensive and target-orientated policy approach. In order to illustrate this, a management model for a hypothetical measure will be formulated.

The main part of the analysis is based on an extensive literature research related to the two objectives. Additionally, international experts and advisors contributed to the research via interviews and written contributions. In addition to classic sources like libraries, government agencies and internet based scientific databases, the research team had access to the HDFF research network

containing the University of Applied Sciences Munich, the Helmut Schmidt University, Hamburg, Germany and the University of Trier, Germany as well as related United States Research Centers. Inter alia the Department for Environmental Protection (DEP) and the University of Hawaii.

1.3. Structure of the study

Beyond this one, the study contains five more chapters. In order to lay down a framework for the following analysis, Chapter 2 will examine the relationship between land use and climate change. It will identify how land usage is both affected by and also causes climate change. Adittionally, it will outline social and economic impacts of land use related climate change impacts. It will then analyze what adaption and mitigation measures can be addressed through land policy. Hereby, the examination will follow a general framework for assessing climate change and land linkages developed by the *Food and Agriculture Organization of the United Nations* (FAO), which will be the core frame applied to the research study. Based on these findings it will discuss how these potential measures are constrained and what challenges implementation might cause for policy making.

Chapters 3 through 5 contain the analyses of the three regions and countries chosen for the study. They will first identify land use issues and climate change vulnerabilities of the regions and countries, analyze the institutional and legal framework, and examine concrete policies. This includes a listing of existing legal and institutional framework referring to climate change related to land use and land rights in ASEAN, EU, and NAFTA, in order to get an overview of climate change related land issues, provide case studies and examine best practices examples of social impacts and mitigation measures in other regions of the world.

Chapter 3 focuses on the Association of Southeast Asian Nations (ASEAN). In addition to the assessment of climate change vulnerability in South East Asia and ASEAN institutions and policies, it contains an examination of the climate change related legal framework of all ASEAN member states as well as several case studies describing adaption and mitigation measures in ASEAN member states and lessons learned from them. Section 3.3. is then an examination of the situation in Thailand more closely, focusing on climate change impacts, Thai institutions and laws, and also two concrete case studies on mitigation and adaption measures.

Chapter 4 is deals with the European Union and focuses on Germany as a country example. The EU as well as Germany is not only committed to climate change policy but they also have shown economic and administrative capacity to formulate and implement their policies. As open and democratic

societies, EU/Germany are capable of providing some indications on how the management of social adjustment was done in a participatory way for affected citizens. Even though some measures are quite different from the Thai settings, analogies can be drawn and will be included in the respective policy recommendation for the national level.

The example of NAFTA, discussed in Chapter 5, will not only discuss the regional framework but also the situation in all three member states, USA, Canada and Mexico. Since – at least in Canada and the US – the need for combating climate change is seriously doubted, the issue is not addressed as prominently as in the EU. Also NAFTA integration lacks the depth of EU integration. Therefore the examination of NAFTA will provide an interesting contrast to the situation in Europe. Each of the three analyzed regions will thus convey a very different perspective, providing lessons learned for policy making.

Therefore, the objective of Chapter 6 is not only to summarize the findings of the study but also to issue policy recommendations for land use planning. These recommendations address the national as well as the supranational level and also keep in mind the issues of social adjustment and social acceptance. Proposing a generally participatory and subsidiary approach, a practical management model will be developed and described by a hypothetical example. Since the study focuses primarily on the institutions and policies within the three regional integration schemes, it will not discuss in detail the international dimension of climate change policy on the level of the United Nations and in development cooperation, although they are highly important for ASEAN and Thailand (e.g. the matter of the Clean Development Mechanism). As such, the last section will include remarks concerning this international dimension linking it to the issues discussed in this study.

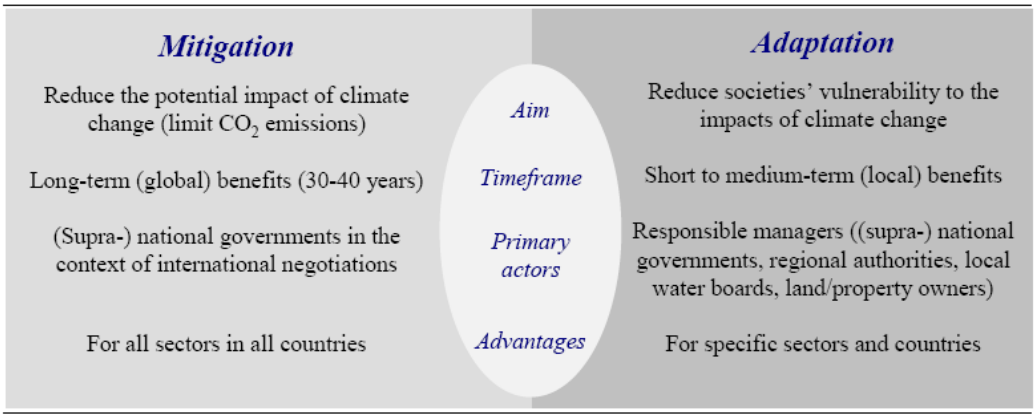
Chapter 2

Climate Change and Land Use

2.1. Linkage between climate change and land use policy

Since climate change is considered to have a substantial impact on worldwide ecosystems, it will also affect the conditions of land use, land occupation, and human settlement. On the other hand, human land usage is also a source of climate change due to emissions mainly caused by agriculture and deforestation. As a result, land issues and land policy play an important role for climate change adaptation as well as for mitigation strategies.

Figure 2.I: Climate Change Mitigation and Adaptation



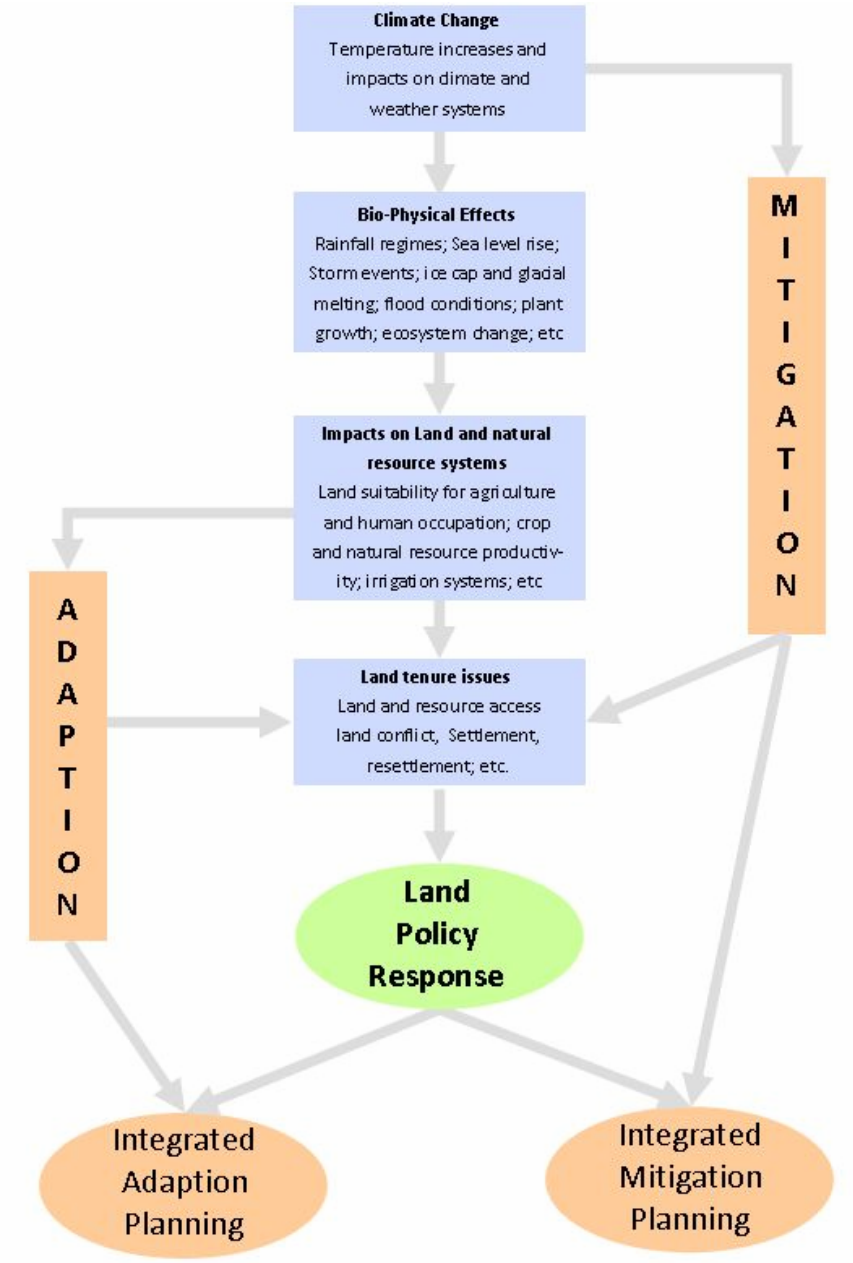
Source: Policy Research Corporation, "The economics of climate change adaptation in EU coastal areas", study done on behalf of the European Commission - Directorate-General for Maritime Affairs and Fisheries (Brussels and Rotterdam: no year), *11*

Quan and Dyer - who did previous research on climate change and land tenure - provided a framework to examine the relevant linkages between climate change effects, land usage and land policy.[1] According to this framework, the starting point is to identify main elements on climate change and its effects on land and natural resources. Based on this, the implications of these effects on human land usage have to be examined. This has to include long term changes as well as increased threats due to extreme weather events.[2]

Since the necessity to cope with social impacts generates requirements for adaptation by land users and policy makers, the third step is to identify potential adaptation measures and needs for systematic adaptation planning on different levels.

[1] Quan, Julian with Dyer, Nat, "Climate Change and land tenure – The implications of climate change for land tenure and land policy" (IIED - International Institute for Environment and Development and Natural Resources Institute, University of Greenwich: 2008), illustrated in figure 1 on the next page
[2] Quan and Dyer, "Climate Change and land tenure", 8

Figure 2.II: Framework for assessing land and climate change linkages according to Quan/Dyer



Adapted from: Quan, Julian with Dyer, Nat, "Climate Change and land tenure – The implications of climate change for land tenure and land policy" (IIED - International Institute for Environment and Development and Natural Resources Institute, University of Greenwich: 2008), 10

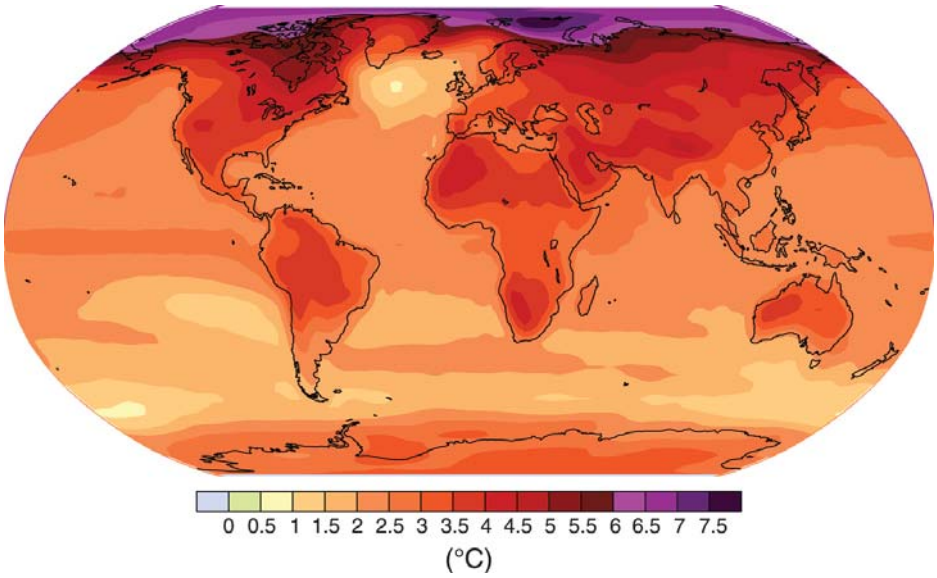
Simultaneously, the linkages between land usage and climate change mitigation measures have to be considered, because mitigation might require both strategic policy planning and careful consideration of social impacts.[3] Against this backdrop it is possible to identify in the last step, which implications the impacts of climate change as well as the implementation of adaptation and mitigation strategies will have for land policy. This approach covers issues like land tenure, access to land or resources, and the necessity of land management.

[3] Quan and Dyer, "Climate Change and land tenure", 8

2.2. Impacts of climate change on land usage

Although anthropogenic climate change is widely acknowledged among the scientific community, it is not easy to project its gravity and its impacts accurately. Therefore the *Intergovernmental Panel on Climate Change* (IPCC) developed several scenarios on the increase of global surface temperature until 2100, based on different predictions of the amount of greenhouse gas (GHG) emissions. The estimated average increase differs between 1.8 and 4.0 degrees Celsius while the likely range goes up to 6.4.[4] Since climate change is considered to be already in progress, even a progressive global strategy would not be able to completely prevent temperature increases during the next decades. As a consequence, a temperature increase between 1 and 3 degrees until 2050 is considered as virtually certain.[5]

Figure 2.III: Geographical pattern of surface warming



Projected surface temperature changes for the late 21st century (2090-2099). Temperatures are relative to the period 1980-1999.

Source: IPCC (ed.), "Climate Change 2007: Synthesis Report. Contribution of Working Groups I, II and III to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change – Summary for Policy Makers", (Cambridge University Press, Cambridge:2007), 7

[4] IPCC (ed.), "Climate Change 2007: Synthesis Report. Contribution of Working Groups I, II and III to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change – Summary for Policy Makers", (Cambridge University Press, Cambridge:2007), 7

[5] Quan and Dyer, "Climate Change and land tenure", 11

Figure 2 illustrates that the IPCC scenario assumes huge differences among the different areas around the world. Especially for the northern subpolar and polar regions the increase of temperatures is expected to be far above the average. This is particularly important because it has an impact on the arctic and on Greenland's ice shields. Additionally, it is through this that projections of the average rise of the sea level can be made. Depending on the scenarios and their range, IPCC projects a rise of sea level between 18 and 59 centimeters by the end of the 21st century.[6]

IPCC – Climate Scenarios (SRES)[7]

In this report, projections on climate change impacts and related maps and figures are based on the findings of the IPCC and based on its scenarios. Therefore the reader will find references e.g. to "IPCC scenario A1". These numbers refer to scenarios described in the IPCC Special report on emissions scenarios (SRES)[8] These scenarios are grouped into four scenario families (A1, A2, B1 and B2) that explore alternative development pathways, covering a wide range of demographic, economic and technological driving forces and resulting GHG emissions.

- The **A1** storyline assumes a world of very rapid economic growth, a global population that peaks in mid-century and rapid introduction of new and more efficient technologies. A1 is divided into three groups that describe alternative directions of technological change: fossil intensive (**A1FI**), non-fossil energy resources (**A1T)** and a balance across all sources (**A1B**).
- **B1** describes a convergent world, with the same global population as A1, but with more rapid changes in economic structures toward a service and information economy.
- **B2** describes a world with intermediate population and economic growth, emphasizing local solutions to economic, social, and environmental sustainability.
- **A2** describes a very heterogeneous world with high population growth, slow economic development and slow technological change.

Furthermore, climate change is projected to influence regional weather conditions, affecting precipitation, extreme weather events, and the availability of water. IPCC projects the following impacts of these changes[9]:

- Increased frequency of hot extremes, heat waves, and heavy precipitation
- Contraction of snow cover area, increases in thaw depth in permafrost regions, and decreases in sea ice extent

[6] IPCC (ed.), "Climate Change 2007: Synthesis Report – Summary for Policy Makers", 8 – According to IPCC this is an uncertain projection since it is based on the melting ice shields as it was observed between 1993 and *2003. This could increase or decrease in the future.*

[7] IPCC (ed.) "Climate Change 2007: Synthesis Report. Contribution of Working Groups I, II and III to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change", (Cambridge University Press, Cambridge: 2007), 44

[8] IPCC (ed.) "Emission Scenarios", (Cambridge University Press, Cambridge: 2000)

[9] IPCC (ed.), "Climate Change 2007: Synthesis Report – Summary for Policy Makers", 8-10; Quan and Dyer, "Climate Change and land tenure", 6

- Increases of intense tropical cyclone activity and pole ward shift of tropical storm tracks with consequent changes in wind, precipitation, and temperature patterns
- Potential shifts in regional weather patterns
- Increased incidence of storm tides
- Precipitation increases in high latitudes and decreases in most subtropical land regions
- Increased annual river runoff and water availability at high latitudes and in some tropical wet areas; decreased water resources in many semi-arid areas and dry regions at mid-latitudes and in the dry tropics, due to changes in rainfall and transpiration, and in areas dependent on snow and ice melt
- Increases in areas affected by drought

Virtually all of these projected impacts affect directly or indirectly the conditions and possibilities of human land usage. Changes in regional weather conditions and water availability affect agricultural productivity. The rise of sea levels as well as increased risk of floods and extreme weather events is a potential threat not only to agriculture but also to human settlements due to land loss. Figure 2.IV shows exemplarily on Asian countries the extent of land degradation caused mainly by wind or water.

Figure 2.IV: Extent of degraded land

Countries	Total land area (M ha)	Arable land area (% of total total land	Degraded land		Major causes
			Total area (m ha) total land	% of total land area	
Bangladesh	13.39	68	0.99	7.0	Water and wind
China	932.64	10	279.70	30.0	Water
India	297.32	57	144.10	48.5	Water and wind
Indonesia	181.16	12	43.00	24.0	Water
Laos	23.08	4	8.10	32.0	Water
Myanmar	65.75	15	0.21	3.2	Water
Pakistan	77.09	27	15.50	17.3	Wind and water
Philippines	29.82	27	5.00	16.8	Water
Western Samoa	0.28	43	0.03	11.3	Water
Sri Lanka	6.47	29	0.70	10.8	Forest clearing & water
Thailand	51.09	39	17.20	33.7	Water
Vietnam	32.54	20	2.90	8.9	Water

Source: Shrestha, Rajendra, "Land use and climate change", (presentation given at the API seminar series on Climate, Energy and Food Security in the Asia Pacific, Bangkok - 12 December 2008), 14

Effects on land usage do not have to be necessarily negative. The conditions for agricultural land usage, for example, are projected to improve in higher latitudes leading to potentially higher crop yields (compare figure 3). But in most regions changing weather conditions are projected to place diminishing supplies of land under greater pressure, for both productive use and human settlement.[10] One calculation estimates that the monetary costs of lost production due to land degradation are roughly US$65 billion per year already.[11] Examples of social implications of related climate change effects land usage can be found around the world:

- Especially in Africa, decreasing crop yields could leave hundreds of millions without the ability to produce or purchase sufficient food.
- Rising sea levels could result in tens to hundreds of millions of people affected by flooding each year.
- There will be serious risks and increasing pressures for coastal protection in Southeast Asia, small islands in the Caribbean, and the Pacific, as well as for large coastal cities.
- By the middle of the century, up to 200 million people could become permanently displaced due to rising sea levels, heavier floods, and more intense droughts.

[10] Quan and Dyer, "Climate Change and land tenure", 9
[11] Shrestha, Rajendra, "Land use and climate change", (presentation given at the API seminar series on Climate, Energy and Food Security in the Asia Pacific, Bangkok - 12 December 2008), 12

- Melting glaciers, increasing flood risk, and subsequently reduced water supplies, would eventually threaten one sixth of the world's population.

- Shifts in regional weather patterns (like monsoon rains in South Asia or the El Niño phenomenon) could cause severe consequences for water availability and flooding in tropical regions and threaten the livelihoods of millions of people.

- The melting or potential collapse of ice sheets threatens land which today is home to 1 in every 20 people.[12]

The effects on ecosystems and socioeconomic impacts for the society and their gravity will not only depend on the projected local temperature rise or weather conditions, but also on the vulnerability and the adaptation capacity of a certain region or community. Especially in poor regions, where this capacity is low, the projected changes might have enormous social implications due to constraints to basic needs. Therefore, in order to avoid economic and social costs, policy planning to deal with conflicts and support or implement adaptation measures is needed. This in turn will generate the need for different, regional, and case-specific policies, such as strengthening management capacities, establishing institutions, setting legal frameworks etc.

As a Summary, figure 2.V provides an overview of the linkages discussed so far, considering the climate change effects, their impacts on land use, social implications and issues for land policy and land tenure that may arise out of this:

Figure 2.V: Land-related impacts, risks and policy implications

Climate Change effect	Impact on land usage	Social implications	Land tenure and policy issues
- Temperature rise	- Initial increases followed by reductions in crop yields	- Reduced food production and food security - Changes in land suitability for different crops; increased land competition - Exits from agriculture	- Tenure security for retention of land holdings investment in improved land use - land reallocation and access due to changes in land suitability
- Reduced rainfall - greater rainfall variability	- Less water availability for agriculture	- Reduced food production and food security - Increased land competition and - exits from agriculture - Competition for water use	- As above - Need for improved water resource management - Strengthened governance of remaining productive areas

[12] Quan and Dyer, "Climate Change and land tenure", 6; See also: IPCC (ed.), "Climate Change 2007: Synthesis Report – Summary for Policy Makers", 8-10.

- Increases in rainfall	- Possible increases in land productivity	- Flood and erosion risks - May lead to new opportunities - migration - Resource competition	- Need for institutions to manage mobility, land use / tenure change, and regulate conflict where new opportunities emerge
- Sea level rise - increased frequency of storm surges	- Coastal and inland flooding - Salinisation of coastal lands	- Displacement and migration - Declines and losses of coastal and riverine resource and livelihood systems	- Greater tenure security to facilitate adaptive management; resettlement and facilitated migration - Compensation for land loss - Improved land inventory - Land sharing and release schemes
- Increased glacial melt	- Initial greater and earlier seasonal volume of melt waters with heightened flood risk - Longer term declines in melt waters	- Short run implications for management and seasonal use of glacial melt waters - Longer run declines in productivity and sustainability of glacial fed irrigation systems Risks to settlement in sub-glacial areas	- Dam construction for seasonal water - Flood management - Short term displacement and resettlement - Better land and water management in irrigation systems
- Biodiversity loss	- Extent and diversity of natural ecosystems	- Threats to hunting & gathering livelihood systems - Increased pressures on particular species and ecosystems	- Better governance of common lands - Conservation of genetic resources and indigenous knowledge

Adapted from: Quan and Dyer, “Climate Change and land tenure”, 13; see also: IPCC (ed.), “Climate Change 2007: Synthesis Report – Summary for Policy Makers”, 13

2.3. Social implications and adaptation strategies

In order to look deeper into the anticipated social impacts of climate change effects and to identify adaptation measures and needs for adaptation, the effects and implications that are named in Table 3 are structured into two main categories related to seal level rise and change in agricultural productivity. Of course these aspects are interlinked since sea level rise, for example, also threatens agricultural land use. But aiming to elaborate target points for adaptation differentiation is useful to focus on adaptation to sea level rise separately from adaptation in agricultural production.

Impacts of sea level rise

The so-called *Low Elevation Coastal Zone* (LECZ) - defined as area along the coast that is less than ten meters above sea level – is especially threatened by sea level rise. While the definition applies only for 2% of land area worldwide, 10% of the world's population and 13% of the world's urban population lives there.[13] Considering also the "near coastal zone", defined as being within 100 meters of elevation and up to 100 km from the coast, up to 1.2. billion people could directly or indirectly be affected by sea level rise.[14] The following effects particularly threaten coastal areas:

Table 2.VI: Risks of climate change effects on coastal areas

Effect	Risk for coastal area
General rise of sea level	• Increased risk of floods • Damages from flood and storm • Erosion • Saltwater intrusion • Rising water tables • Wetland loss
Increasing storm intensity or frequency	• Extreme water levels and wave heights • Episodic erosion • Risk of storm damages • Risk of flooding and defense failure
Water run-off/precipitation	• Flood risk in coastal lowlands • Impacts on water quality/salinity • Altered fluvial sediment supply • Altered circulation and nutrient supply

Source: IPCC (ed.),"Climate Change 2007: "Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change, Chapter 6", (Cambridge University Press, Cambridge:2007), 323

[13] Quan and Dyer, "Climate Change and land tenure", 23

[14] IPCC (ed.) "Climate Change 2007: "Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change, Chapter 6", (Cambridge University Press, Cambridge:2007), 323

On the economic importance, Quan and Dyer estimate, that $1 trillion US worth of assets are contained on coastal land less than 1-m elevation above current sea level, and almost two thirds of the world's mega cities with populations greater than 5 million are situated at least partly within the LECZ.[15] The recent 2011 flood in Ayutthaya and Bangkok has demonstrated what impacts as well as social and economic costs extreme floods and weather events can cause. Although it would be scientifically incorrect to link the latest flood in Thailand or any other extreme weather condition directly to climate change impacts, it is sufficient to draw the conclusion, that climate change is projected to increase the frequency and the intensity of those kinds of extreme conditions. The IPCC working group report states that, for example, for Thailand, *"loss of land due to a sea-level rise of 50 cm and 100 cm could decrease national GDP by 0.36% and 0.69% (US$300 to 600 million) per year, respectively; due to location and other factors, the manufacturing sector in Bangkok could suffer the greatest damage, amounting to about 61% and 38% of the total damage, respectively."*[16]

Sea level rise and its effects also have potential impacts on coastal lands that are used for agriculture. This is not only related to short term damages through floods or storms, but especially through the increased salinity levels that could be caused through storm tides and the inundation of salt water into agricultural areas and the ground water. Through this effect and the potential permanent loss of wetlands, according to Quan/Dyer who analyzed potential impacts only for Bangladesh which is highly threatened through sea level rise, Bangladesh alone, for example, could lose up to a million hectares of agricultural land.[17]

Regions that are identified as particularly vulnerable are the highly populated mega deltas. The following map shows hotspots around the world marked by the potential number of people that could be displaced due to sea level rise and its consequences until 2050. As the map shows, the issue is especially relevant for East and Southeast Asia, where coastal areas and mega deltas are densely populated. The biggest hotspots here are the Mekong and the Ganges deltas:

[15] Quan and Dyer, "Climate Change and land tenure", 23
[16] IPCC (ed.), "Climate Change 2007: Working Group II, Chapter 6", 339
[17] Quan and Dyer, "Climate Change and land tenure", 23

Figure 2.VII: Vulnerable deltas and mega deltas around the world

Relative vulnerability of coastal deltas as shown by the indicative population potentially displaced by current sea-level trends to 2050 (Extreme = >1 million; High = 1 million to 50,000; Medium = 50,000 to 5,000; following Ericson et al., 2006).

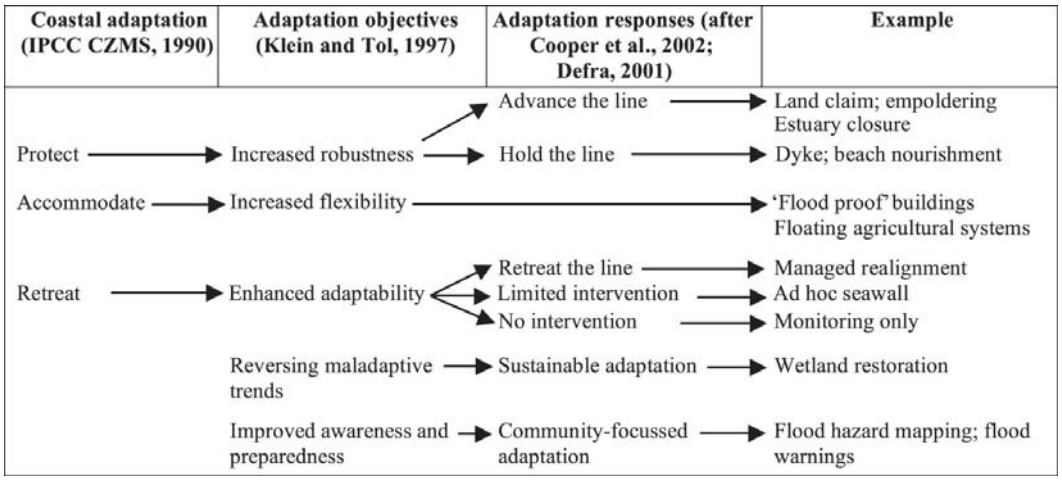
Source: IPCC (ed.), Climate Change 2007: "Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change, Chapter 6", (Cambridge University Press, Cambridge:2007), 327.

When it comes to the threats to human settlements, Quan/Dyer identify a particular group that is especially under threat: the urban poor.[18] They are considered most vulnerable to flooding due to a lack of infrastructure, bad sanitary conditions, inadequate housing conditions, and poor drainage. The authors estimate that up to 360 million people live under these conditions in the LECZ. Referring to this, the IPCC states that any significant additional stress could be the trigger for serious disruptive events and impacts, and these are likely to be particularly acute in coastal cities.[19] As an additional constraint, the urban poor do not have many alternatives. They often have to settle in threatened areas because land in other areas is not available and/or affordable.[20] In the long term perspective, the permanent loss of land could displace millions of people from the LECZs.

Adaptation strategies to cope with this can be divided into three categories: retreat, accommodation, and protection.[21] Based on findings by different studies named in the table, the following figure gives an overview on the three main strategies and their objectives.

[18] Quan and Dyer, "Climate Change and land tenure", 24
[19] Cited in: Quan and Dyer, "Climate Change and land tenure", 24
[20] Quan and Dyer, "Climate Change and land tenure", 25
[21] Quan and Dyer, "Climate Change and land tenure", 19

Figure 2.VIII: Adaptation strategies for coastal areas



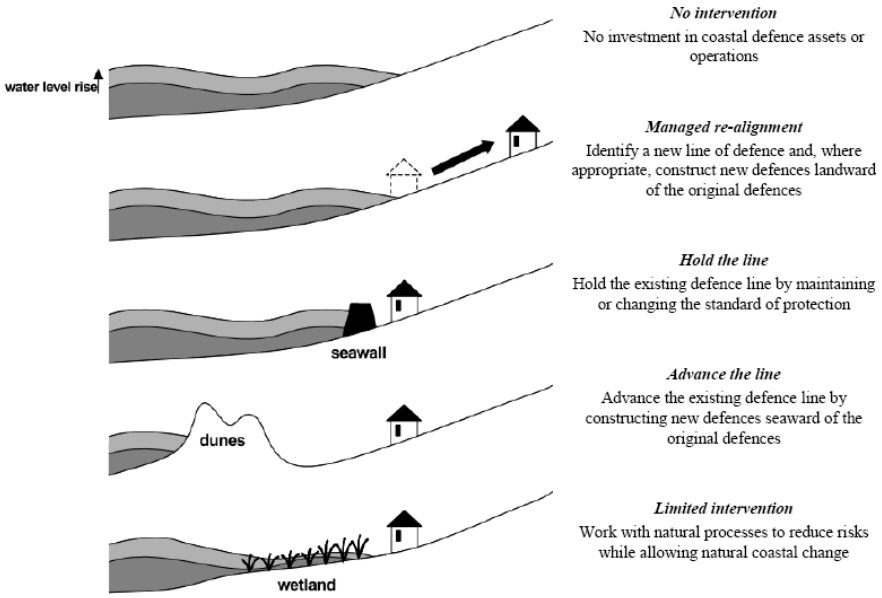
Source: IPCC (ed.), "Climate Change 2007: "Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change, Chapter 6", (Cambridge University Press, Cambridge: 2007), 342.

Retreat basically means the (partial) withdrawal from threatened areas and/or the limitation to ad-hoc measures. This strategy generates the necessity for resettlements that would require money and available settlement areas. Even if mass resettlement would be affordable - what can be doubted in most LDCs - this would cause further social impacts on the non-coastal areas. Due to the scarcity of land, stress in water and food supply or high population density, the scope of migration and the availability of land are very limited in many regions.[22] Therefore, mass retreat with the necessity of resettlement is not an option where it can be avoided.[23] *Protection* refers to coastal and flood protection, like measures to elevate dikes or build new ones, establish polders or retention basins for storm water runoff and flood warning systems. *Accommodation* is a form of strategic adaptation to cope with flood and weather impacts. This includes forestation measures or mangrove conservation to mitigate flood-induced soil erosion. In the agricultural sector this means, for example, to change to crop varieties that are ruggedized (e.g. deep water rice that can resist longer flooding periods). A curious but quite colorful example of accommodation as an adaptation strategy is a Dutch company that builds houses that can swim and therefore rise upwards with the flood.[24]

[22] Quan and Dyer, "Climate Change and land tenure", 20
[23] Quan and Dyer, "Climate Change and land tenure", 19
[24] Spiegel Online, "Dutch Answer to Flooding: Build Houses that Swim", last modified: 26.09.2005 http://www.spiegel.de/international/spiegel/0,1518,377050,00.html (accessed 01.02.2012)

Figure 2.IX: Overview of Coastal Management Measures and Shoreline Management

	Protect = effort to continue use of vulnerable areas	*Accommodate* = effort to continue living in vulnerable areas by adjusting living and working habits	*Retreat* = effort to abandon vulnerable areas
Hard	Dikes, seawalls, groins, breakwaters, salt water intrusion barriers	Building on pilings, adapting drainage, emergency flood shelters	Relocating threatened buildings
Soft	Sand nourishments, dune building, wetland restoration or creation	New building codes, growing flood or salt tolerant crops, early warning and evacuation systems, risk-based hazard insurance	Land use restriction, set-back zones



Source: Policy Research Corporation, "The economics of climate change adaptation in EU coastal areas", study done on behalf of the European Commission - Directorate-General for Maritime Affairs and Fisheries (Brussels and Rotterdam: no year), 13 and 14

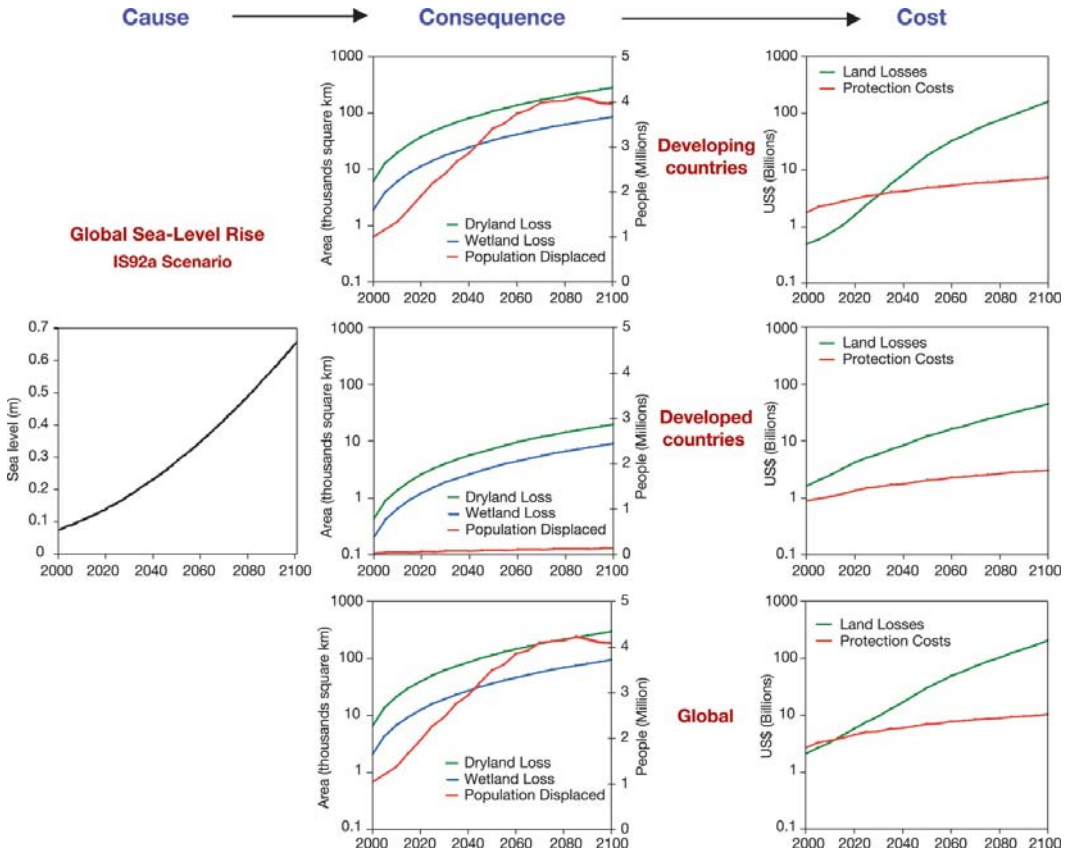
Adaptation in the form of accommodation in urban settlements is much more complicated. Since resettlement is often impossible or not affordable for the urban poor, policy measures could be taken to support their adaptation capacity, including the upgrade of informal settlements, improving tenure security, increasing delivery of appropriate land through public-private collaboration, simplifying and strengthening planning arrangements and extend popular participation.[25]

However, the biggest constraint to potential adaptation is the financial issue. Especially, protection measures can be quite expensive. Roughly estimated by IPCC, adaptation measures would cost the developing countries over one billion dollars per year. Nevertheless these costs are - due to land loss

[25] Quan and Dyer, "Climate Change and land tenure", 26

and displacement - far outweighed by costs of non-adaptation in the long run, as figure 7 demonstrates:

Figure 2.X: Consequences and costs of land loss due to sea level rise



Source: IPCC (ed.), "Climate Change 2007: "Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change, Chapter 6", (Cambridge University Press, Cambridge: 2007), 339.

In addition to the economic challenge, IPCC names further impediments to the success of coastal adaptation:

- Lack of dynamic predictions of landform migration
- Insufficient or inappropriate shoreline protection measures
- Data exchange and integration hampered by divergent information management systems
- Lack of definition of key indicators and thresholds relevant to coastal managers

- Inadequate knowledge of coastal conditions and appropriate management measures
- Lack of long-term data for key coastal descriptors
- Fragmented and ineffective institutional arrangements and weak governance
- Societal resistance to change[26]

These constraints show that, in the long run, successful and sustainable adaptation strategies will depend on knowledge and capacity building as well as on political management.

Impacts of changes in agricultural productivity

Agricultural land use was already named several times as one sector that is especially vulnerable to climate change impacts. All changes of weather conditions, such as temperature increases, rainfall variation, water availability, droughts etc. influence the possibilities to plant certain crops or to harvest. According to the *Food and Agriculture Organization of the United Nations* (FAO) the following factors are most relevant for agriculture (and fishery):

- Physiological effects on crops, pasture, forests, and livestock (quantity, quality)
- Changes in land, soil, and water resources (quantity, quality)
- Increased weed and pest challenges
- Changes to ocean salinity and sea temperature rise causing fish to inhabit different ranges[27]

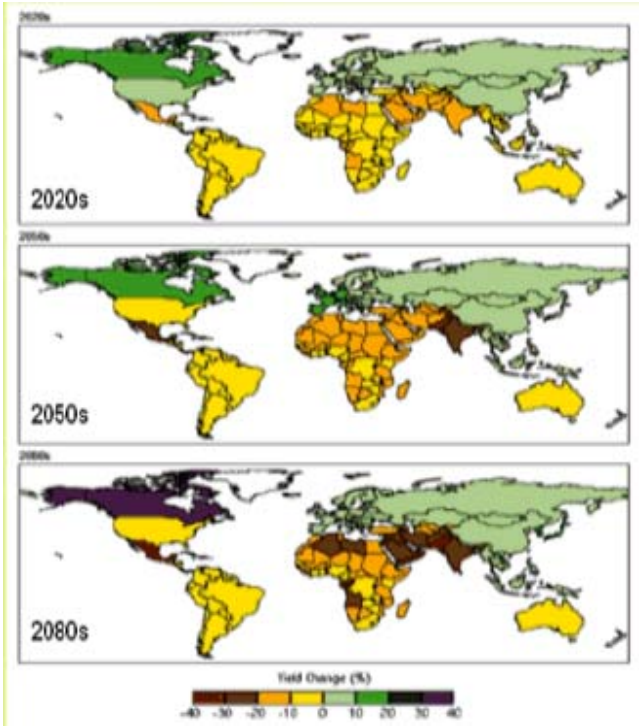
Furthermore, vast areas of land might become completely useless for agriculture due to soil degradation. According to Shrestha, one third of the world's total land and 69% of agricultural dry lands are threatened by degradation.[28]

These risks are particularly evident for low technological rain-fed agricultural plantations in developing countries. According to the FAO, this applies for example to 95% of the cropland in Africa.[29] The socioeconomic consequences starting with a decline in yields and production would lead to a reduced marginal *Gross Domestic Product (*GDP) from agriculture. The social implications of decreasing agricultural productivity are very dire in regions where food and water supply is already

[26] IPCC (ed), "Climate Change 2007:- Working Group II, Chapter 6", 341
[27] FAO (ed.), "Adaptation to climate change in agriculture, forestry and fisheries: Perspective, framework and priorities", (Food and Agriculture Organization of the United Nations, Rome: 2007), p.2.
[28] Shrestha, "Land use and climate change", 12
[29] Cited in: Quan and Dyer, "Climate Change and land tenure", 12

under stress today - leading to an increased number of people at risk of hunger.[30] Since in many developing countries, agriculture is still the main source of income for relatively large parts of the population (e.g. in Africa approximately 70% rely on agriculture).[31] Loss of agricultural land or decreasing productivity also threatens the economic livelihood of local communities and might lead to exits from agriculture, migration, or even civil unrest.[32]

Figure 2.XI: Projected change in crop yield by region



Source: Shrestha, Rajendra, "Land use and climate change", (presentation given at the API seminar series on Climate, Energy and Food Security in the Asia Pacific, Bangkok - 12 December 2008), 25 – based on IPCC data (according to the author)

Figure 3 confirms that especially the developing countries in Africa, South America, and South Asia, will have to cope with decreasing crop yields. For some African regions, the IPCC projects that already by 2020 between 75 and 250 million of people could be exposed to increased water stress.

[30] FAO (ed.), "Adaptation to climate change in agriculture, forestry and fisheries: Perspective, framework and priorities", 2
[31] FAO (ed.), "Adaptation to climate change in agriculture, forestry and fisheries: Perspective, framework and priorities", 6; Quan and Dyer, "Climate Change and land tenure", 12.
[32] FAO (ed.), "Adaptation to climate change in agriculture, forestry and fisheries: Perspective, framework and priorities", 2

Therefore, the IPCC state that yields from rain-fed agriculture could be reduced by up to 50%.[33] As a consequence, the panel projects that "*agricultural production, including access to food, in many African countries is projected to be severely compromised and this would further adversely affect food security and exacerbate malnutrition."*[34]

The need for adaptation in the agricultural sector is therefore highly demanded in order to maintain a stable level of productivity and ensure food security. But even in regions where the general crop yield is not projected to decrease, climate change effects generate the need for adaptation in agricultural production. In Thailand, for example, it is projected that changing weather conditions will have a negative impact on rice plantations. Jintana Kawaski from UN University states that the unpredictability of conditions that affect rice growing (rainfall distribution, temperature levels and increasing types of pests and diseases) will intensify in the years ahead. As an outcome, without adaptation, the rice production could decrease up to 10% in the regions examined in his survey. [35]

These changes and constraints to agricultural productivity force producers worldwide to implement adaptation measures. According to Reilly and Schimmelpfennig, the major classes of adaptation in agriculture are defined as following:[36]

- Adaptation of seasonal changes and sowing dates
- Using different variety or species
- Improved water supply and irrigation system
- Technological inputs (fertilizer, tillage methods, grain drying, other field operations)
- Using new crop varieties
- Forest fire management, promotion of agro forestry, adaptive management with suitable species and silvicultural practices[37]

[33] IPCC (ed.), "Climate Change 2007: Synthesis Report – Summary for Policy Makers", 11
[34] IPCC (ed.), "Climate Change 2007: Synthesis Report – Summary for Policy Makers", 11
[35] Kawasaki, Jintawa, "Thailand rice farmers adapt to climate change", http://ourworld.unu.edu/en/climate-change-adaptation-for-thailands-rice-farmers/, (accessed 18.01.2012)
[36] Reilly, J.M. and Schimmelpfenning, D. "*Agricultural impact assessment, vulnerability, and the scope for adaptation"* Climatic Change 43(1999), 745–788, cited in: FAO (ed.), "Adaptation to climate change in agriculture, forestry and fisheries: Perspective, framework and priorities", 5.
[37] Reilly, J.M./Schimmelpfenning, D. *Agricultural impact assessment, vulnerability, and the scope for adaptation*. Climatic Change 43(1999), 745–788, cited in: FAO (ed.), "Adaptation to climate change in agriculture, forestry and fisheries: Perspective, framework and priorities", 5.

As they react to climate and weather changes they already face, farmers themselves already have taken autonomous adaptation measures based on their own experiences with the local weather conditions such as changes of crops or using of different harvest and planting/sowing dates.[38] Beyond that, further adaptation measures may generate the requirements for systematic planning at different levels such as introducing land management practices or the development of new crops.[39] Referring to the example of the Thai rice farmers given above, the farmers on the one hand have adopted seasonal changes themselves while the Thai government has been promoting new genetically modified rice varieties that can remain longer in flood waters or are especially drought resistant.[40]

In general, successful adaptation could not only help to cope with negative effects on agriculture, but even increase productivity. The FAO calculates that in South and Southeast Asia a projected decrease of 0.7% in overall GDP could be turned into an increase of 0.6% if proper adaptation measures will be taken.[41] Also Jintawa states that – in contrast to the projected decrease of 10% - the rice yield in the observed regions could be higher in 2047 than today if efficient technologies would be used.[42]

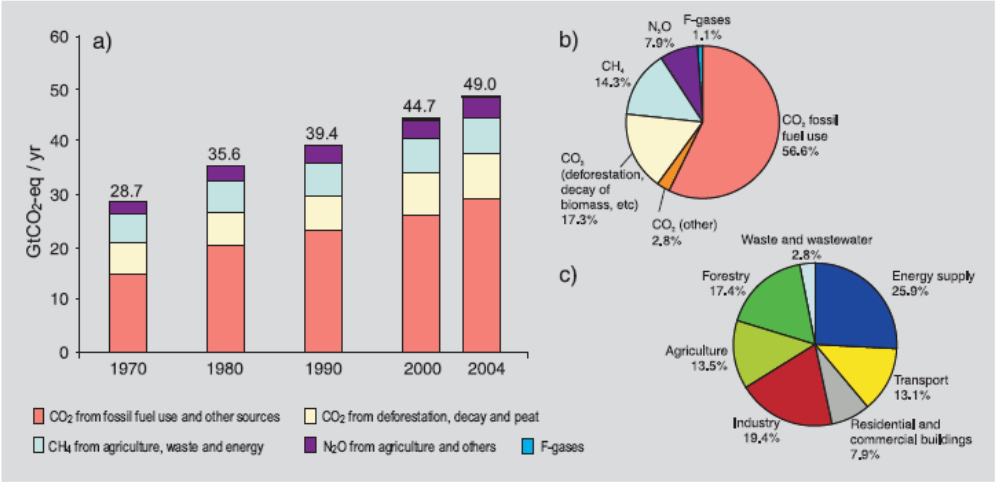
The challenge related to these adaptation measures is that especially the most affected poor regions and communities might not have the economic possibilities to change their production through introducing new technologies or buying more expensive crop varieties. Also, developing and least developed countries might not have the capacity to introduce such policies or provide sufficient financial and technical support. Another potential problem in these countries is the lack of enforcing institutions or pastoral legislation. Furthermore, land rights and land tenure are often unclear or not even defined.[43] Therefore a question for policy making is how these adaptation measures can be implemented where they are most needed.

[38] FAO (ed.), "Adaptation to climate change in agriculture, forestry and fisheries: Perspective, framework and priorities", 5
[39] Quan and Dyer, "Climate Change and land tenure", 8
[40] Kawasaki, Jintawa, "Thailand rice farmers adapt to climate change"
[41] FAO (ed.), "Adaptation to climate change in agriculture, forestry and fisheries: Perspective, framework and priorities", 3 – The timeframe for this projection was not given.
[42] Kawasaki, Jintawa, "Thailand rice farmers adapt to climate change"
[43] Quan and Dyer, "Climate Change and land tenure", 35

2.4. Land usage and climate change mitigation

The importance of human land usage as a source of global warming is underlined by the fact that agriculture and forestry together cause nearly one third of GHG emissions. This is more than the emissions from the energy, transport, or even industry sector, as shown in Figure 3:

Figure 2.XII: Global anthropogenic GHG emissions



Source: IPCC (ed.), "Climate Change 2007: Synthesis Report. Contribution of Working Groups I, II and III to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change – Summary for Policy Makers", (Cambridge University Press, Cambridge: 2007), 5

Being responsible for 13.5% of overall GHG emissions, the agricultural sector particularly causes emissions of non-CO_2 GHGs. Based on data from different studies, the IPCC holds it responsible for 32-38% of all non-CO_2 emissions in total, for 47% of all CH_4, and 58% of all N_2O emissions.[44] The largest sources of these emissions are enteric fermentation, N_20 from the soil, biomass burning, rice production, and manure management.[45]

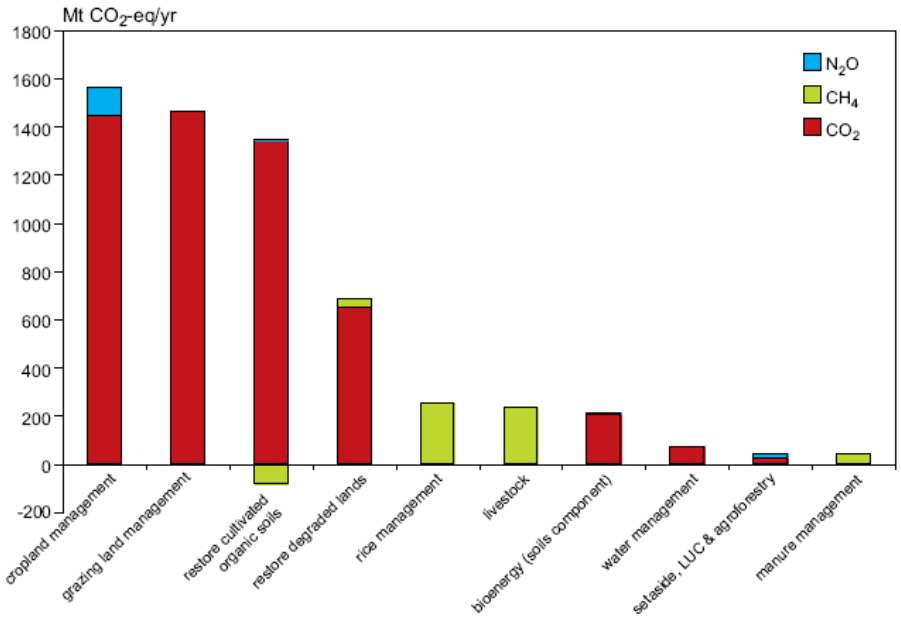
The amount of GHG emissions in the agricultural sector is especially high in developing countries where rice production and burning of biomass are the main sources of emissions, with 97% and 92% of world totals, respectively. While CH_4 emissions from rice occurred mostly in South and East Asia,

[44] IPCC (ed.), "Climate Change 2007: Mitigation. Contribution of Working Group III to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change", Chapter 8, (Cambridge University Press, Cambridge: 2007), 503
[45] IPCC (ed.), "Climate Change 2007 - Working Group III, Chapter 8", 503

those from biomass burning mainly originated in Sub-Saharan Africa and Latin America and the Caribbean.[46]

Mitigation potentials can be found at many steps of the agricultural production process, including the management of crop and grazing land, livestock feeding, water management, land restoration, or the use of bioenergy. A detailed overview on potential mitigation measures related to these sectors is provided in Annex 2.I. to this study. As figure 2.XIII shows, proper land management alone could avoid up to three gigatones of CO_2 and N_2O per year.

Figure 2.XIII: Global technical mitigation potential in the agricultural sector



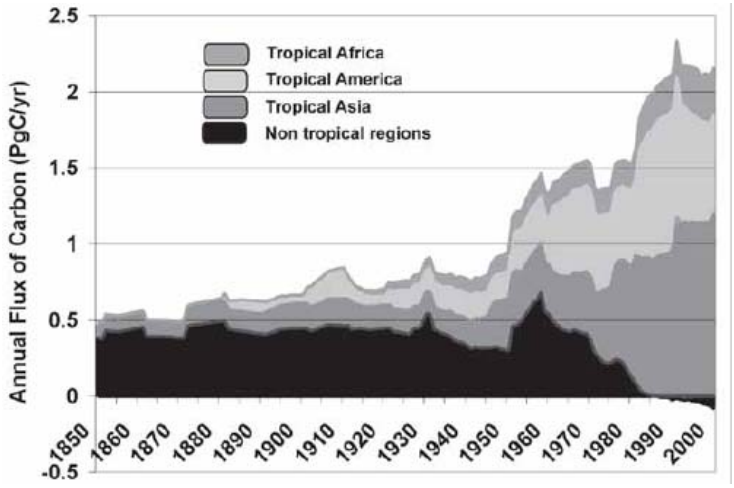
Source: IPCC (ed.), "Climate Change 2007: Mitigation. Contribution of Working Group III to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change", Chapter 8(Cambridge University Press, Cambridge: 2007), 515.

Somehow these mitigation measures are consistent with the adaptation policies in terms of rising productivity and simultaneously lower consumption of resources. Therefore, constraints are also familiar. First of all, many low technology-based farms in developing countries might neither have the economic wherewithal nor the knowledge to implement new technologies, effective land management, or different crops. Therefore, the need for systematic planning on different levels and policy making also applies for effective mitigation planning. Second, it is important that the farmers

[46] IPCC (ed.), "Climate Change 2007 - Working Group III, Chapter 8", 503-504.

have a net benefit from the changes, because otherwise they won't adapt. Therefore, incentives and or regulations might be needed to encourage certain practices.

Figure 2.XIV: Carbon released through Deforestation



Source: Houghton, Richard A., "Tropical deforestation as a source of greenhouse gas emissions", in Tropical Deforestation and Climate Change, ed. Paulo Moutinho and Stephan Schwartzman, (Belem, Brazil: Amazon Institute for Environmental Research, 2005), 17

The second major source of GHG emissions is deforestation, causing 17.3% of global GHG emissions. It is estimated that worldwide forests hold over 50% of terrestrial carbon. Furthermore, especially tropical forests – while accounting for only slightly less than half of the world's forest area - hold about 50% more carbon per hectare than trees outside the tropics.[47] It is even calculated that tropical forests alone hold more CO_2 than the remaining fossil fuel resources.[48] Therefore deforestation, especially if forests were just burned down by farmers,[49] can cause enormous releases of carbon to the atmosphere. According to the Quan/Dyer, in some countries, like Indonesia or Brazil, deforestation is even the largest source of GHG emissions at all.[50] Over the last few years, Asia has become the main emitter of GHG through deforestation. Based on the current trends, Houghton concludes, that tropical deforestation could release about as 50% as much carbon to the

[47] Houghton, Richard A., "Tropical deforestation as a source of greenhouse gas emissions", in Tropical Deforestation and Climate Change, ed. Paulo Moutinho and Stephan Schwartzman, (Belem, Brazil: Amazon Institute for Environmental Research, 2005), 15-16
[48] World Wildlife Fund (WWF), Deforestation and Climate Change -Forest Area Key Facts &Carbon Emissions from Deforestation (no year), 3
[49] On the effects of forest fires on carbon emission see for example Alencar et al.,"Carbon emissions associated with forest fires in brazil", in Tropical Deforestation and Climate Change, ed. Paulo Moutinho and Stephan Schwartzman, (Belem, Brazil: Amazon Institute for Environmental Research, 2005)
[50] Quan and Dyer, "Climate Change and land tenure", 39

atmosphere as has been emitted through fossil fuels since the start of the industrial revolution.[51]

Despite the release of bounded carbon, deforestation also reduces the storage capacity for terrestrial carbon in the future. Even if the land is used for plantations, it only has a capacity of one third to one half of a natural forest to store carbon due to the different storage capacity of the plants and recurring harvests.[52] Figure 2.XV shows the relative loss of storage capacity for different kinds of post-deforestation land usage:

Figure 2.XV: Carbon loss depending on land use

Land Use	Carbon lost to the atmosphere expressed as % of initial carbon stocks	
	Vegetation	Soil
Cultivated land	90-100	25
Pasture	90-100	12
Degraded croplands and pastures	60-90	12-25
Shifting cultivation	60	10
Degraded forests	25-50	<10
Logging	10-50	<10
Plantations*	30-50	<10
Extractive reserves	0	0

Source: Houghton, Richard A., "Tropical deforestation as a source of greenhouse gas emissions", in Tropical Deforestation and Climate Change, ed. Paulo Moutinho and Stephan Schwartzman, (Belem, Brazil: Amazon Institute for Environmental Research, 2005), 15

The IPCC names four main categories of ways how forestry can contribute to the mitigation of GHG emissions:

- Maintaining or increasing the forest area through reduction of deforestation and degradation and through afforestation/reforestation
- Maintaining or increasing the stand-level carbon density (tones of carbon per ha) through the reduction of forest degradation and through planting, site preparation, tree improvement, fertilization, uneven-aged stand management or other appropriate silviculture techniques

[51] Houghton, "Tropical deforestation as a source of greenhouse gas emissions", 20
[52] Houghton, "Tropical deforestation as a source of greenhouse gas emissions", 15

- Maintaining or increasing the landscape-level carbon density using forest conservation, longer forest rotations, fire management, and protection against insects

- Increasing off-site carbon stocks in wood products and enhancing product and fuel substitution using forest-derived biomass to substitute products with high fossil fuel requirements and increasing the use of biomass-derived energy to substitute fossil fuels[53]

However, the implementation of these measures raises social implications as well, since, for example, local communities in many cases burn forests for farming and though fulfilling their basic needs. Therefore forest preservation measures are likely to further undermine land access to those people who are already under threat. A political response could be to set incentives that make it attractive for locals to maintain the forests by providing jobs in the forestry sector or financial incentives. On an international level, it is, for example, possible, to include anti-deforestation projects - so called LULUCF (Land use, land use change, and forestry) projects - under the Clean Development Mechanism (CDM).[54] LULUCF has been defined by United Nations Climate Change Secretariat as a greenhouse gas inventory sector that covers emissions and removals of greenhouse gases resulting from direct human-induced land use, land-use change, and forestry activities. LULUCF has been extensively studied internationally in order to better understand the impacts on the global carbon cycle and how these activities can add or remove carbon dioxide from the atmosphere, contributing to solving the dilemma of climate change.

Also projects under the titles of RED (Reduced Emissions from Deforestation) or REDD (Reduced Emissions from Deforestation and Degradation of forests) aim to establish systems of financial incentives. The basic idea of these incentives is to include forests in carbon trade. This would mean, that existing forest areas as well as reforestation projects are being granted with carbon credits that could be traded. Through this there would be a financial incentive to maintain forest areas as a source of income. Including this into global carbon trade and the CDM would furthermore set an incentive for companies and developed states to finance and conduct reforestation projects in developing countries in order to gain carbon credits. However, this is a controversial approach. Critics

[53] IPCC (ed.), "Climate Change 2007: Mitigation. Contribution of Working Group III to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change", Chapter 9, (Cambridge University Press, Cambridge: 2007), 549
[54] Quan and Dyer, "Climate Change and land tenure", 39

argue that an inclusion of forests and reforestation in carbon trade would float the market with carbon credits and therefore weaken the instrument.[55]

2.5. Political and institutional challenges

The sections above already named several challenges that are related to successful adaptation and mitigation, especially for developing countries. Acknowledging that adaptation has to be addressed at different levels of society – from autonomous adaptation by individuals up to the potential necessity for supranational cooperation – it has to be identified what measures have to implemented on what level and who is capable of doing that. While, for example, the changing of seed dates was named as an act of autonomous adaptation, coping with natural disasters might generate transnational actions. Dealing with ASEAN, EU, and NAFTA it will be particularly important to compare the influence and capability of supranational planning and implementation capacity.

The second aspect is the economic problem. Although climate change adaptation is much cheaper in the long run, adaptation and mitigation have to be financed. The main reason why the adaptation capacity of individuals and local communities in developing countries is considered as being very poor is that they are not able to conduct autonomous adaptation that is cost intensive. This is a big constraint for introducing new technologies or flood protection measures. Therefore action by a higher level might be needed to implement adaptation measures, offer financial support, etc. But again, the most affected countries and regions in the world in many cases do not have the economic capacity to take the necessary measures and/or support local initiatives. In this case it has to be further discussed how measures could be supported in the framework of development cooperation. The CDM mechanism is just one example of such cooperation that could work.

The third issue is the balance of economic interests in land use and the needs of adaptation and mitigation. (e.g. forest protection vs. livelihood of rural communities). This could also just mean that market chances for certain products are better than for those considered more sustainable. After Hurricane Kyrill destroyed large forest areas in central Europe in 2007, it was recently criticized that due to economic interests, reforestation has focused on pinewoods instead of mixed forests that are more robust and could help to minder destruction and soil erosion in case of a similar weather event.[56] Therefore it has to be examined how these interests were balanced in similar cases. What

[55] BUND für Umwelt und Naturschutz Deutschland e.V. (BUND), "*Verantwortung Ernst nehmen* – Industriestaaten muessen Klimaschulden tilgen", BUND-Positionen zur Weltklimakonferenz in Poznan, (Berlin: 2008), 2

[56] NABU Niedersachsen, „Chance für naturnahe Wiederbewaldung vertan Forst- und Holzwirtschaft haben zu wenig aus Kyrill-Katastrophe gelernt", last modified 18.01.2012, http://niedersachsen.nabu.de/themen/wald/14518.html (accessed: 03.02.2012)

possibilities do the authorities have to enhance economic behavior that is in accordance with adaptation and mitigation needs? Theoretical possibilities could be the subsidies, other financial incentives, systems of carbon trade etc. If incentives are not enough, the question beyond that has to be raised as to how far authorities should be entitled to enforce the adaptation and mitigation agenda by legal regulations on land use. (e.g. dictate certain crop plantations). Since EU, NAFTA, and ASEAN are designed as free trade areas with the goal of minimizing constraints to the free flow of goods, capital, and services, this question might also need to be addressed on the supranational level.

This leads to a fourth issue: the political management. Since the impacts of climate change as well as adaptation and mitigation measures cause social impacts, adaptation and mitigation planning has to cope with that. Balancing the economic interests and adaptation and mitigation needs as described above demands such political management to avoid conflicts and gain public support. Also the concrete implementation of adaptation measures potentially raises challenges that have to be managed. If, for example, land loss or desertification causes significant migration movements, policy will have to ensure that the process is somehow managed to avoid civil unrest and potential conflicts. This means that, for instance, if retreat from a certain area is acknowledged as being unavoidable, resettlement areas have to be defined and land access to be ensured. Political management also means that the demands of adaptation and mitigation have to be balanced with other interests of society. An example of contradicting interests is the production of biofuels. In order to mitigate CO_2 emissions, the use of it is promoted in many parts of the world. Subsidies as well as demand-driven price increases have led to an increase of ethanol plantations and production. This limits the space available for food production. For example, a decline in corn available for the food market due to ethanol production in the United States was held responsible for a massive increase in corn prices in Mexico in 2007, leading to the so called "Tortilla riots".[57] Therefore a comprehensive adaptation and mitigation planning will have to balance the needs of mitigation with the basic needs such as food security, especially in countries where the food supply is already under stress. Beyond such economic interests, this also affects other political preferences. The extension of alternative energy supplies, for example, requires land for solar or wind energy parks as well as for high voltage lines etc. Although, the scale is not really high, this might cause resistance. This is mainly a challenge in developed countries. In Germany for example, the enforced energy transition plan generated the need for a massive extension in the supply infrastructure. Although the German public generally approves of the energy transition plan, citizen action groups and political parties on the

[57] Financial Times. "Tortilla riots give foretaste of food challenges", last modified 12.10.2010, http://www.ft.com/cms/s/0/a0aa9ef0-d618-11df-81f0-00144feabdc0.html#axzz1lDDzohIU (accessed 02.02.2012)

local level oppose construction measures in many cases due to assumed negative impacts on the local level. As a result, the political challenge in developed countries is not so much related to economical constrains but on the capacity to balance interests and to implement decisions. Looking at the following cases, it will be therefore interesting to see if best practice examples for such political planning exist.

The fourth issue can be named as a legal and institutional one. Since it also affects the other three named aspects it can be also seen as a comprehensive one. The possibility to effectively implement any measures of adaptation or mitigation as well as the effectiveness of political management is directly linked to the implementation capacity of the different levels. This capacity is mainly constrained by two factors: weak institutions and insufficient legislation. The best adaptation plan written on the national or supranational level will fail if state institutions are not capable to implement measures or enforce regulations. This contains the whole range of a public administration from ministries, local authorities, and legal bodies. Declaring a certain area as national reserve, for instance, will only be effective if authorities are capable to prevent illegal deforestation there. Numerous scenarios could be named in this context but basically it comes down to the necessity of a certain degree of state capacity and the principles of good governance. The legal aspect particularly affects one crucial point: the question of land tenure and land ownership rights. In many affected regions in developing countries the legal situation is not defined, especially in vulnerable areas such as in tropical forest regions or habitats of the urban poor in coastal regions. But if land tenure is not defined, it will be difficult to identify the beneficiaries of adaptation measures or financial incentive. If, for instance, a slum is destroyed by a flood, it will be nearly impossible to define who is entitled for reconstruction or general support funds. Also if carbon credit would be granted for forest preservation or other financial incentives for a certain behavior, it has to be defined who holds which ownership rights and is entitled to receive funding. Examples from India show that land ownership improves climate resilience of local communities, since it improved access to loans, compensation, and homes.[58] Therefore, suitable land legislation has to make sure that not only land tenure is defined, but also mechanisms to deal with conflicts and proper safeguards from misuse (e.g. regarding to land speculation).

Against this backdrop the following chapters 3 through 5 will examine the cases of ASEAN, EU, and NAFTA, in order to identify if and how they dealt with the discussed issues and what can be learned from their experience. Based on this, policy recommendations will be given for the future adaptation and mitigation planning and its implementation.

[58] "Land ownership boosts climate resilience in India", last modified: 11.03.2012, http://www.trust.org/alertnet/news/land-ownership-boosts-climate-resilience-in-india, (accessed: 20.03.2012)

Chapter 3

ASEAN and Thailand

Vulnerability

Institutional frameworks

Policies

3. 1. ASEAN

3.1.1. Vulnerability

Southeast Asia is characterized by long coast lines, high population densities, important economic activities in coastal areas, a relatively high reliance on agriculture as a livelihood for a large share of the population, and a high dependence on natural resources and forestry. Considering all these factors, the region has to be considered as one of the most vulnerable areas to climate change in the world.[59] Based on the IPCC SRES scenarios temperatures could increase between 2.02 and 3.92^{o}C.[60] Along with sea level rise and a change of precipitation intensity and frequency in this region directly connected to the monsoon season and its occurrence, this is projected to lead to more extreme weather events, like droughts, floods and tropical storms. A study carried out by the Economy and Environment Program for Southeast Asia (EEPSEA) in Singapore assessed the vulnerability of regions in Southeast Asia, based on a hazard risk assessment, the population density and protected areas and the adaptation capacity of this region.[61] The result was the map presented in figure 3.II, giving a detailed regional risk assessment.

Figure 3.I: Climate hazard hotspots and dominant hazards

Climate hazard hotspots	Dominant hazards
Northwestern Vietnam	Droughts
Eastern coastal areas of Vietnam	Cyclones, droughts
Mekong region of Vietnam	Sea level rise
Bangkok and its surrounding area in Thailand	Sea level rise, floods
Southern regions of Thailand	Droughts, floods
The Philippines	Cyclones, landslides, floods, droughts
Sabah state in Malaysia	Droughts
Western and eastern area of Java Island, Indonesia	Droughts, floods, landslides, sea level rise

Source: Yusuf, Arief Anshory and Francisco, Herminia , "Climate Change Vulnerability Mapping for Southeast Asia", (Economy and Environment Program for Southeast Asia (EEPSEA) , Singapore: 2009), 6 – see also the climate hazard index map on the same page.

[59] Zhuang, Juzhong, Suphachalasai, Suphachol, Smason,Jindra, "The Economics of Climate Change in South East Asia", Asia Security Initiative Policy Series, Working Paper No.9 (Singapore: 2010), 11

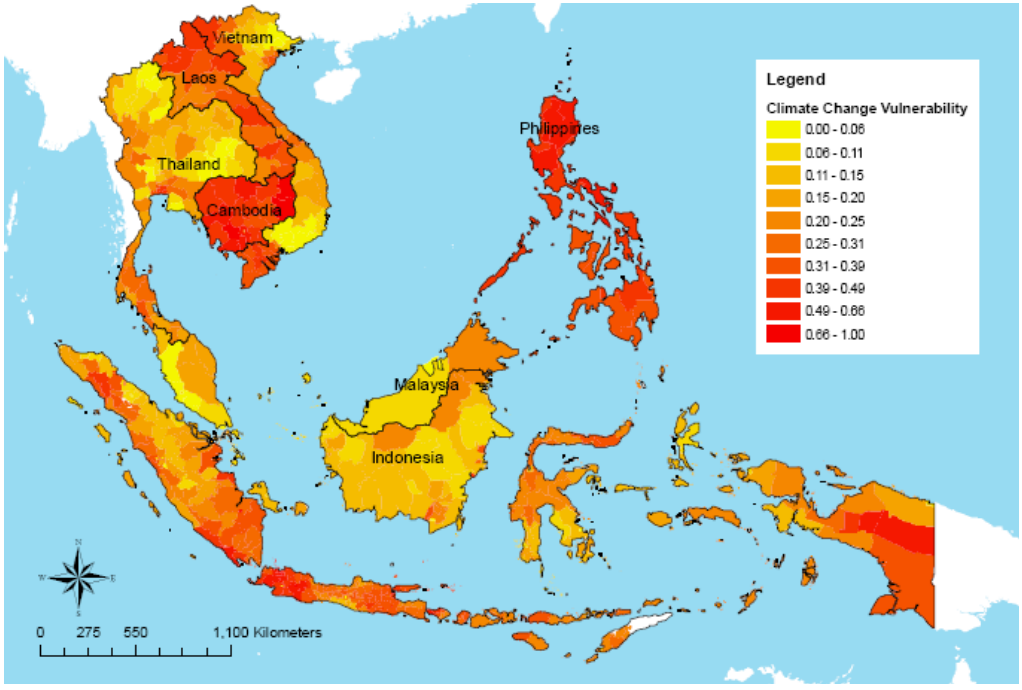
[60] IPCC (ed.), "Asia. Climate Change 2007: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change," (Cambridge University Press, Cambridge:2007), 480.

[61] Yusuf, Arief Anshory and Francisco, Herminia , "Climate Change Vulnerability Mapping for Southeast Asia", (Economy and Environment Program for Southeast Asia (EEPSEA) , Singapore: 2009)

According to the risk hazard assessment the following areas are deemed especially vulnerable: the Philippines, the Mekong Delta in Vietnam, parts of Java, North-Vietnam, areas in southern Thailand and also Bangkok and its surroundings.

Due to the differences in the standard of living, the economic capacity and existing infrastructure and technology among the ASEAN members varies.The adaptation capacity of states like Thailand, Malaysia, parts of Vietnam, is considered to be much higher than in Laos, Cambodia, the Philippines, or Indonesia.[62] Considering also the high population densities in areas like in Bangkok, the Mekong Delta or Java, the final vulnerability assessment came to the following result as depicted in Figure 3.II.

Figure 3.II: Southeast Asia Climate Change Vulnerability Map



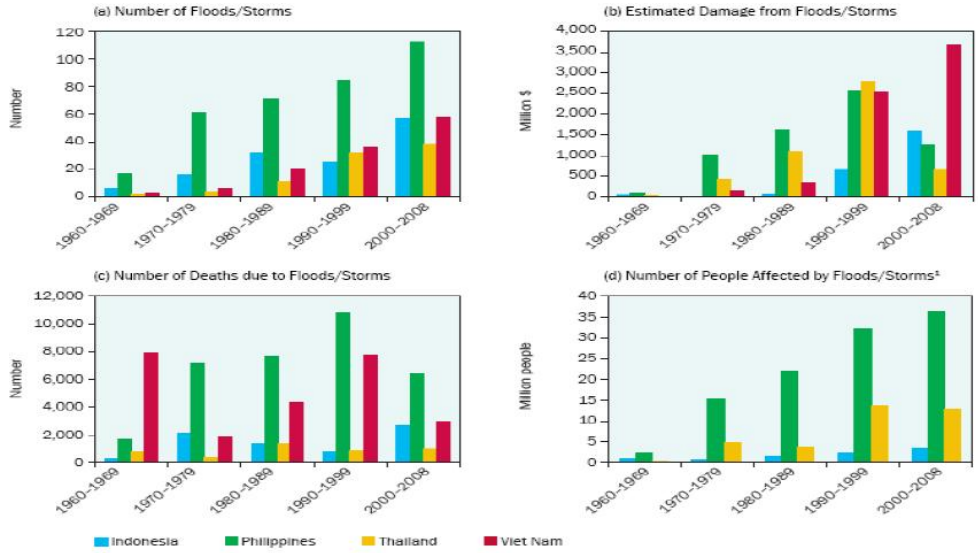
Source: Yusuf, Arief Anshory and Francisco, Herminia , "Climate Change Vulnerability Mapping for Southeast Asia", (Economy and Environment Program for Southeast Asia (EEPSEA) , Singapore: 2009), 11

The findings of the assessment not only underline the vulnerability of climate hazard hotspots threatened through extreme weather events, but also show that regions with a very low adaptation capacity – especially Cambodia and Laos – are highly vulnerable to climate change impacts. As

[62] Yusuf, Arief Anshory and Francisco, Herminia , "Climate Change Vulnerability Mapping for Southeast Asia", (Economy and Environment Program for Southeast Asia (EEPSEA) , Singapore: 2009), 10

mentioned, one of the biggest threats is flooding from rivers and seas. Hotspots that are especially affected in the region are the mega deltas of the Mekong delta, home to approximately 15.6 million, and the Chao Praya Delta, home approximately 11.5 million people.[63] The following figure illustrates the huge economic and social impacts that floods have had on Thailand, Indonesia, Vietnam, and the Philippines, during the last 50 years. Although the recent flood in Thailand is not even included in these estimations, it can be seen that the economic damages, deaths, and numbers of affected people, are enormous.

Figure 3.III: Extent of damages due to flood and storms (1960-2008)



Source: Zhuang, Juzhong, Suphachalasai, Suphachol, Smason,Jindra, "The Economics of Climate Change in South East Asia", Asia Security Initiative Policy Series, Working Paper No.9 (Singapore: 2010), 3

Due to climate change and Sea Level Rise (SLR), the frequency and the level of inundation of these mega deltas are projected to increase. According to further studies examining possible impacts, the following effects might occur, depending on the intensity of SLR:

- Even assuming the SLR to be below 30 cm, 69 – 91 percent of land area in Mekong Delta would be affected by SLR during flood season.
- An assumed SLR between 30-50 cm would affect about 29,808 km of shoreline in Southeast Asia with estimated direct costs of US$226 million per year.

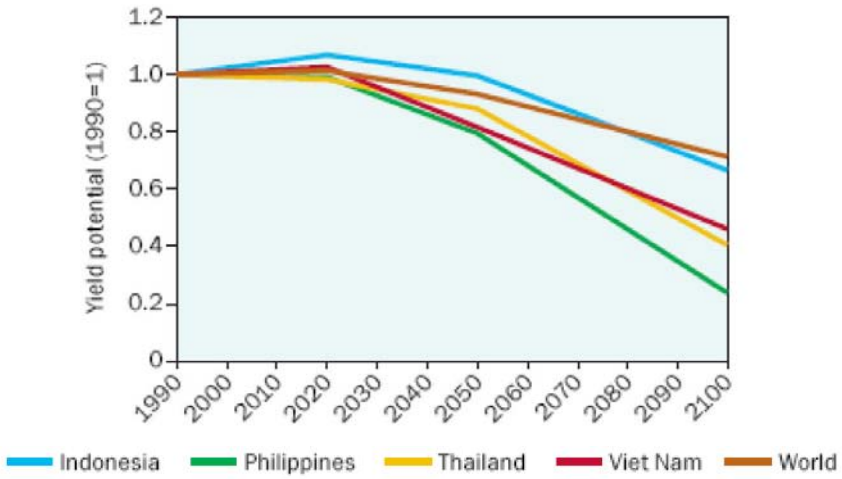
[63] IPCC (ed.), "Asia. Climate Change 2007: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change," (Cambridge University Press, Cambridge:2007), 496

- About 34,000 km^2 of land area would be lost in Indonesia affecting 3.1 million people.
- About 86 – 100% of land area in the Mekong Delta, Vietnam, would be affected by SLR during flood season.

- Sea level rise over 50 cm:
  - 7,000 km^2 of land area would be lost in Malaysia, affecting about 500,000 people.
  - 40,000 km^2 of land area would be lost in Vietnam, affecting 26.9 million people.
  - 15% of dryland and consequently 8 per cent of GDP would be lost in Vietnam.[64]

The impacts could be even more pronounced in megacities located in mega deltas where natural ground subsidence is enhanced by human activities, such as in Bangkok in the Chao Phraya delta.[65] The recent flood in Thailand in 2011 already demonstrated how severe a highly populated and economically important area can be hit by flooding.

Figure 3.IV: Rice yield potential in South East Asia and the world



Based on the SRES A1F scenario – assuming no adaptation and mitigation measures

ดูกลบ: adaption

Source: Zhuang, Juzhong, Suphachalasai, Suphachol, Smason,Jindra, "The Economics of Climate Change in South East Asia", Asia Security Initiative Policy Series, Working Paper No.9 (Singapore: 2010), 5

[64] Yuen, Belinda and Kong, Leon, "Climate Change and Urban Planning in Southeast Asia", (2009), 5
[65] IPCC (ed.), "Asia. Climate Change 2007: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change," (Cambridge University Press, Cambridge:2007), 493

Important from a social perspective are the impacts in the agricultural sector. Assuming an average temperature increase beyond 2.5°C, a decline of yields of wheat and rice is projected to be a significant cause of losses in farm level net revenue between 9% and 25%.[66]

Figure 3.IV shows an even more pessimistic scenario for the local rice production. Based on the SRES A1F scenario and assuming no adaptation and mitigation measures, production potential could decrease down to 20% of the 1990 potential in the Philippines and down to 50% in Vietnam and Thailand.

The social implications of these potential impacts on agriculture have to be taken very seriously. Compared to the EU or NAFTA, the share of people who economically depend on agriculture is much higher than the ASEAN-wide average. Decline in production and income will directly threaten their economic livelihood. Furthermore, the demand for food supply will increase due to rapidly growing populations. Decreasing production in crucial food supplies such as rice is therefore highly likely to stress food security. With more farmers not able to make a sufficient income, the already ongoing urbanization process might even speed up. social systems and urban infrastructure are already not able to cope with the present migration flows in megacities.

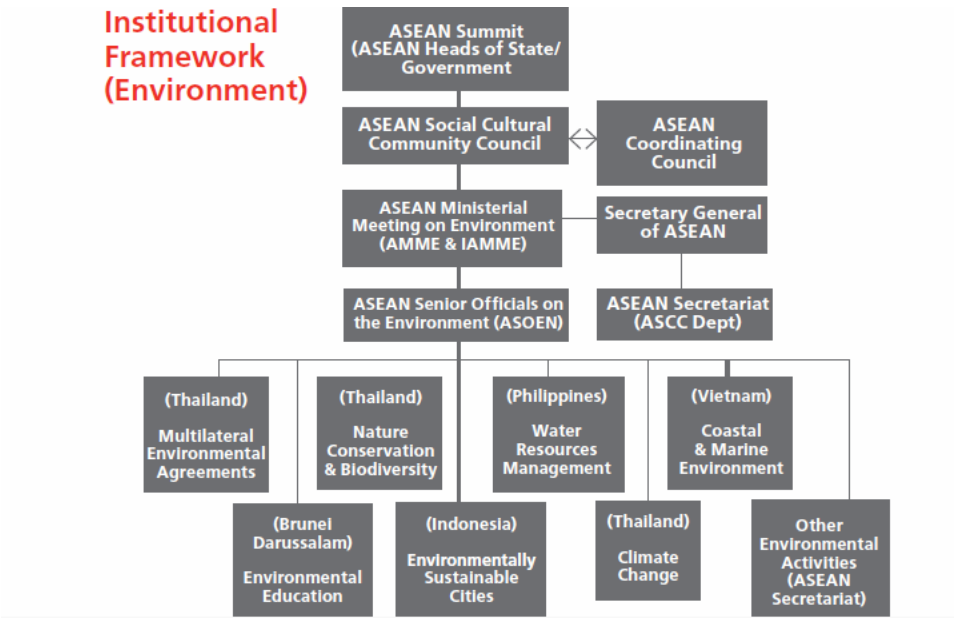
The urban poor are further highly vulnerable to other social impacts that climate change might cause, from the increased flood risks in low lying coastal areas to an increased probability of health problems. Assuming a temperature increase of up to 2 degrees, epidemic potential for malaria and dengue in Southeast Asia could change by +7 to +45%, and +24 to +47%, respectively.[67] Furthermore, in the Greater Mekong area alone, up to 105 million people could be exposed to increased water stress. Economic projections – as uncertain as they might be – project dramatic numbers in respective case studies. The Asia Development Bank (ADB), for example, has calculated that additional cumulative health costs associated with treatments of infectious disease in Indonesia could add up to US$64.5 billion, and total climate change losses could be equivalent to US$766 billion in Indonesia.[68] Therefore, due to their vulnerability, the ASEAN countries urgently need effective climate change adaptation policies.

[66] Yuen, Belinda and Kong, Leon, “Climate Change and Urban Planning in Southeast Asia”, (2009), 5
[67] Yuen, Belinda and Kong, Leon, “Climate Change and Urban Planning in Southeast Asia”, (2009), 5
[68] Yuen, Belinda and Kong, Leon, “Climate Change and Urban Planning in Southeast Asia”, (2009), 5

3.1.2. ASEAN's institutional framework and policies

The ASEAN community consists of the ASEAN Economic Community, ASEAN Socio-Cultural Community, ASEAN Political Security Community, and the Initiative for ASEAN Integration. The ASEAN Socio-Cultural Community Council is in charge of overseeing the work of the ASEAN Environmental Ministers. These ministers meet on a formal basis once every three years. However, informal meetings take place every year. Their main objectives are policy and strategy matters related to the environment. The ASEAN Senior Officials on the Environment (ASOEN) meet annually.

Figure 3.V: ASEAN's Institutional Framework regarding the Environment



Source: Letchumanan, Dr. Raman. "Is there an ASEAN policy on climate change?", 55

They consist out of the heads of environmental ministries, agencies, and departments in their respective countries. It is their responsibility to help the ASEAN Environmental Ministers in formulating, implementing and monitoring regional activities and programs. Apart from this they are the national focal points for promoting ASEAN's environmental activities in their respective countries. The ASOEN are being supported by six working groups:

- the ASEAN Working Group on Coastal and Marine Environment (AWGCME),
- the ASEAN Working Group on Environmental Education (AWGEE),
- the ASEAN Working Group on Environmentally Sustainable Cities (AWGESC),

- the ASEAN Working Group on Multilateral Environmental Agreements (AWGMEA),
- the ASEAN Working Group on Nature Conservation and Biodiversity (AWGNCB),
- the ASEAN Working Group on Water Resources Management (AWGWRM).

*A*SEAN has started a range of activities to mitigate climate change effects. A focus lies on Energy and Transportation, Disaster Management, Environment and Agriculture & Forestry. Among others, the following initiatives were proposed/implemented:

- The *ASEAN Climate Change Initiative (ACCI)* is being created to be a consultative platform to further enhance regional cooperation and coordination. The ASEAN Working Group on Climate Change (AWGCC) chaired by Thailand was established to implement ACCI. Its main objectives are to improve collaboration in the fields of policy formulation, capacity building, information sharing and technology transfer.

- The *Cool ASEAN, Green Capitals Initiative* aims at addressing climate change by improving transportation, waste management and energy conservation in ASEAN cities. The Governor of Bangkok promised to lead the implementation of this initiative with the support of the ASEAN Secretariat and the World Bank.

- The *ASEAN Agreement on Disaster Management and Emergency Response Work Programme* (2010-2015) includes climate change adaptation. It covers "Prevention and Mitigation, Risk Assessment, Early Warning and Monitoring, Preparedness and Response and Recovery and Rehabilitation. "

- The *ASEAN Air Transport Integration* aims at limiting the environmental impacts of aviation. It wants to achieve this by exchanging international rules and regulations, including collaborative research and development, and evaluating other possible measures of noise and CO2 reduction as well as other emissions from aviation.[69]

Figure 3.VI: ASEAN Declarations related to Climate Change

Year	Declaration/Statement
2007 (13th ASEAN Summit)	ASEAN Declaration on Environmental Sustainability
2007 (13th ASEAN Summit)	ASEAN Declaration on COP-13 to the UNFCCC and CMP-3 to the Kyoto Protocol

[69] Letchumanan, Dr. Raman. "Is there an ASEAN policy on climate change?"

2007 (3rd EAS Summit)	Singapore Declaration on Climate Change, Energy and the Environment
2007	Joint Ministerial Statement of the 1st EAS Energy Ministers Meeting
2008	Ministerial Statement of the Inaugural EAS Environment Ministers Meeting
2009 (15th ASEAN Summit)	ASEAN Joint Statement on Climate Change to COP-15 to the UNFCCC and CMP-5 to the Kyoto Protocol
2009 (11th AMME)	Singapore Resolution on Environmental Sustainability and Climate Change

Data from: Letchumanan, Dr. Raman. Is there an ASEAN policy on climate change?

The above statements and declarations highlight ASEAN's determination to mitigate climate change effects. Their commitment can also be noticed when looking at the range of activities and initiatives ASEAN has implemented to mitigate and adapt to climate change. They have taken a broad based approach by choosing to pursue climate change mitigation measures in different areas including Energy and Transportation, Disaster Management, Environment and Agriculture & Forestry. ASEAN also embedded climate change mitigation in their institutional framework and established several working groups dealing with environmental issues, including a working group directly dealing with climate change. Regular meetings between the ASEAN Environmental Ministers and the ASOEN ensure a constant exchange and flow of information within the region.

However, it must be noted that ASEAN is also following a voluntary approach, meaning that climate change mitigation measures are not compulsory, which might affect their implementation. This can endanger the efficacy of climate change mitigation, especially when national short-term interests contradict with the climate change strategy set by the ASEAN Environmental Ministers. Therefore, it is necessary to take a closer look at the national legal framework in the respective ASEAN countries to analyze in how far they have embedded climate change into their laws and regulations.

ASEAN also focuses on Energy and Transportation, Disaster Management, Environment and Agriculture & Forestry. This does not include industrial premises, which are one of the main sources of greenhouse gases. Therefore, closer cooperation with the ASEAN economic community would be preferable to address climate change in even more areas. ASEAN free trade agreements should include provisions on environmental protection and climate change in order to guarantee a sustainable development.

3.2. ASEAN member states policies

3.2.1. Environmental legislation in ASEAN member states

The extent to which climate change policies are integrated in the countries' legal framework differs. Only the Philippines have a law that specifically deals with climate change while the other countries merely included some provisions on sustainable and environmentally friendly management in other laws related to land, forests, energy, urban planning and environmental protection. Apart from this, the Philippines also specifically mention disasters related to climate change in their Disaster Risk Reduction and Management Act of 2010. Since the Philippines are one of the countries most vulnerable to climate change, they have started to take the necessary steps to embed climate change mitigation and adaptation into their legal framework. However, other Southeast Asian countries still lag behind. Figure 5.VI at the end of this chapter gives a detailed overview on the legal frameworks.

With regard to land, it became obvious that many ASEAN countries do not, or only very briefly, cover environmental protection and climate change in their respective land laws. An exception to this is the Land Law of Vietnam, which gives land users the obligation to manage the land in a sustainable and environmentally friendly manner and even states that allocated land may be withdrawn in case it is not used for the correct purpose. The Lao Land Law (2003) stipulates that industrial land-use, in particular, shall not harm the environment. However, it must be noted that these laws usually refer to environmental protection and do not make any specific provision related to climate change.

The same can be said in regard to energy or electricity law. Some countries, such as Brunei, do not have any provisions for using energy in a sustainable way in their Electricity Laws. Laos, on the other hand, does have these provisions. The 1997 Law on Electricity requires electricity enterprises to conduct an environmental impact assessment to prevent harmful effects on the environment. Furthermore, it takes into account the effects of hydropower dams that can lead to an increase in floods during the raining season. Apart from Laos, another country recently shifted its focus to environmentally friendly energy production. In 2011 Malaysia passed the Renewable Energy Act that focuses on the use of green energy. It establishes a Renewable Energy Fund as well as a special tariff system to catalyze the generation of renewable energy.

When looking at different laws in regard to landownership, it can be noted that only few countries have laws that acknowledge the indigenous people's rights over their land. Of those that do acknowledge their rights, there are some, such as Indonesia. However, the law only allows them to use the land; it does not provide for secure land ownership titles that effectively protect them from

land grabbing. The Cambodian Forestry Law, on the other hand, urges the Ministry of Agriculture, Forestry and Fishery to work together with the Ministry of Land Management and Urban Planning to ensure that indigenous communities can officially register their land. This gives them more security over their land. Since land ownership usually gives people the incentive to manage their land in a more sustainable way, this can be seen as a positive development in regard to climate change mitigation measures. Apart from this, a clear distribution of official land titles is an effective measure to prevent conflicts regarding landownership in the future.

The forestry laws in Southeast Asia include provisions to manage the forest in a sustainable way. However, there are large differences between the countries. Myanmar, for example, only briefly covers environmental protection, while Vietnam has its own law for forest protection. Once again it must be noted that almost no country in Southeast Asia includes the local population living in or near forest areas in their forestry laws. Exceptions are Brunei, which allows natives of Brunei to collect timber for private consumption and Laos which allows the customary utilization of forest land by local communities. Since forests, if properly managed, have high potential as carbon sinks, it is necessary that countries have the proper legal framework as well as a good implementation of these rules and regulations to successfully protect their forest areas.

With regards to the REDD initiative, it can be noted that legal framework for the possessions and the sale of carbon rights is non-existent. This will complicate the process of establishing a functioning carbon market and participating in it for Southeast Asian countries. Another problem is that often rules and regulations exist, but they are poorly implemented. Therefore, strengthening the rule of law is necessary to ensure the proper measures are taken for climate change mitigation and adaptation. Often countries just react to natural disasters related to climate change, instead of trying to prevent them beforehand.

The creation of national parks as regulated in the National Park Acts of Malaysia and Singapore is a positive development, because they specify how and by whom national parks are to be managed. Clear regulations help with the implementation of protection measures. The Singapore National Park Act clearly states that the National Parks Board is responsible for the management of immovable property in national parks, which makes it easier to deal with the authorities. The Cambodian REDD case study showed that it is important to specify which the authority in charge is to avoid problems regarding ownership. In Cambodia it was not clear who the owner of the carbon rights were which might have led to problems when selling them on the carbon market.

Another positive development is that all ASEAN countries have National UNFCCC Focal Points. There are also existing government bodies to deal with climate change as well as national strategies. This

shows that there have already been some steps taken to mitigate climate change in Southeast Asia even though the legal framework in the respective countries is still lacking behind. The following figures show the focal points and government bodies in the respective ASEAN countries and summarize detailed the relevant national laws on environment and climate change:

Figure 3.VII: National Focal Points, Government Bodies and Action Plans for Climate Change

Country	National UNFCCC Focal Points for Climate Change	National Government Body	Specific Body for Coordination and Implementation Purposes	National Action Plans
Brunei	Department of Environment, Parks and Recreation	National Council on Climate Change		Nationally Appropriate Mitigation Action Plan (under development in 2010)
Cambodia	Ministry of Environment	National Climate Change Committee (April 2006)	Ministry of Environment, Department of Planning and Legal Affairs: Climate Change Office (June 2003)	National Adaptation Program of Action supported by the UNDP
Indonesia	Ministry of Environment: Climate Change Division	National Committee on Climate Change and Environment (1992) National Council for Climate Change (July 2008)	Ministry of Environment: Subdivision of Adaptation to Climate Change (August 2005)	National Action Plan Addressing Climate Change (RANPI) Indonesia Climate Change Sectoral Roadmap 2010
Laos	Department of Environment: Water Resources and Environment Administration	National Steering Committee on Climate Change (2008)		National Adaptation Program of Action supported by the UNDP
Malaysia	Ministry of Natural Resources and Environment	National Steering Committee on Climate Change		National Policy on Climate Change (2009)
Myanmar	National	NA		National Adaptation

	Commission on Environmental Affairs			Program of Action supported by the UNDP (under preparation)
Philippines	Presidential Task Force on Climate Change	Inter-Agency Committee on Climate Change (1991) Presidential Task Force on Climate Change (2007) Advisory Council on Climate Change Mitigation, Adaptation and Communication	Climate Change Commission (2009)	National Framework Strategy and Program on Climate Change Medium Term Philippine Development Plan (MTPDP) for 2004-2010*[70]
Singapore	Ministry of Environment and Water Resources	National Climate Change Committee (2007) National Climate Change Secretariat (2010)	Ministry of National Development: National Adaptation Taskforce	National Climate Change Strategy (2008)
Vietnam	Ministry of Natural Resources and Environment: Department of Meteorology, Hydrology and Climate Change	National Climate Change Committee	Ministry of Natural Resources and Environment: Thematic Ad Hoc Working Group on Climate Change Adaptation (November 2007)	National Strategy for Environmental Protection until 2010 and vision toward 2020 National Target Program (NTP) to Respond to Climate Change 2008

Data from: Lian, Koh K., Bhullar, Lovleen. Adaptation to Climate Change in the ASEAN Region. Draft dated 04.10.2010.

[70] Refers to climate change only in relation to disaster risk reduction

Figure 3.VIII: Environment related legal Framework of the ASEAN countries

Country	Constitution	Ministries/ Agencies	Laws	Effect on Land Management	Effect on Land Rights	Remarks
Brunei	no[71]	Department of Environment, Parks and Recreation (UNFCCC focal point) Ministry of Industry and Primary Resources Ministry of Development Ministry of Home Affairs	Forest Act (revised edition 2002):[72] - for cutting, felling, or burning of trees a license issued by the Forest Officer is needed Electricity Act (1973, revised edition 2003):[73] - this act has no provisions on using electricity in a sustainable manner or the use of green energy Land Code (1984):[74] - any person who cuts timber (excluding Brunei natives cutting timber for private consumption) or produces on state land without lawful permission shall be guilty of an offense (Article 32)	The Forest Act prohibits the felling of old forest for cultivation. However, it gives natives of Brunei the privilege to cut or remove timber from State Land for the purpose of construction or repairing of his family's dwelling and other domestic consumption (article 9).		
Cambodia	Chapter V, Article 59: The State shall protect	Ministry of Environment:	Law on Land Management, Urban Planning and	Article 12 of the Law on Land	The Forestry Law stipulates that	In 2003 the Cambodia Climate

[71] Constitution of Brunei Darussalam. (Brunei: 2011). http://www.agc.gov.bn/agc1/images/LOB/cons_doc/constitution_i.pdf.
[72] Brunei. Forest Act. (revised edition 2002). http://www.agc.gov.bn/agc1/images/LOB/PDF/Cap46subR1.pdf.
[73] Brunei. Electricity Act. (Brunei: 1973). http://www.agc.gov.bn/agc1/images/LOB/PDF/Cap71.pdf.
[74] Brunei. Land Code. (Brunei: 1984). http://www.agc.gov.bn/agc1/images/LOB/PDF/Chp.40.pdf.

	the environment and balance of abundant natural resources and establish a precise plan of management of land, water, air, wind geology, ecologic system, mines, energy, petrol, and gas, rocks and sand, gems, forests and forestrial products, wildlife, fish and aquatic resources.[75]	Climate Change Department (UNFCCC focal point, see remarks)[76] Ministry of Agriculture, Forestry and Fishery Ministry of Land Management and Urban Planning	Constructions, (1994):[77] Article 1: "to promote the organization and embellishment of the urban and the rural areas" Law on Environmental Protection and Natural Resource Management, (1996):[78] -establishment of a National and Regional Environmental Plan - ensuring responsible management and protection of natural resources including land Forestry Law (2002): - forests within the Permanent Forest Estates shall be classified, registered and have set boundaries	Management, Urban Planning and Constructions stipulates that no construction work is to be conducted in the forest zones, gardens and public parks, water reservoirs, and rivers.	the Ministry of Agriculture, Forestry and Fishery shall work together with the Ministry of Land Management and Urban Planning to ensure indigenous communities can officially register their land (Article 11).	Change Office (CCCO) was established under the Ministry of Environment to be the focal point for CDM, the UNFCCC and the Kyoto Protocol.[79] Climate change makes Cambodia especially vulnerable to floods and draughts.[80]

[75] Constitution of Cambodia. (Cambodia: 1999). http://www.embassy.org/cambodia/government/constitution.htm.
[76] Cambodian Ministry of Environment: Climate Change Department. (Cambodia: n.d.). http://www.camclimate.org.kh/.
[77] Cambodia. Law on Land Management, Urban Planning and Constructions. (Cambodia: 1994). http://www.gocambodia.com/laws/data%20pdf/Law%20on%20Land%20Management,%20Urban%20Planning%20and%20Construction/Law%20on%20Land%20Management,%20Urban%20Planning%20and%20Construction%28EN%29.pdf.
[78] Cambodia. Law on Environmental Protection and Natural Resource Management. (Cambodia: 1996). http://www.mekonglawcenter.org/download/0/cambodia.htm.
[79] Yeang, Donal. Tenure Rights and Benefit Sharing Arrangements for REDD: A Case Study of Two REDD Pilot Projects in Cambodia. Forest and Nature Conservation Policy Group. Wageningen University. (The Netherlands: 2010). http://www.agentschapnl.nl/sites/default/files/bijlagen/30%20Tenure%20Rights%20and%20Benefit%20Sharing%20Arrangements%20for%20REDD.pdf.
[80] Climate Change and Disaster Management Policy Mapping and Analysis in Cambodia. DanChurchAid/Christian Aid (DCA/CA). (September 2011). http://www.climatecapacity.org/files/RC_Reports%20and%20Cases/Consultancy%20report%20on%20cc%20policy%20mapping%20in%20Cambodia_final.pdf.

			- recognition of land rights of indigenous people			
Indonesia	Chapter XIV, Article 33: [81] (3) The land, the waters, and the natural resources within, shall be under the powers of the State and shall be used to the greatest benefit of the people. (4) The organization of the national economy shall be conducted on the basis of economic democracy upholding the principles of togetherness, efficiency with justice, continuity, environmental perspective, self-sufficiency, and keeping a balance in	Ministry of Environment (UNFCCC focal point) National Board on Climate Change (DNPI) National Development Planning Agency (BAPPENAS)	Forestry Law (No. 41, 1999): - forests should be managed in a optimal and sustainable manner (Article 22) - Article 14 specifies the environment Waste Management Act (No. 18, 2008): - promotes sustainable waste management for household, household-like and specific waste[82] Environmental Protection and Management Act (No. 32, 2009): - takes climate change into account and includes plans on mitigation and adaptation of climate change (Article 10) - establishment of criteria to measure environmental damage (Article 21)[83]	The Forestry Law takes into account the customary laws and social community institutions. Forest management should benefit the environment as well as local communities (Article 17&18).	The Forestry Law stipulates that in accordance with customary "adat" law, local communities can collect forest products for their daily needs as long as their activities not contradict existing laws. Local regulations will recognize the "adat" community's rights. However, the Forestry Law does not stipulate that local communities are given a land title over their	Indonesia lacks an integrated plan on climate change. Even though the National Board on Climate Change should be in charge of coordinating climate change activities, the National Development Planning Agency and the Ministry of Environment also play coordinating roles.[86]

[81] The 1945 Constitution of the Republic of Indonesia. (as amended before 2002). http://www.embassyofindonesia.org/about/pdf/IndonesianConstitution.pdf.
[82] Indonesia. Undang-undang Republik Indonesia No. 18 Tahun 2008 tentangPengelolaan Sampah. (Indonesia 2008). http://birohukum.pu.go.id/Rumah%20Negeri/UU18-2008.pdf.
[83] Indonesia. Undang-undang Republik Indonesia No. 32 Tahun 2009 tentang Perlindungan dan Pengelolaan Lingkungan Hidup. (Indonesia: 2009). http://birohukum.pu.go.id/Peraturan/UU32-2009.pdf.

	the progress and unity of the national economy.		Law on Energy (2007):[84] - energy shall be managed among others, with a fair efficiency, in a sustainable way and by preserving environmental functions (Article 2) - energy management activities shall prioritize environmentally-friendly technologies (Article 8) - locally produced energy shall be prioritized; businesses using renewable energy may receive government incentives (Article 20)		customary land (Article 67).[85]	
Lao PRD	Chapter 2, Article 19: All organizations and citizens must protect the environment and natural resources: land surfaces, underground [resources,] forests,	Department of Environment: Water Resources and Environment Administration (UNFCC focal point)	Environmental Protection Law (1999): - promotes the establishment of an environmental protection fund - the Science, Technology and Environment Agency is responsible for environmental management and monitoring	Article 16 of the Environmental Law stipulates that operations on certain land such as historical, cultural, and natural heritage sites, must comply with special	Article 4 of the Forestry Law determines the nation as the owner of natural forests and forestland and transfers the right to manage it to	

[84] Indonesia. Law on Energy. (Indonesia: 2007). http://www.bkpm.go.id/file_uploaded/uu-30-2007-energy.pdf.
[85] Indonesia. Forestry Law No. 41, 1999. (Indonesia: 1999). http://www.bkpm.go.id/file_uploaded/Law_4199.htm.
[86] Thornton, Nigel. Realising Development Effectiveness: Making the Most of Climate Change Finance in Asia Pacific. Capacity Development for Development Effectiveness Facility. (October 2010). http://www.oecd.org/dataoecd/23/51/46518692.pdf.

	animals, water sources and the atmosphere.[87]	Ministry of Agriculture and Forestry	(Article 35) Forestry Law (2007): - Forests are categorized as follows: protection forest, conservation forest and production forest - Individuals, households and organizations have the responsibility to protect the forest (Article 7) - Article 29 forbids shifting cultivation - conservation and protection forestland is to be demarcated and for production forestland zoning plans of management areas have to be written that ensure sustainable management (Article 59-61). Land Law (2003):[88] - Article 6 states that land-use shall have no negative effect on the environment Law on Electricity (1997):[89] - an electricity business shall be economically efficient and the	regulations issued by the local administrative authorities. The Forestry Law allows customary utilization of forest products with a designed plan and in accordance with village laws and regulations on forest management (Article 42). Article 29 of the Land Law states that the use of industrial land shall not cause harm to the environment.	the State. However, trees planted by organizations or people become their property with the recognition of the Forest and Forestland Management Organization.	

[87] Constitution of the Lao People's Democratic Republic. (Laos: May 6, 2003). http://www.undplao.org/whatwedo/bgresource/demogov/Lao%20Constitution.pdf.
[88] Laos. Land Law. (Laos: 2003). http://www.la.emb-japan.go.jp/jp/laos/Law_on_Land_&_Decree.pdf.
[89] Laos. Law on Electricity. (Laos: 1997). http://www.na.gov.la/docs/eng/laws/econ/Electricity%20&%20Decree%20%281997%29%20Eng.pdf.

			assessment on the impact on the environment shall be taken into account to limit the impacts on the society and the wildlife (Article 6) - electricity enterprises need to conduct an environmental impact assessment (EIA) to apply for a concession (Article 12) - Article 14 specifies the EIA and states that it should include means to limit downstream impacts of hydropower dams, which is a contributor to downstream floodings during the rainy season			
Malaysia	Part VI, Chapter 4, Article 91: [90] (5) It shall be the duty of the National Land Council to formulate from time to time in consultation with the Federal Government, the State	Ministry of Natural Resources and Environment (UNFCCC focal point) Ministry of Agriculture and Agro-	Land Conservation Act (1960, as amended until 01.01.2006):[91] - aims at conserving hill land and protecting it from erosion Environmental Quality Act (1974):[92] - establishes an Environmental Fund (Article 36b) - the Minister after consulting	With special permission from the State Authority the creation of resorts, roads, dwelling houses, or mining activities may be allowed in a National Park (National Park Act, 1980).		

[90] Constitution of Malaysia. http://confinder.richmond.edu/admin/docs/malaysia.pdf.
[91] Malaysia. Land Conservation Act. (Malaysia: 1960). http://www.agc.gov.my/Akta/Vol.%208/Act%20385.pdf.
[92] Malaysia. Environmental Quality Act. (Malaysia 1974). http://www.agc.gov.my/Akta/Vol.%203/Act%20127.pdf.

	Governments and the National Finance Council a national policy for the promotion and control of the utilization of land throughout the Federation for mining, agriculture, forestry or any other purpose, and for the administration of any laws relating thereto; and the Federal and State Governments shall follow the policy so formulated.	Based industries	with the Council may impose restrictions on the emission of environmentally hazardous substances (Article 21) - in general it prohibits open burning, especially if the air quality has already reached an unhealthy level and it would be hazardous to the environment - some owners of ships, premises or vehicles may be required to carry out an environmental audit National Parks Act (1980):[93] - regulates the establishment of national parks to protect and preserve the natural and wildlife Renewable Energy Act (2011):[94] - establishes a Renewable Energy Fund (Article 23) - establishes a special tariff system to catalyze the generation of renewable energy			
Myanmar	Chapter VIII, Article 390: [95]	National Commission	**The Protection of Wildlife and Conservation of Natural Areas**	**Causing damage to the original**		The 1997 Agenda 21 identified activities

[93]Malaysia. National Park Act. (Malaysia: 1980). http://www.agc.gov.my/Akta/Vol.%205/Act%20226.pdf.
[94] Malaysia. Renewable Energy Act. (Malaysia: 2011). http://www.seda.gov.my/renewable_energy_act_2011.html.
[95]Constitution of the Republic of the Union of Myanmar. (Myanmar: 2008). http://www.scribd.com/doc/7694880/Myanmar-Constitution-2008-English-version.

	Every citizen has the duty to assist the Union in carrying out the following matters: (a)preservation and safeguarding of cultural heritage; (b)environmental conservation; (c)striving for development of human resources; (d)protection and preservation of public property.	on Environmental Affairs (UNFCCC focal point) Forest Department	**Law (1994):**[96] **- Article 12 stipulates that that the Director General with approval of the Minister of the Ministry of Forestry may carry out measures to protect the natural areas from external environmental dangers** **Forest Law (1992):**[97] **- the Director General may with approval of the Minister declare forest land as plantation (Article 13)**	**condition of the reserved forest land without a permit is considered an offense (Article 40).**		for environmental education and to raise public awareness about the environment. Some of these activities were implemented between 2008-2010.[98]
Philippines	Article IIIX, Section 4:[99] (…) the State shall encourage and undertake the just distribution of all agricultural lands, subject to such priorities and reasonable retention	Presidential Task Force on Climate Change (UNFCCC focal point) Department of Environment and Natural Resources	Urban Development and Housing Act of 1992 (Republic Act No. 7279):[100] - aims at providing poor and underprivileged citizens with housing - a cooperation with the DENR shall regulate activities for conservation and protection of the environment (Section 36)	Within two years after the Urban Development and Housing Act comes into effect people living in danger areas such as riverbanks, waterways, shorelines or garbage dumps		

[96] Myanmar. **The Protection of Wildlife and Conservation of Natural Areas Law. (Myanmar: 1994).** http://www.blc-burma.org/html/myanmar%20law/lr_e_ml94_06.html**.**
[97] Myanmar. Forest Law. (Myanmar: 1992). http://www.ibiblio.org/obl/docs/forest_law_1992-NP.htm.
[98] Climate Change Management in Myanmar.
[99] Constitution of the Republic of the Philippines, 1987. (Philippines: 1987). http://www.chanrobles.com/article13agrarianreform.htm.
[100] Philippines. Urban Development and Housing Act of 1992. (Philippines: 1992). http://philippines.ahrchk.net/news/mainfile.php/leg_sel/18.

	limits as the Congress may prescribe, taking into account ecological, developmental, or equity considerations, and subject to the payment of just compensation. In determining retention limits, the State shall respect the right of small landowners. The State shall further provide incentives for voluntary land-sharing.	(DENR) Department of Agriculture	Climate Change Act of 2009 (Republic Act No. 9729):[101] - establishes a national Climate Change Commission - creates a Climate Change Office to assist the Climate Change Commission - formulate a Framework Strategy on Climate Change - integrate climate change and disaster risk management in the national, sectoral and local development plans Disaster Risk Reduction and Management Act of 2010:[102] - aims at reducing risks and being proactive in reducing socio-economic and environmental impacts including disasters related to climate change	shall be relocated and resettled.		
Singapore	no[103]	Ministry of the Environment and Water	Environmental Pollution Control Act (2002):[104] - owners of industrial premises	The immovable property in National Parks is		As part of Singapore's "National Climate

[101] Philippines. Climate Change Act of 2009. (Philippines: 2009). http://tonyocruz.com/?p=2536.
[102] Philippines. Disaster Risk Reduction and Management Act of 2010. (Philippines: 2010). http://www.ifrc.org/Docs/idrl/878EN.pdf.
[103] Constitution of the Republic of Singapore. (Singapore: 16th September 1963). http://statutes.agc.gov.sg/aol/search/display/view.w3p;page=0;query=DocId%3Acf2412ff-fca5-4a64-a8ef-b95b8987728e%20Depth%3A0;rec=0;resUrl=http%3A%2F%2Fstatutes.agc.gov.sg%2Faol%2Fbrowse%2FtitleResults.w3p%3Bletter%3DConstitutional%2520Documents%3Btype%3DactsAll.
[104] Singapore. Environmental Pollution Control Act. (Singapore: 2002). http://www.nlsenlaw.org/asian-countries/singapore/UNPAN026601.pdf.

		Resources (UNFCCC focal point) National Environment Agency	must keep the air pollution control equipment installed and in an efficient condition - the National Environment Agency may, with the Minister's approval, make regulations to prevent the pollution of land - the National Environment Agency may, with the Minister's approval, require the owner or occupier of industrial premises dealing with hazardous substances to maintain an insurance policy National Parks Act (1990):[105] - establishes a National Parks Boards that may, with approval of the Minister, sell, mortgage, acquire or lease immovable property (Article 8)	managed by the National Parks Board (Article 8).		Change Strategy" they are conducting a study which will project possible effects of climate change in Singapore and analyze its impacts on the country. The following threats have been identified: - Increased flooding - Coastal land loss - Water resource scarcity - Public health impact from resurgence of diseases - Heat stress - Increased energy demand - Impacts on biodiversity [106]
Vietnam	Chapter II, Article 18:	Ministry of Natural	Law on Environmental Protection (1993):[108]	Article 14 of the Law on	The Land Law stipulates that	

[105] Singapore. National Parks Act. (Singapore: 1990). http://statutes.agc.gov.sg/aol/search/display/view.w3p;query=Status%3Acurinforce%20Type%3Aact,sl%20Content%3A%22forest%22;rec=5;resUrl=http%3A%2F%2Fstatutes.agc.gov.sg%2Faol%2Fsearch%2Fsummary%2Fresults.w3p%3Bquery%3DStatus%253Acurinforce%2520Type%253Aact,sl%2520Content%253A%2522forest%2522;whole=yes.

[106] Singapore's National Climate Change Strategy: 2. Vulnerability and Adaptation. http://app.mewr.gov.sg/data/ImgUpd/NCCS_Chapter_2_-_VA.pdf.

	(…) Organizations and individuals who use the land are duty-bound to ensure its protection, replenishment, rational exploitation and economical utilization. They are also entitled by law to transfer the right to use the land allocated by the State.[107]	Resources and Environment: Department of Meteorology, Hydrology and Climate Change (UNFCCC focal point) Ministry of Agriculture and Rural Development (MARD)	- Organizations or individuals that cause damage to the environment shall pay compensation for it (Article 7) - Article 18 stipulates that organizations or individuals conducting certain activities*[109] must submit Environmental Impact Assessment reports to the State Management Agency for environmental protection Land Law (1993):[110] - coastal land may be used for agricultural reasons if the ecosystem and the environment are as well as the land itself is protected (Article 48) - if urban land is used for agriculture and forestry it must conform with environmental protection, urban planning as well as aesthetics (Article 61)	Environmental Protection states that "exploitation of agricultural land, forest land, and land for aquaculture must comply with land use plans, land improvement plans, and ensure ecological balance." The Land Law divides land into different categories. Land in each category has to be used according to its purpose Furthermore Article 79 gives	there are limits to the amount of agricultural land a household can own. Natural forest and forest planted by state investment belongs to the state whereas forest planted by private investors on state-allocated land is in the possession of the investing institution or individual (Article 3, Law on Forest Protection and Development).	

[107] Constitution of the Socialist Republic of Vietnam, 1992 as amended 2002. (Vietnam: 2002). http://www.vietnamlaws.com/freelaws/Constitution92%28aa01%29.pdf.
[108] Vietnam. Law on Environmental Protection. (Vietnam: 1993). http://coombs.anu.edu.au/~vern/luat/english/Law-envir-protect.txt.
[109] This includes: constructing, renovating production areas, population centers or economic, scientific, technical, health, cultural, social, security and defence facilities; owners of foreign investment or pint venture projects, and owners of other socio-economic development projects
[110] Vietnam. Land Law. (Vietnam: 1993). http://coombs.anu.edu.au/~vern/luat/english/Law-land-law.txt.
[111] Vietnam. Law on Forest Protection and Development. (Vietnam: 1991). http://coombs.anu.edu.au/~vern/luat/english/Law-forest-protect.txt.

			Law on Forest Protection and Development (1991): [111] - all activities such as burning forests, forest encroachment or transporting forest products are strictly prohibited (Article 20) - forest tenures are responsible for making forest fires and they need to apply prevention measures (Article 22) - protection forest is used to protect among others the land, prevent erosion and harmonize the climate (Article 26) - in the period after exploiting production forest it should either be replanted or the regeneration method should already be applied during the exploitation period (Article 38)	land users the obligation to comply with the regulations on environmental protection. If land is used for the production of porcelain, bricks and tiles or for exploitation purposes a permit from the authorized state body is needed. Furthermore it must be made sure that the environment is protected, there is proper waste treatment and harming land users must be avoided (Article 66&67).	If for 12 consecutive months a land user who was allocated land for afforestation purposes, does not carry out environmental protection measures and afforests the land according to the plan authorized by the proper authority without good reason the allocated land may be withdrawn (Article 14, Law on Forest Protection and Development).	

3.2.2 Examples for national adaptation and mitigation measures

It can be noted that the ASEAN countries face climate change on many different levels. As Southeast Asia is one of the most densely populated regions in the world, disasters related to climate change may affect millions of people. Water related disasters as well as deforestation are two of the most urgent problems in Southeast Asia as the case studies showed. Insufficient drainage systems and the rapidly increasing number of people in large cities leave less room for the water, which increases the likelihood of floods as well as the damage caused by them. Another problem is deforestation, especially in regard to landownership rights. Forests have high potential as carbon sinks, whereas the destruction of forestland has severe impacts on the environment. In spite of this, Southeast Asia continues to have large deforestation rates. A closer look at some case studies demonstrates who different member countries try to cope with in these environmental challenges and where climate change adaptation and mitigation policies could be already successfully implemented. The examples include case studies from Cambodia, Malaysia, the Philippines, Indonesia and Vietnam.

Cambodia: Community Forestry Carbon Offset Project (CFCOP) in Oddar Meanchey Province

In 2007 the United Nations Framework Convention on Climate Change (UNFCCC) introduced Reducing Emission from Deforestation and Forest Degradation (REDD) as a financial mechanism to reduce deforestation in developing countries. This case study about a pilot project in Cambodia shows how REDD can be implemented and what difficulties regarding land rights may have to be faced.

The project area in Oddar Meanchey province was selected because of the high deforestation rate of 2.1% annually. The project wants to protect a forest area of 60,000 ha and thereby store some 7.1 million tons of carbon over the next 30 years. Apart from storing carbon and implement effective payment mechanisms, a secondary goal related to land includes securing tenure rights of local communities.

The Forestry Administration approved the project in November 2007 and a legal basis was created by the prime minister in May 2008 with Decision No. 699. This clarified that the forestlands belong to the Forestry Administration. However, local communities were granted use and management rights, which include traditional activities such as gathering dead firewood, picking fruit, and collecting honey. Timber may be collected with prior approval by the local Community Forestry Management Committee (CFMC) for building houses of community members. Commercial use of the forest is strictly forbidden. The community rights were secured by a 15-year renewable lease agreement between the Forestry Administration and the CFMC.

Cambodia does not have any legal framework for carbon rights. Carbon credit ownership rights are also not specified in Decision No. 699. However, since the forest belongs to the Forestry Administration, they will act as the carbon credit seller in this project. On the other hand, the Decision No. 699 does specify that the revenues of the carbon selling will be used to benefit local communities. The distribution mechanisms and the amount of money to be generated were not known at the time of research, because the sale of carbon credits had not started yet. But interviews with the local communities showed that their primary goals were to secure tenure rights and benefit from technical and financial support for the forest protection. Apart from this, jobs for local communities would be created.

Another important factor during this project was conflict resolution. Since most of the land has not been demarcated, this was the first step that had to be taken. The whole project area was demarcated, which led to a number of conflicts. While most of them could be resolved with the help of the Forestry Administration, NGOs, and local communities, there also were serious disputes that had to be settled by the provincial court. The case of military family land encroachment in the project area was brought to court, and after five Forestry Administration staff had been injured during this land dispute, the military families were ordered to move to new villages outside the project area. Firm political support for the REDD project was a main reason why conflicts could be resolved.[112]

Malaysia: Changing land-use patterns at the Bernam Watershed

This case study analyzed changing land-use patterns and their consequences regarding sediment runoffs and the loss of soil. Even though it did not include climate change directly, the effects of changing land use can increase the vulnerability of an area to climate change. The Bernam watershed is located in Selangor, West Malaysia. The average rainfall in this area is 2000 mm – 3500 mm, while the mean annual runoff is between 800 mm – 1850 mm. The dominant vegetation is tropical hill rainforest, forests, rubber, and palm oil plantations as well as some urban areas.

The case study looked at the land-use patterns between 1989 and 1998. During this time an increase of sediment runoff was found. The reasons for this were attributed to the following changes in land-use:

[112] Yeang, Donal. Tenure Rights and Benefit Sharing Arrangements for REDD: A Case Study of Two REDD Pilot Projects in Cambodia. Forest and Nature Conservation Policy Group. Wageningen University. (The Netherlands: 2010).
http://www.agentschapnl.nl/sites/default/files/bijlagen/30%20Tenure%20Rights%20and%20Benefit%20Sharing%20Arrangements%20for%20REDD.pdf.

- the amount of rubber plantations decreased while more land was being used for palm oil plantations
- old palm trees were replaced with new palm trees
- ongoing urbanization and deforestation resulted in more bare land where more rainfall runoffs occur

As climate change often affects rainfall patterns, an increase in precipitation would result in even more sediment runoffs and therefore, the changes in land-use patterns make the area more sensitive to climate change. It was concluded in the case study that more attention should be paid to land use patterns and the establishment of control measures is needed.[113]

The Philippines: Flood mitigation in Manila

Predictions based on climate models that support the IPCC (Intergovernmental Panel on Climate Change) Fourth Assessment Report suggest an increase in local temperatures as well as heavier and more variable rainfall. This makes large coastal cities in Southeast Asia especially vulnerable to floods, especially if the drainage systems are overstrained due to heavy and unexpected rainfall. Against this background the Japan International Cooperation Agency conducted a case study in Manila on the impact of climate change in these megacities.[114]

Manila is a typical example of a Southeast Asian coastal megacity. It is located in a low-lying area close to the sea with two river systems and a large lake making it especially vulnerable to floods. Manila's climate is shaped by two distinct seasons, the dry season and the raining season with most rain falling between May and October. During these months the combination of increased precipitation and an insufficient drainage causes frequent flooding.

For this case study 300 households in three flood-prone communities, namely the Pasig-Marikina River Basin, the West Mangahan area and the KAMANAVA area, were interviewed. About 2/3 of

[113] Aimrun W., Alansi. AW, Amin M.S.M., Abdul Halim G., Ezrin M.H., Shafri, H.Z.M., Thamer A.M., Waleed A.R.M. The Effect of Development and Land Use Change on Rainfall-Runoff and Runoff-Sediment Relationships Under Humid Tropical Condition: Case Study of Bernam Watershed Malaysia. European Journal of Scientific Research Vol.31 No.1. (2009). pp. 88-105. EuroJournals Publishing, Inc. 2009. http://www.eurojournals.com/ejsr.htm.

[114] Muto, M., Morishita, K., and Syson, L. Impacts of Climate Change upon Asian Coastal Areas: The case of Metro Manila. Japan International Cooperation Agency. (The Philippines: 2010). http://jica-ri.jica.go.jp/publication/other/impacts_of_climate_change_to_asian_coastal_areas_the_case_of_metro_manila.html.

them stated that they have been affected by typhoons, floods, or storm/tidal surges in the past. They were affected by floods in the following ways:

- Out of the respondents that owned toilets, more than a quarter stated that their toilets became clogged with waste. Apart from this they complained of the bad smell during floods and that the water carries garbage from other neighborhoods.

- Fluctuating energy supply and "brown-outs" frequently occur during floods. Often the *barangay* police ask them to shut off their electricity for safety reasons.

- The water supply of 23% of the households is affected during floods.

- The respondents affected by the floods or their household members were more vulnerable to diseases. They were sick for an average of 12 days.

- People could not go to work for an average of 4 days and lost an average 925 Pesos (median of 500 Pesos) of income during floods.

- Children were absent from school for an average of 5 days due to floods.

The case study also includes how the communities try to prepare for future floods and how they adapted to living with the water.

- Many residents put their household appliances on higher ground to protect them from the water. Some even built improvised platforms where they could store their belongings during floods.

- Only about 5% reported that they received help from community officials or religious leaders. Most residents rely on informal support networks.

- Some communities installed water pumps to control the water. However, this leads to surrounding communities having higher floods.

- People in some communities, such as Malabon and Pasig City, have added another storey to their homes to be better protected from floods. However, people living upstairs might get trapped during floods since they cannot leave the building.

- In Taguig city a dike has protected nearby communities from floods.

- In Napindan, area residents have build small ports for boats carrying supplies and transporting people to their workplaces during floods.
- Some communities have build bamboo bridges between households to connect each other during floods.
- Informal community groups and warning systems have been arranged and some *barangay* officials formed groups that help with the evacuation of people during floods.
- In Marikina a successful flood mitigation system has been built consisting of:
    - concreting of roads, reducing the amount of sand, pebbles, and mud entering the drainage system
    - rehabilitation and construction of up-to-date drainage systems to allow water in flooded areas to recede faster in order to reduce flood damages
    - frequent dredging operations cause faster discharge of floodwaters from residential areas to rivers
    - relocation of squatters living next to the Marikina river
    - improvement of existing water diversion channels
    - constructing river barriers to protect people living along the river

Another way the Philippines are trying to improve the situation is the "KAMANAVA Area Flood Control and Drainage System Improvement Project". This integrated plan includes the "construction of a polder dike, heightening of river walls (…), construction of a submersible radial navigation gate facility, construction of flood gates, construction of control gates, construction of pumping stations, and improvement and new construction of drainage channels".[115]

Indonesia: Effects of climate change in the Spermonde Archipelago

Two major research excursions came to the conclusion that the existence of the Spermonde archipelago is threatened by climate change and the rising sea level. According to the villagers living on these islands, storm surges as well as island flooding have increased. Apart from this, increased

[115] Muto, M., Morishita, K., and Syson, L. Impacts of Climate Change upon Asian Coastal Areas: The case of Metro Manila. Japan International Cooperation Agency. (The Philippines: 2010). Page 9. http://jica-ri.jica.go.jp/publication/other/impacts_of_climate_change_to_asian_coastal_areas_the_case_of_metro_manila.html.

erosions, higher waves, and more dangerous weather as well as a loss of island surface were noticed. Some houses were already lost to the sea and the families living there either moved in with relatives or left the islands.

However, the people living on the islands did not identify climate change as the reason for rising sea levels and they did not seem to have any plans for the future development of the islands with regard to climate change. Some of the interviewed villagers stated that they might have to leave the island if the sea level rises further, but they did not know where they could go. The villagers had started to build a stone dam to protect the island from water, but after they received no government assistance they stopped the project.[116]

[116] Glaeser, B., Glaser, M. Global change and coastal threats: "The Indonesian case - An attempt in multi-level social-ecological research", Human Ecology Review, Vol. 17, No. 2, 2010.

Vietnam: Climate Change Impacts on Catfish Farming in the Mekong Delta

Vietnam is very vulnerable to disasters related to climate change due to its long coastline, the climate, and its topography. The Mekong delta region is especially vulnerable to extreme weather conditions. As the delta experienced rapid growth in agriculture and aquaculture in the 1990s, catfish farming became especially popular and it accounts for a large amount of the total production in this area. This case study summarizes the findings of group discussions between catfish farmers, managers from various government agencies, staff from commercial companies, and scientists as well as other stakeholders. During these discussions they identified the following changes in climate, their impacts, and adaptation measures:

1. An earlier rainy reason affects the fish, since they lose appetite, which reduces the growth rate as well as the mortality rate. Farmers reacted to these problems by using higher quality food, feeding with more nutritients (Vitamin C), and by using probiotocs. This leads to higher costs for the catfish farmers.

2. More storms, typhoons lead to higher water levels which let fish escape while sudden heavy rain causes the water temperature to decrease suddenly and leads to more bacterial diseases and parasite problems. Measures taken include an increased use of probiotics and strengthening the walls of the ponds.

3. Increasing salt water intrusion causes a loss of production area and less productivity due to the fact that the fish have less appetite, more diseases, and a consequently poorer meat quality. To face these problems farmers exchange the pond water daily, use probiotics, and selected more resilient fish species.

4. Higher water level in rivers and canals lead to increased floods, dike erosions, fish escapes, disease outbreaks, but also a better meat quality due to better water exchange. Measures taken include strengthening the pond dikes (e.g. by planting trees on the dikes), increasing the height of sluice gates and adding different substances to the water.

5. More hot as well as cold days (more extreme weather) changes the water quality and leads to more diseases. Farmers react to these conditions by increasing the water exchange and the use of chemicals as well as using higher quality food.

6. More changing weather patterns are leading to the fish being more stressed and losing appetite, which is resulting in slower growth rates. Measures taken include feeding better food, adding salt to the water to stabilize it, and using lime on the slopes of the dike.

Apart from the measures the farmers have already taken on their own, they also asked for additional support. This includes:

- Advice from scientists, research institutions, and the fishery managers at the district and provincial levels
- A university research centre specializing disease diagnosis and treatment
- Advice and training from drug and chemical supply companies to ensure the appropriate chemicals are being used
- Investment by government departments to improve the water supply, drainage, and irrigation systems
- An early warning system through the media (TV stations) and mass communication
- More environmental police units in Can Tho city
- Improve the seed quality from the government and private hatcheries
- A study on potential new more salt-tolerant species and select catfish that are genetically more tolerant to salt
- Development of vaccines against major diseases[117]

Results of the case studies

The case studies show that there has already been some work done by the different governments to implement mitigation and adaptation measures. The Philippines' integrated flood mitigation program in Manila found some ways to lower the impacts of floods. The Cambodian case study about the REDD pilot project provided a possible solution to address the problem of deforestation. It also shows difficulties that may have to be faced while implementing the project. A clear distribution of

[117] Truong Hoang Minh, Nguyen Thanh Phuong, Nguyen Van Hao, Sirisuda Jumnongsong, Varunthat Dulyapurk, Udaya Sekhar Nagothu, Patrick White, Nigel W. Abery, Sena S. De Silva. Perception of climate change impacts and adaptation of catfish farming in the Mekong delta, Vietnam: Focus group discussions and stakeholder workshop. Network of Aquaculture Centers in Asia-Pacific (NACA). (Vietnam: 2009).

land titles is needed to prevent future conflicts. While in Cambodia the REDD pilot program was only possible with support from government officials, the case study from the Spermonde archipelago demonstrated on the other hand that without government support, projects to mitigate climate change effects can still be completed successfully.

This demonstrates that government action might be necessary but that it cannot be the sole responsibility of the government. Local participation and adaptation have often prevented more damage than official government measures. An example can be found in Manila/Philippines, where local communities learned to adapt to frequent floods by building two-storey houses and moving valuables to higher floors during floods. Their social networks also helped flood victims when government aid was not available. In Cambodia the participation of local communities in the REDD pilot program was also vital, because they are the ones directly affected by the carbon sink project. They will also provide some of the staff in the forest area, which makes for good cooperation between the government and local communities and essential parts of the project.

Another important factor is the legal framework. In Cambodia it was not clear, who the legal owner of a carbon right is. Since trading carbon rights is a relatively new concept most countries lack laws and regulations defining the agencies in charge and the decision making process regarding carbon rights. Apart from this, strong rule of law is needed to effectively implement the climate change mitigation and adaptation measures outlined in the legal framework. Conflict resolution mechanisms are needed as the case study in Cambodia shows. This is especially important in regards to land rights and land ownership, since there are still many people that do not have an official land title for their land, which makes them vulnerable to land grabbing and threatens their livelihoods. Indigenous communities living in forest areas might be affected by government plans to create carbon sinks or natural reserves. In order to prevent disputes during the establishment of protected forest areas, the first step during the implementation must be to ensure that there are clear landownership rights. Another advantage of giving local and indigenous communities official land titles is that it will give them the opportunity to develop their land on a long-term basis and encourages them to use their land in a more sustainable way.

A group that is especially vulnerable to climate change are people without a social network helping them during and after floods. Therefore, they will need special attention from the government. People without a large social network rely heavily on information provided by the government as they are not part of community warning systems. If the government does not provide accurate and timely information they do not have time for preparation, which leads to the floods causing greater damage. Therefore, an efficient warning system is essential. This can be achieved by supporting

community warning systems and making sure everyone gets the necessary information as well as improving the official warning systems. The case study about flood mitigation in Manila showed that metropolitan areas lying in flood prone areas need special attention. The high population density in these areas increase the damage caused by floods if there is no effective flood mitigation system.

A major difficulty in almost all of the case studies was to obtain data that can give a reliable prognosis on how exactly climate change will affect the area. Depending on the location, climate change has different effects and predictions for one place might not necessarily be true for another one. Furthermore in only some of the case studies, such as the Philippines, a detailed analysis was carried out, whereas the Vietnam case study was based on observations of the local farmers and not backed by scientific research. However, this does not necessarily mean that one cannot draw conclusions from it. The effective adaptation measures of the local communities can provide valuable lessons learned for Thailand.

3.3. Thailand

3.3.1. Land Use and Vulnerability

The projected effects of climate change, including higher surface temperature, floods, droughts, severe storms, and sea level rise, put Thailand's rice crops at risk and threaten to submerge Bangkok within 20 years. Already one degree of warming could destroy the rice crops that are central to the economy, submerge the capital city, and threaten coastal tourism. This has the potential to cause enormous economic, cultural, and environmental impacts. Risks are especially significant for the agricultural sector, which have the potential to cause severe social impacts, since the majority of Thailand's population lives in rural, agricultural areas. Agriculture employs 49% of the population and contributes 10% of GDP.

Figure 3.IX: Forest and Agricultural Land in Thailand

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

Source: Source: Office of Natural Resources and Environmental Policy and Planning, "Thailand's Second National Communication under the United Nations Framework Convention on Climate Change", (Bangkok 2010), 29

Tourism and fisheries abound along Thailand's 3,200 kilometers of coastline and play important roles in the economy, providing 6% of GDP, and support the livelihoods of 10% of the population. The capital city, Bangkok, is home to 15% of the national population and serves as the economic, political, and social center not only for Thailand, but for the greater Mekong region, giving it the status of global city. Located in the Chao Praya Delta, the city is especially exposed to threats from river flooding and SLR. The impacts could be seen during the flood 2011 which is therefore discussed separately (see the following section).

The overall allocation of land resources among agriculture, forestry, and other sectors has changed only slightly during the last 30 years. Paddy land has more or less been constant, although the proportion of fields crops to total agriculture land declined, while that of permanent trees and fruit trees increased. Land use for agriculture has been relatively stable at 21 million hectares, or about 40% of the total land area (see figure 3.IX), whereas land use for forestry has increased slightly in proportion to the total land area due to reforestation and conservation.[118]

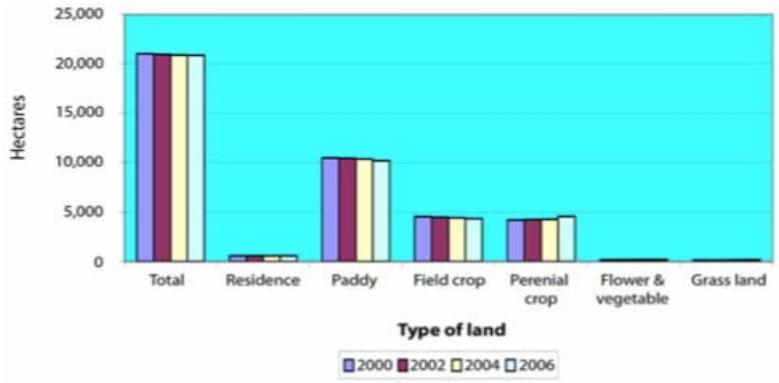
Despite its relative stability, agricultural land use has seen changes in recent years (Figure 3.X). Rice-planted areas, though generally stable, declined slightly in recent years from about 10.5 million hectares in 2000 to about 10 million hectares in 2006. The same is true for land planted to field crops, which dropped from 4.6 million hectares to 4.4 million hectares during the same period. Land

[118] Ministry of Natural Resources and Environment Policy and Planning, "Thailand's second National Communication under the United Nations Framework Convention on Climate change", 28

planted to perennial crops and grass increased by nearly 300,000 hectares between 2004 and 2006.[119]

The shift in land use from annual to perennial crops was due to changes in climate and market conditions. Frequent droughts motivated farmers to grow fast-growing trees for the paper industry. Also, high prices for the rubber and palm oil induced farmers, particularly in the south and northeast, to switch to these two crops.

Figure 3.X: Agriculture land distribution in Thailand, 2000 to 2006



Source: Source: Office of Natural Resources and Environmental Policy and Planning, "Thailand's Second National Communication under the United Nations Framework Convention on Climate Change", (Bangkok 2010), 29

Threats to the agricultural sector

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. Damage caused by droughts or floods has increased, with some fluctuations over time[120]. 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 has saline, sandy, shallow, or acidic soils (Figure 6.III). These areas have already low productivity and on top have restricted ability to adapt to climate changes.

[119] Ministry of Natural Resources and Environment Policy and Planning, "Thailand's second National Communication under the United Nations Framework Convention on Climate change", 29

[120] Ministry of Natural Resources and Environment Policy and Planning, "Thailand's second National Communication under the United Nations Framework Convention on Climate change", (February 2011), 9

Figure 3.XI: 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: Source: Office of Natural Resources and Environmental Policy and Planning, "Thailand's Second National Communication under the United Nations Framework Convention on Climate Change", (Bangkok 2010), 29

Since the conditions for agricultural land use in Thailand are highly depended on the monsoon winds in terms of wind directions, seasonal occurrence, and rainfall intensity, the sector is highly vulnerable to changes in these patterns. In the northern, central, and western regions, an average annual rainfall of about 1500mm is expected, while the Thai section of the Malay Peninsula usually gets over 2500 mm. The Khorat Plateau gets the least rainfall with about 1270 mm or less per year. Nevertheless, a large part of Thailand remains vulnerable to the limited availability of surface water. Existing water resource management has not been able to cope effectively with demand. Water storage capacities vary from region to region and can only partially support the demand.

Furthermore agricultural production as well as the livelihood of many people is threatened through 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. The major highlight of this case is that during the period of 1992 to 2002, there were more areas affected by frequent flooding than ever (Figure 3.XI). The extent of damage varies from year to year, sometimes reaching hundreds of million dollars and affecting more than 2 to 3 million households.[121]

Figure 3.XII: Flood damages by provinces, aquaculture and agricultural land (1989-2008)

[121] Ministry of Natural Resources and Environment Policy and Planning, "Thailand's second National Communication under the United Nations Framework Convention on Climate change", 30

Year	Provinces (number)	Fish and shrimp ponds (number)	Agicultural 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: Office of Natural Resources and Environmental Policy and Planning, "Thailand's Second National Communication under the United Nations Framework Convention on Climate Change", (Bangkok 2010), 30

It can be seen, that during two decades (1988-2008) Thailand hasn't been particularly spared by flood damages. Every year, considerable amounts of agricultural land or fish and shrimp ponds have been damaged. The lowest number of provinces affected during these two decades is 52 (out of 75 provinces in total), which is still a usually high number. The table demonstrates the urgent necessity for the Thai government to address those issues.

Figure 3.XIII: 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: Office of Natural Resources and Environmental Policy and Planning, "Thailand's Second National Communication under the United Nations Framework Convention on Climate Change", (Bangkok 2010), 31

This figure demonstrates that drought damages are relatively costly for the entire Thai population. Every year the damages caused by the drought can be counted in millions of dollars. In 2005, the year after the disastrous Indian Ocean earthquake and Tsunami, the drought damages were as high as $US 232,795,723. It must be noted that around 75% of the Thai population live off the farm and the food-processing sectors, so these droughts are particularly damaging for the entire economy of Thailand. The following figure provides an overview on economic impacts of disasters during the first half of the last decade:

Figure 3.XIV: Numbers and economic impacts of disasters on 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: Office of Natural Resources and Environmental Policy and Planning, "Thailand's Second National Communication under the United Nations Framework Convention on Climate Change", (Bangkok 2010), 65

Generally, it is projected that climate change will further increase the variability and probability of extreme weather events and disasters. To examine potential scenarios on Thailand a pilot study was conducted in Koh Tao (Tao Island), Surat Thani province. Historical data and 30-year scenarios using a climate model indicated that there was slight increase in the number of monsoons days. When using the historical data to forecast future trends, it was found that the frequency of depressions is likely to decrease but that typhoons are likely to increase and monsoon storms will see no change.

Figure 3.XV: 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

Source: Office of Natural Resources and Environmental Policy and Planning, "Thailand's Second National Communication under the United Nations Framework Convention on Climate Change", (Bangkok 2010), 65

Forests and Deforestation

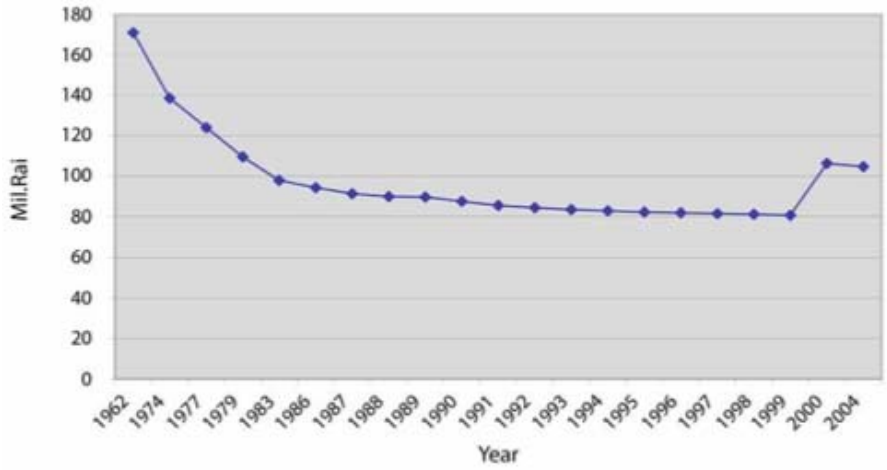
Forest areas in Thailand have gradually declined and have been relatively stable only in the 1990s due to strong measures implemented by the respective Thai governments, particularly those that banned logging and expanded forest conservation areas. In the early years of 2000, forest land was redefined 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 3.XVI: Forest Land Distribution in Thailand (2004)

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

Due to exploitation, Thailand's mangrove forest was reduced from nearly 320, 00 hectares in 1975 to less than 200,000 hectares in 1987. In 1996, the then Thai government decided to revoke all mangrove forest concessions and to rehabilitate these areas. Consequently, 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 December 2004. Areas protected by mangrove forests were saved from the devastating effects of the tsunami, while those without such shield were completely destroyed.

Figure 3.XVII: Forest Land in Thailand, 1962-2004



Source: Office of Natural Resources and Environmental Policy and Planning, "Thailand's Second National Communication under the United Nations Framework Convention on Climate Change", (Bangkok 2010), 32

The figure shows that for decades there was continual deforestation all across the country until the Thai government put strong measures against logging and implemented a policy of protected forest areas and reforestation at the turn of the century.

Sea level rise

The knowledge of potential impacts of SLR on Thailand is limited since there is still a lack of research regarding this issue. A small study in Krabi province using DIVA (Dynamic Interactive Vulnerability Assessment) shows that the sea level along the coast of Krabi could rise by 11 to 22 cm. As a consequence, in 25 to 35 years about 10 to 35 meters of the coastline could be inundated.

On the other hand, a study on SLR in the Gulf of Thailand over the past 56 years indicated a reverse trend, that is, a decline by 56 cm per century, potentially due to geological change.[122] Thus, an assessment on vulnerability to SLR needs to consider the potential impacts into socio-economic scenarios, in addition to other physical and biological changes over the same period. Another study examining potential SLR effects on the island of Koh Tao came to the conclusion, that already an estimated 20cm 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 consultation with the local community and together drew up community development scenarios

[122] Vongvisessomjai, S. 2006, *Will sea-level really fall in the Gulf of Thailand?,* Songklanakarin Journal of Science and Technology, 28(2): 227-248.

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.[123]

SLR studies in Thailand use simple mapping techniques to observe potential inundation due to one-meter SLR along detailed contour lines. A simple model to analyze SLR that is more specific to local areas has been used in the Gulf of Thailand.[124] 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 measures cannot be derived.[125]

As already pointed out, the Mekong Area is a crucial regional hotspot, particularly vulnerable to climate change. A study on potential climate change impacts on the Mekong river basin (based on IPCCs A1B scenario) examined the implications for the affected regions in Thailand (among others). Although an increased flood risk can be predicted for all regions, some regions are affected less or could even generate some profits. The study predicts for example, that in North East Thailand, the agricultural production and food availability could increase while in Northern Thailand agricultural productivity in the Mekong basin is projected to decrease. In some areas of Northeast Thailand, increased precipitation is also likely to reduce annual water stress during the dry season.[126]

3.3.2. Impacts of the Bangkok Flooding of 2011

During the 2011 Flood crisis in Thailand, five tropical storms hit the northern area of Thailand during June-October 2011 which brought continuous heavy rainfall. The amount of rain in the northern region of Thailand is equivalent to 1,674.5 mm (an increase of 42% compared to the rainfall during

[123] Ministry of Natural Resources and Environment Policy and Planning, "Thailand's second National Communication under the United Nations Framework Convention on Climate change", 65
[124] 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, 35
[125] Ministry of Natural Resources and Environment Policy and Planning, "Thailand's second National Communication under the United Nations Framework Convention on Climate change", 59
[126] Eastham, Judy at all, "Mekong River Basin Water Resources Assessment: Impacts of Climate Change", (CSIRO: Water for a Healthy Country National Research Flagship: 2008)

Jan-Oct 2011). The huge amount of rainfall followed by subsequent release from water from the dams overloaded the rivers which flooded the surrounding areas. The situation deteriorated and some areas of Bangkok were flooded for more than two months. The floods impacted agriculture, community, housing and transportation. It was recognized as the most severe flood in 50 years.

The recent floods in Thailand had not only profound impacts on people livelihoods, but also caused a lot of damage to their houses and properties, affecting over 2.5 million people nationwide. Hundreds of thousands of residents became internally displaced. The floods that began in late July ravaged 30 provinces in the northern, northeastern and central regions, including Bangkok – the capital city of Thailand. In Bangkok, 36 districts out of total 50 were hit by the floods. The level of floodwaters ranged up to three meters deep in heavily flooded areas. The news reported that these were the worst floods in 50 years in Thailand with a mass movement of over 100,000 people – the biggest displacement in the country since World War II. Initially, many flood victims in rural provinces moved into Bangkok to live with their relatives and friends. Then, when the floods reached Bangkok many inbound and outbound roads and highways were closed or became difficult to access, hundreds of thousands of Bangkok residents had to evacuate to other flood-free areas. Some people chose to stay at evacuation centers, whereas others moved away to remote provinces. Others, who were financially able, rented a condominium or a hotel room within the city. At the height of the floods, all outbound flights to regional cities were fully booked, and highways to these regions were jammed for six to ten hours

The floods put great pressure on internal migration. Not to mention a shortage of housing, food supplies, and drinking water as factories became flooded and supply chains disrupted. The massive floods are very much in line with the finding in the UK's Foresight Report on "Migration and Global Environmental Change.''[127] The report states that ''*the impact of environmental change on migration will increase in the future''*. It examines not only global migration trends but also internal migration trends. In particular, ''*environmental change may threaten people's livelihood and traditional response is to mitigate*.'' The report also points out that individuals who experience the impacts of environmental change may need extra financial resources to move. But these people may be unable to move away from locations in which they are extremely vulnerable to environmental change. This can be seen as a ''trapped population'' and is a real concern for well-planned migration policy.

The government reports that around 800,000 people became trapped in the city with little access to daily necessities and food supplies. The floods have also affected communities of Burmese migrant

[127] Beddington, John. "Foresight: Migration and Global Environmental Change, Final Project Report", (The Government Office for Science, London: 2011), 186-201

workers outside Bangkok. Factories where many of them work became submerged, leaving many workers unemployed and homeless. Around 100,000 of them chose to return back home and waited until the situation was back to normal before coming back to Thailand. It is highly evident that Thai people have become more aware of environmental and climate change impacts on their livelihoods. The massive floods are a real wake-up call, as nobody wants a repeat. In particular, the government agencies engaged in flood management are now working together to discuss what actions and policies need to be implemented.[128]

The APEC forum in Hawaii and the ASEAN Summit in Bali were welcome opportunities for Thai representatives to try and regain international investor confidence by promising, among other things, to set up a better water management system. The ASEAN Head of States agreed to intensify cooperation on climate change as well as mitigation and prevention measures. He further elaborated on long-term flood prevention measures ranging from digging a new floodway between the Central Plains and the sea, to new cities, highways and railways. It remains to be seen if those plans will be followed up with or ever be implemented once flooding related news has diminished in importance and investor confidence is fully restored.

Total damage to infrastructure and industry is over 2% of Thailand's GDP and the total recovery period will take over two years. Rebuilding has become the number one priority. A strong weight has been laid on Thailand to improve disaster management, not only by nationals but regional and global citizens who were affected as well. Thailand is in need of cooperative action to solve the crisis in addition to supporting sustainable water management resources. The success of rejuvenating Thailand relies on political and community will to support transformation and start over. The devastating floods in Thailand have added another dimension to the range of threats to the country and Thai's cannot afford to mismanage developing a long-term strategy.[129]

Recovery and future planning is now the biggest focus of Thai politicians, policy makers, and global onlookers. The World Bank has offered to loan 30 billion baht (US$1 billion), for investment in long-term flood prevention projects. A budget has also been secured of about US$10 billion for post-flood restoration. The World Bank predicted that Thailand will need to invest US$25.2 billion over the next two years. Predictions of growth have reached as high as 7% for next year as the government plans to spend heavily on reconstruction, specifically in infrastructure. Thailand will be counting on foreign investment, with a strong need for companies to maximize output, re-investing in the skill

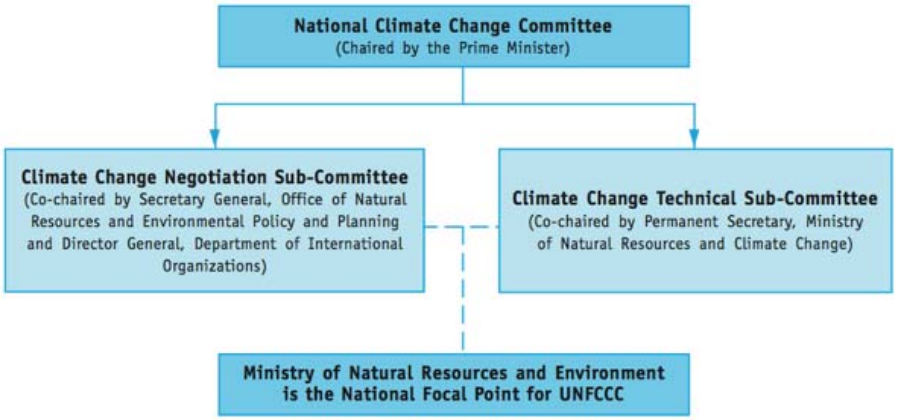
[128] Kanayon Tansubhapol, Floods and Migration in Thailand, December 2011, http://blogs.fco.gov.uk/2011/12/16/floods-and-migration-in-thailand/
[129] Human Development Forum Foundation, HDFF Thailand Flood 2011 Special, November 2011. http://hdff.org/2011/11/05/hdff-thailand-flood-2011-special/

development of their labor force. To stimulate domestic spending, Thailand's government is proceeding with the plan to raise the minimum wage, although many businesses are deeply troubled over the potential negative effects. The central bank has also cut the interest rate for the first time in two years. The one-day bond repurchase rate was reduced by a quarter of a percentage point from 3.5% to 3.25 percent. The central bank claimed it may continue to ease the policy if the nation continues to struggle. The bank forecasts 4.8% growth in 2012. Thailand's economic future remains unseen.[130]

3.3.3. Institutional and legal framework

After ratification of the United Nations Framework on Climate Change (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 position 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.[131]

Figure 3.XVIII: Policy making concerning climate change in Thailand



Source: Office of Natural Resources and Environmental Policy and Planning, "Thailand's Second National Communication under the United Nations Framework Convention on Climate Change", (Bangkok 2010), 36

[130] Human Development Forum Foundation, Follow up Flood Analysis, November 2011. http://hdff.org/2011/12/09/follow-up-flood-analysis-%E2%80%93-november-2011/

[131] Ministry of Natural Resources and Environment Policy and Planning, "Thailand's second National Communication under the United Nations Framework Convention on Climate change",36

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*)[132] Thailand has integrated climate change issues into the national development planning process since the 7th plan (1992-1996).

Thailand has commenced preparation of the Eleventh National Economic and Social Development Plan[133] with the introduction of its vision for the period starting in 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 development issue identified is the management of natural resources and the environment to achieve sustainability. Conditions that are vital to the pursuit of 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, neuro technology and energy security. It can be said that Thailand has become increasingly concerned about global warming and climate change as critical factors affecting sustainable development.

The *Office of Natural Resources and Environmental Policy and Planning* (ONREP) was established under the Ministry of Natural Resources and Environment to be the national focal point for climate

[132] Office of Environmental Policy and Planning,Thailand's Initial National Communication under the United Nations Framework Convention on climate change, October 2000.
[133] Office of the National Economic and Social Development Board, Summary of the Eleventh National Economic and Social Development Plan, http://www.nesdb.go.th/Portals/0/news/academic/Executive%20Summary%20of%2011th%20Plan.pdf

change under the UNFCCC. ONREP was designated to create a 10-year national master plan starting from 2010. Its main objectives were:

- To create an integrated climate change management
- to enable Thailand to adapt and cope with climate change effects,
- to promote sustainable development in all sectors while reducing greenhouse gas emissions

In this master plan, the forest is one of the highlighted sectors, particularly in strategy number 2. A specific project under strategy 2 has direct reference to the promotion of REDD plus activities. The Cabinet has yet to approve the master plan. Further, the ONREP is reviewing the master plan based on the demands of the civil society.[134]

In 2008 the public *Thailand Green Gas Management Organization* (TGO) was established as an autonomous governmental organization to be the Designated National Authority (DNA) for Clean Development Mechanisms (CDM) of greenhouse gas (GHG) emission reduction in Thailand. It is also in charge screening and analyzing the CDM projects for the issuance of the Letter of Approval as well as monitoring these projects. Within the first 16 months of its existence the TGO had already approved 60 projects, raising the number of overall CDM projects to 75.

Apart from this they are involved in capacity building of the government and the private sector and raising awareness on GHG and CDM. Its activities also include promoting low carbon activities such as the Carbon Footprint, which will state the amount of carbon produced during the life-cycle of a product. The TGO implements the Carbon Labeling initiative as the first ASEAN country. As of May 2009, Thailand had granted 25 manufacturers this label for reducing the amount of GHG in the production process tup to 10%.[135] The above mentioned institutions and strategic plans established and implemented by the Thai government as well as relevant government agencies are listed in the following figure:

Figure 3.XIX: Development of Thai institutions related to climate change issues

Year	Development
1993	The National Committee on Climate Change was established.
2007	The National Board on Climate Change Policy and Climate Change Coordinating Unite

[134] Climate Change, Trees and Livelihood: A Case Study on the Carbon Footprint of a Karen Community in Northern Thailand. Northern Development Foundation, Oxfam-GB. (Thailand: 2010).
[135] Thailand Green Gas Management Organization official website. Accessed on 14.02.2012. http://www.tgo.or.th/english/index.php?option=com_content&view=category&id=25%Itermid=28

	became the government body dealing with climate change.
2008	The Thailand Green Gas Management Organization (Public Organization), or TGO was established as the autonomous governmental organization for Clean Development Mechanisms (CDM) and greenhouse gas (GHG) emission reduction.
2008	The Thailand Green Gas Management Organization (Public Organization), or TGO was established as the autonomous governmental organization for the Clean Development Mechanism (CDM) and greenhouse gas (GHG) emission reduction.
2008-2012	Strategic Plan on Climate Change: · capacity building · promoting greenhouse gas mitigation activities · supporting research and development · raising awareness and public participation · establishing a framework of coordination and integration · supporting international cooperation
2010-2019	National Master Plan on Climate Change

Legislation

Thailand has several laws dealing with different sectors that are related to climate change. Environmental, industrial, land, as well as energy laws, contain regulations about environmental and sustainable management and development of land. However, most of the industrial, energy, and land laws only briefly cover environmental protection and/or climate change mitigation. There is no law specifically dealing with climate change, such as in the Philippines.

Regarding landownership rights the National Reserved Forest Act allows granting permission to utilize the land in national forest reserves, however these permissions are not land title deeds. This means that indigenous communities living on this forest land do not have secure land rights, which might lead to land disputes. On the other hand, there are the permissions to some communities to utilize the land on a long-term basis (5-30 years), which does give local communities some kind of security.

The Thai government also created funds to financially support sustainable environmental management. The 1992 Energy Conservation Promotion Act sets up a fund for energy development and conservation. In the same year the Enhancement and Conservation of National Environmental Quality Act also creates an environmental fund.

Apart from this, Thailand has two energy laws that refer to sustainable energy use and management. The National Energy Policy Council Act of 1992 and the Energy Conservation Promotion Act (1992) deal with monitoring changing energy needs and energy conservation in buildings and factories. To ensure factories are being run in an environmentally friendly manner the Ministerial Regulation to the Factory Act prohibits the discharge of polluted air. Another measure taken by the government is the requirement to carry out Environmental Impact Assessments before certain activities. This is regulated by the Enhancement and Conservation of National Environmental Quality Act of 1992.

Figure 3.XX: Overview on important Thai Laws related to Climate Change and Land

Year	Name	Content
2007	Constitution of the Kingdom of Thailand	The State shall implement the land, natural resources, and environment policy as follows: 1) To set the principles of land use nationwide and to keep in mind the conformity to the natural environment be it land, water, ways of life of local communities and the effective preservation and maintenance of natural resources, and to set standards on sustainable land use which allows people in the area affected by the implementation of that land use principle to participate in the decision making process; 2) To distribute the ownership of land equitably and take action to allow farmers to have ownership over agricultural land (…)[136]
1941	Forestry Act	It restricts logging activities in Thailand and prescribes licenses or special permissions for logging.[137]
1964	National Reserved Act	People claiming and utilizing land that is determined to become a National Reserve shall send a request to the head of the sub-district officer (Nai Amphur or Palad Amphur). However, if the land is owned under the Land Code this is not necessary. Permission to utilize and live on land in the National Reserved Forest may be given for a period between 5 and 30 years. However, this permission is no acquisition of land right under the Land Code.[138]
1977	Investment Promotion Act as	According to section 16 of the Board of Investment may, among others, promote activities that are beneficial for the social

[136] Constitution of the Kingdom of Thailand, (Thailand: 2007). http://www.isaanlawyers.com/constitution%20thailand%20 2007%20-%202550.pdf

[137] Thailand, Forestry Act. (Thailand: 1941). http://www.thailawonline.com/en/thai-laws/laws-of-thailand/218-forest-act-be-2484-1941.html

[138] Thailand. National Reserved Forest Act. (Thailand: 1964). http://www.thailawonline.com/en/thai-laws/laws-of-thailand/211-national-reserved-forest-act-be-2507-1964.html

	amended 2001	development and/or utilize natural resources. The promoted activities should include measures to prevent and control negative effects on the environment (section 19) Foreigners promoted by the Board may own land in Thailand for the duration of the promoted activity. However, they must dispose of the land within one year of the dissolution of the activity (section 27)[139]
1992	Enhancement and Conservation of National Environmental Quality Act	It establishes the National Environment Board to make recommendations related to the environment to the cabinet and proposes changes to existing environmental to the cabinet and proposes changes to existing environmental laws. An environmental fund managed by the Board is being created. The law further requires the creation of an Environmental Quality Management Plan to implement the national policy regarding the environment. After publishing this plan a Changwat Action Plan should be submitted to the National Environment Board. It shall include among others procurements for land acquisition (section 38). Section 42-45 covers the protection of the environment and the establishment of conservation areas. Land use prescription are one the protective measures. An environmental Impact Assessment (EIA) may be required before certain activities or projects (section 46).[140]
1992	Energy Conservation Promotion Act	It covers energy efficiency in factories and buildings (section 7-22) as well as measures to oversee, promote and examine energy conservation. Furthermore, this act set up a fund for energy development and conservation (section 24-41).[141]
1992	Factory Act	The Factory Act divides factories into different groups. While group 1 may start business immediately, group needs to give prior notification to the Department of Industrial Works. Group 3 has to apply for license.
1992	Ministerial Regulation No. 2, 1992 to the Factory Act	Group 1, 2 and 3 factories may be situated in houses and condominiums for residential purpose. Group 1&2 factories are also not allowed to be within 50 meters from public places such as schools. Group 3 factories have to be more than 100 meters from these places (clause 1&2). Exceptions may be granted (clause 3). Clause 16 prohibits factories to discharge of polluted air. In case the level of pollution is too high it needs to be treated until it meets the characteristics prescribed by the Ministry of Industry

[139] Thailand Investment Promotion Act of 2520 as amended 2544 (Thailand 2002).
http://www.boi.go.th/english/download/boi_forms/proact_eng.pdf
[140] Thailand Enhancement and Conservation of National Environmental Quality Act. Thailand: 1992.
http://www.pcd.go.th/info_serv/en_reg_envi.html
[141] Thailand. Energy Conservation Promotion Act. (Thailand: 1992).
http://thailaws.com/law/t_laws/tlaw0072.pdf
[142] Thailand Ministerial Regulation No.2, 1992 (Thailand: 1992).
http://www.jetro.go.jp/thailand/e_activity/pdf/minreg2.pdf

		in the respective Government Gazette.[142]
1992	National Energy Policy Council Act[143]	The Office of The National Energy Policy Council shall collect data, monitor the changing energy needs and analyze trend as well as impacts.[144]

Nevertheless, despite the existing laws and regulations for protecting natural resources and the environment, there are still rampant violations of the law and encroachment into protected areas. This problem is attributed to weak law enforcement, but the root cause underlying the problem seems to be the lack of good governance and environmental recognition.

Natural Resource Management and Greenhouse Gas Mitigation

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. And 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 main approaches to address these issues in a comprehensive approach can be found in the *National Strategy on Management of Climate Change* and the four year operational plan of the Ministry of Natural Resources and Environment.[145]

To achieve the target concerning greenhouse gas mitigation and effective improvement of conventional production technologies as clean technologies, Thailand supports the reduction of GHG emissions from various sources and trough 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

[143] Report Status of Climate Change Management in Thailand. Thai Water Partnership.
[144] Thailand. National Energy Policy Council Act. (Thailand: 1992). http://www.thailawforum.com/database1/national-energy-act.html
[145] Office of Natural Resource and Environmental Policy and Planning. "National Strategy on Management of Climate Change, 2008-2012", (Ministry of Natural Resources and Environment: 2008); Ministry of Natural Resources and Environment, *4-year Operation plan, 2008-2011*

- 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 3.18millions hectares
- Rehabilitating watershed forest areas, covering 160,000 hectares
- Planting trees in commercial forest areas, covering 448,000 hectares
- Establishing 20 Clean Development Mechanisms (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
- 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_2 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[146]

For the agricultural sector, 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_2 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.

Adaption and Mitigation plans for the Bangkok Metropolitan Area

Bangkok's vulnerability, due to its location at the Chao Praya delta, is projected to increase further, generating an urgent need for proper adaptation measures. Despite the potential effects of floods and SLR, Bangkok has to deal with the additional problem that parts of the city have been "sinking" approximately 10 centimeters annually over the last few years. The combination of these two threats put the city at risk that some areas could disappear within 15 or 20 years.[147] To tackle this threat, it has been proposed to build a flood prevention wall to protect Bangkok that would be roughly 80 kilometers long and three meters higher than the average sea level. If it were to be built 300 meters offshore it would allow mangrove forests to form a natural barrier against coastal erosion. The costs of the project were calculated a few years ago to be about 100 billion baht.[148]

[146] Ministry of Natural Resources and Environment Policy and Planning, "Thailand's second National Communication under the United Nations Framework Convention on Climate change", 77
[147] Kisner, Corinne. "Climate Change in Thailand: Impacts and Adaption strategies, http://www.climate.org/topics/international-action/thailand.htm, accessed: 30.06.2012
[148] Kisner, Corinne. "Climate Change in Thailand: Impacts and Adaption strategies, http://www.climate.org/topics/international-action/thailand.htm, accessed: 30.06.2012

Despite its vulnerability, the Bangkok Metropolitan Area is also responsible for a huge share of Thailand's GHG emissions. With 7.1 tons per capita, Bangkok's emissions are significantly higher than those of other major cities like London (5.9) or Tokyo (5.7). The city's main source of emissions are from transportation (50%), followed by the electricity sector (34%).[149] To reduce these emissions, the Bangkok Metropolitan Administration adopted an action plan on Global Warming Mitigation for the period from 2007 to 2012.[150] This plan addresses five main initiatives:

- Expand the Mass Transit Rail System within Bangkok Metropolitan Area
- Promote the Use of Renewable Energy
- Improve Building Electricity Consumption Efficiency
- Improve Solid Waste Management and Wastewater Treatment Efficiency
- Expand Park Area

The target of theses initiative is to reduce total GHG emission by at least 15% of the total GHG emission anticipated in the year 2012 under business as usual projection.[151] The plan aims to enhance the cooperation of public and private organizations and was signed by 36 different stakeholders as a joint initiative.

According to the plan, 42.75 million tons of GHG were emitted in 2007. Since transport is responsible for the half of these emissions, the transportation sector has the highest potential for emission reduction. The Action plan targeted to save 5.53 million tons per year through three actions: 1) Further implementation of the Mass Transit Rail System 2) Implementation of a Bus Rapid Transit System and Improvement of the existing public bus system and 3) Improvement of the Road-Network.[152] The second biggest target is defined in

[149] Bangkok Metropolitan Administration (ed.). „Action Plan on Global Warming Mitigation 2007 – 2012 – Executive Summary" (Bangkok: 2007): 6
[150] Bangkok Metropolitan Administration (ed.). „Action Plan on Global Warming Mitigation 2007 – 2012 – Executive Summary" (Bangkok: 2007)
[151] Bangkok Metropolitan Administration (ed.). „Action Plan on Global Warming Mitigation 2007 – 2012 – Executive Summary" (Bangkok: 2007)
[152] Bangkok Metropolitan Administration (ed.). „Action Plan on Global Warming Mitigation 2007 – 2012 – Executive Summary", (Bangkok: 2007): 14

initiative 3: Improvement of Energy Efficiency. The following measures targeted to reduce emissions by at least 2.26 million tons:

- Improve Energy Efficiency in all BMA Buildings
- Promote and support the implementation of Energy Conservation Schemes in privately owned buildings
- Campaign for efficient use of electrical appliances
- Campaign for reduced use of Air-Conditioning Systems
- Support Energy Efficiency Labeling of, and proper Maintenance scheme for, electrical appliances
- Promote the Use of Energy-Saving Appliances
- Promote the Use of Energy-Saving light bulbs[153]

The promotion of renewable energies like bio diesel and gasohol (Initiative 2) targets to reduce emissions by 0.61 million tons and an increased waste and wastewater management should add a reduction of 0.46 million tons. Additionally, the promotion of public and private tree planting should increase the absorption capacity by 1 million tons.

At the moment, the period defined in the action plan is in its last year. An evaluation needs to be undertaken in 2013 to demonstrate if the targets were reached. Anyhow, the constant enlargement of the Mass Transit and the Bus Rapid transit system for example could be already seen during the last three years.

Climate Change Mitigation of the Ministry of Agriculture

For the agricultural sector, the Thai Ministry of Agriculture has also developed a mitigation plan, considering the projected effects on rural areas in Thailand as well as an assumed average SLR of 8-12 millimeters per year. The plan outlines three strategies:

[153] Bangkok Metropolitan Administration (ed.). „Action Plan on Global Warming Mitigation 2007 – 2012 – Executive Summary", (Bangkok: 2007): 22

- Strategy on knowledge management
- Strategy on prevention and solution of the climate change problems
- Strategy on campaign, information dissemination, public relation and personnel capacity development

It emphasizes on raising awareness through education, training,distribution of information. Furthermore it recognizes the necessity of participation of farmers as well as measures to monitor and evaluate the strategies and offers advice to the involved stakeholders (government units, staff and farmers). Each strategy separates the operation and management knowledge into five areas:

- Plants
- Soil
- Water
- Livestock and fishery
- The overall effect from climate change to agriculture

It further outlines a concrete time frame, budgets and locations were the plan should be piloted and implemented.[154]

3.3.4. Case studies on concrete adaptation and mitigation measures

To get an idea how measures are implemented in concrete projects, two case studies can be presented showing how local communities deal with adaptation and mitigation measures. The first example refers to community forest management in the Chiang Rai Province. This case study analyzed community forest management and production patterns of the local Karen highland

[154] แผนการบรรเทาภาวะโลกร้อนด้านการเกษตร .กรมพัฒนาที่ดิน, กระทรวงเกษตรและสหกรณ์) .ประเทศไทย :2550)

community in regards to climate change, emissions, and natural resources. Furthermore, it looked at the role communities play in mitigating global warming and climate change.

The Huay Hin Lad community is located in between the National Forest Reservation area about 30 km from Wieng Pa Pao town. One of their main sources of income is agriculture and their agricultural land covers about 3,547 *rai* while the community forest totals around 19,498 *rai*. So far climate change has not directly affected the community so much as the increased measures taken by the Thai government to tackle climate change, such as the expansion of the national forest reservation areas, which almost forced them to leave their lands.

Even though local highland communities are often accused of engaging in practices harming the environment, such as deforestation, this case study shows that this is not the case in Huay Hin Lad. The villagers use shifting cultivation to produce their crops. In April they usually burn selected fields. To prevent the fire from spreading fires are thoroughly planned and only last between 1-2 hours. Annually, around 2,042 tons of CO2 are released from agricultural activities in Huay Hin Lad. About 1,745 tons of these are due to burning shifting cultivation rice fields. However, since the communities use shifting cultivation they let the forest re-grow for 6-10 years before they use a field again. During these ten years a total of 17,643 tons of carbon are stored, which is significantly more than the 2,042 tons released by burning the fields. Due to their shifting cultivation the Huay Hin Lad community uses their land in a sustainable way.

The recommendations of this case study regarding land and climate change are:

- establish mechanisms that allow the highland people to participate in the decision making process for policies that are related to their land and resources as well as mitigation and adaptation measures
- in the long-run, review laws related to forest management in order to incorporate community rights of the highland people
- help communities to identify proper and sustainable cultivation practices and promote the indigenous knowledge of sustainable agriculture
- improve the relationship between highland people and government officials to be able to effectively work together and fight climate change

- legally recognize the right of the highland people to live and utilize the land[155]

The second case study refers to flood prevention in the Chai Buri village, it is located close to two rivers, the Mekong River and the Songkram River. Over 80% of the population engages in agricultural activities and a large amount of land in this area is used for farming. The climate in Chai Buri is distinguished by the dry season from November until May and the rainy season from May until October. Usually the most rainfall is in September. Since it is surrounded by annually inundated floodplains, the village is affected by floods every year. Below are the main socio-economic impacts of the floods and the community's adaptation strategies. Severe floods partially or completely destroy the crops:

- Villagers turn to fishing as a source of income, because during floods the amount of fish increases which can compensate for the loss of their crops.
- Families with paddy fields on higher ground are not affected.
- Some families plant rice only once a year because they fear to lose the second harvest due to floods.

Shortage of food and drinking water:

- Villagers may have to buy rice and drinking water, which increases their costs.
- Many families grow vegetables for their own consumption

Transportation difficulties:

- Many villagers use boats during the flood, which is more expensive.

Apart from the flood impacts above, villagers face further difficulties including damages to housing and equipment, increased illnesses and diseases (especially flu and gastro-intestinal diseases), and an increase in prices for transportation, labor, and food.

The villagers in Chai Buri have developed some strategies to cope with the floods:

- Their houses are built higher and the ground flood is usually used as the common area while the sleeping area is on the second floor. During floods, valuables can easily be moved to the second floor.

[155] Climate Change, Trees and Livelihood: A Case Study on the Carbon Footprint of a Karen Community in Northern Thailand. Northern Development Foundation, Oxfam-GB. (Thailand: 2010).

- The villagers analyze animal behavior (e.g. ants moving their eggs to higher places) to predict floods and prepare for them.
- They have different kind of fishing equipment that can be used for different water conditions.
- They adapt the rice farming activities by planting rice during the dry season rather than the rainy season as they did before. They also plant different rice varieties (khao daw) that can be harvested earlier.
- They turn to alternative sources of income such as fishing, making rice liquor or finding work in Bangkok to provide for their families.

The people stated that apart from these adaptation strategies, they also benefit from their network of friends and family to gain access to information and get assistance during floods. They also received government assistance. It was, however, noted that there was no correlation between government assistance and the adaptive capacity of the people.

The case study came to the conclusion that the people in Chai Buri are highly exposed and sensitive to floods. However, they have developed adaptation strategies to cope with them. There is a concern that these strategies might prove insufficient in the long run because they are mainly sort term solutions. Apart from this government assistance often comes delayed and it was suggested that the government should even more engage with local communities to ensure that their measures meet the local needs. Local participation was identified as a key to successful adaptation to floods.[156]

[156] Pachaly, J., Permpibul, W. Need for local Participation to Adapt to Climate Change: Case Study Thailand. Heinrich Böll Stiftung. (Thailand: n. d.).

3.4. Summary

It became evident, that Southeast Asia is highly vulnerable to climate change impacts, relative to other regions. This is particularly true for the impacts of natural disasters like floods, tropical storms, and regionally droughts. Coastal areas with a high population density, including the Chao Praya and the Mekong Delta as well as parts of Java, also represent high vulnerability from sea level rise. Due to limited economic capacity, states like Laos, Cambodia, and Indonesia also have a very low adaptation capacity.

Furthermore, effective environmental regulations are not in place in the majority of the ASEAN countries or the enforcement capability is not sufficient. Therefore, counterproductive trends are still visible, especially through deforestation (e.g. in Indonesia). Another example is the destruction of mangroves. Experiences during the 2004 Tsunami disaster have proven the ecological and environmental importance of mangroves. Public awareness of the role of mangrove forests in coastal protection has therefore increased greatly. Nevertheless, the pressure on land and mangrove forests remains. Poaching (i.e. . the illegally collecting of wild plants or animals) in natural forest areas 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 therefore remains a huge task for the legislative bodies and authorities. Nevertheless, positive examples can be identified, such as Thailand's efforts to stop deforestation which stabilized the forested areas in the country.

One shortcoming that was identified looking on the legal frameworks is, that often, the needs and stakes of local communities were not included in the most countries. In contrast, the discussed case studies have shown that often, local initiatives proved to be more effective than government actions. Therefore, the inclusion and participation of local communities remains a task for legislation. The case studies have further shown that the legal framework has to be strengthened. This especially refers to land titles, since land ownership is unclear or completely undefined in many areas. This is constraining projects, such as if it comes to the ownership of carbon rights and provides economic and social insecurity.

Generally, it has to be stated, that there is a lack of available data regarding climate change impacts, the intensity and possible impacts of natural disasters, and also the distribution of the population and economic assets. This hinders effective planning of counter measures. A detailed analysis of the

situation in the greater Bangkok for example area, followed by the implementation of flood mitigation measures as well as strong communication and coordination could reduce the impact of further floods in Bangkok. Regarding this, the Manila case study could provide some valuable lessons learned for Thailand. Informal community warning systems, improved water diversion channels, a functioning drainage system and dikes have protected local communities as well as businesses from more severe flood impacts.

Thailand, as a developing country, nevertheless has fully and actively participated in addressing climate change to fulfill its obligations. Economic difficulties and political instability during the last 20 years 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 clean 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 section 3.3., 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 will most likely be needed.

Chapter 4

The European Union and Germany

Vulnerability

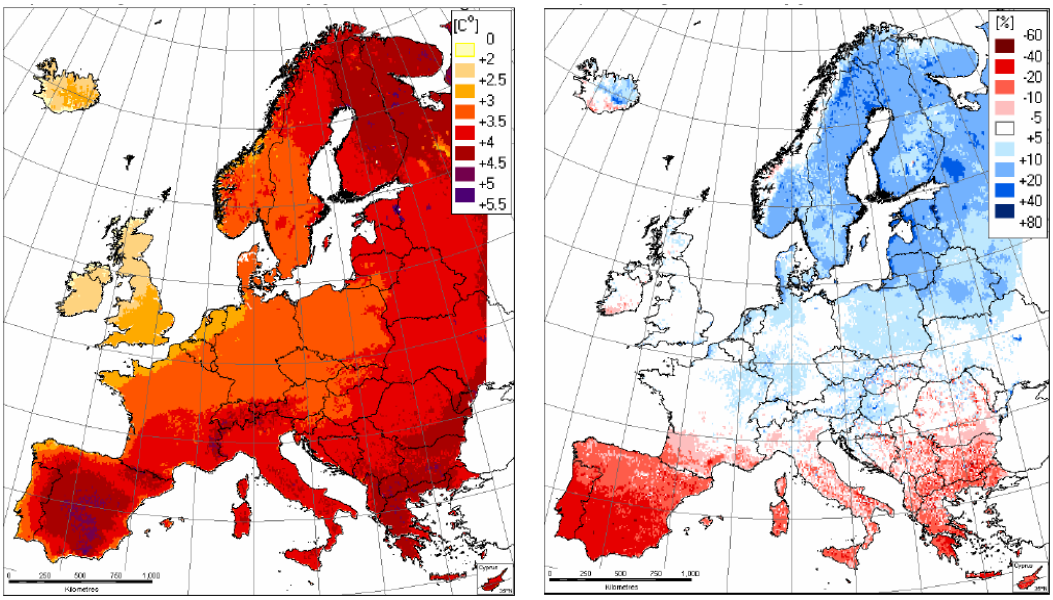
Institutional frameworks

Policies

4.1. Impacts of Climate Change in Europe

Although relatively small, the European continent contains a wide range of different regional climates, including subarctic to subtropical regions and oceanic as well as continental climate. Therefore, the projected climate change related impacts and implications vary, generating very different challenges for certain regions or states.

Figure 4.I: Projected changes in temperature and precipitation in Europe



The figure is based on IPCC SRES scenario A2. The projected climate impacts are estimated for 2071-2100 relative to 1961-1990.

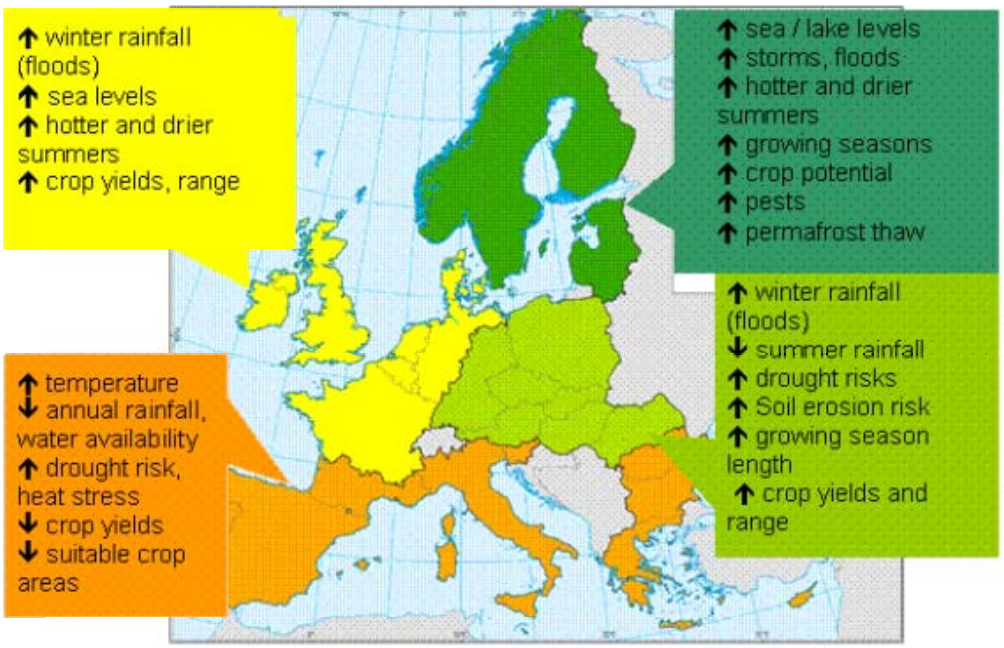
Source: Commission of the European Communities (ed.), "Greenpaper form the commission to the council, the European parliament, the European economic and social committee and the committee of the regions – Adaptation to climate change in Europe – options for EU action", (Brussels: 2007), 7-8.

According to Figure 1, the highest temperature increases can be expected on the Iberian Peninsula, the south Balkan area, Finland, as well as the far north of Scandinavia and the Alps. While rainfall is projected to increase in northern Europe, significant decreases are expected for the Mediterranean. As a result, according to IPCC, southern Europe is will be more severely affected since the microclimate is already hot and semi-arid.[157] But also northern European countries will be affected

[157] IPCC (ed.), "Climate Change 2007: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change" (Cambridge University Press, Cambridge:2007), 547

by the impacts of sea level rise and flood risks. Geographically simplifying, the projected impacts for the European Union can be summarized as followed:

Figure 4.II: Projected impacts of climate change on European regions



Source: European Commission, "Agriculture and Climate Change", *http://ec.europa.eu/agriculture/climate-change/index_en.htm*, accessed: 07.02.2012

Additionally, the European Commission Green Paper on climate change adaptation identifies the following regions in Europe as the most vulnerable:

- Southern Europe and the entire Mediterranean Basin, due to the combined effect of high temperature increases and reduced precipitation in areas already coping with water scarcity
- Mountain areas, in particular the Alps, where temperatures increase rapidly leading to widespread melting of snow and ice changing river flows
- Coastal zones, due to sea level rise combined with increased risks for storms
- Densely populated floodplains, due to increased risks for storms, intense rainfall, and flash floods leading to widespread damages to built-up areas and infrastructure
- Scandinavia, where much more precipitation is expected and a larger part in the form of rain instead of snow

- The Arctic region, where temperature changes will be higher than in any other place on Earth[158]

Analyzing the socioeconomic consequences of these effects, the PESETA (*Projection of Economic impacts of climate change in Sectors of the European Union based on bottom-up Analysis*) Project conducted by European Commission Joint Research Center analyzed specific implications based on four climate and weather projections.[159] As far as land usage is concerned, among others, the following aspects were examined: agriculture, river basin floods, coastal systems and tourism.[160]

Figure 4.III: Expected changes in crop yields by region and scenario

	B2 HadAM3h 2.5°C	A2 HadAM3h 3.9°C	B2 ECHAM4 4.1°C	A2 ECHAM4 5.4°C
Northern Europe	37	39	36	52
British Isles	-9	-11	15	19
Central Europe North	-1	-3	2	-8
Central Europe South	5	5	3	-3
Southern Europe	0	-12	-4	-27
EU	3	-2	3	-10

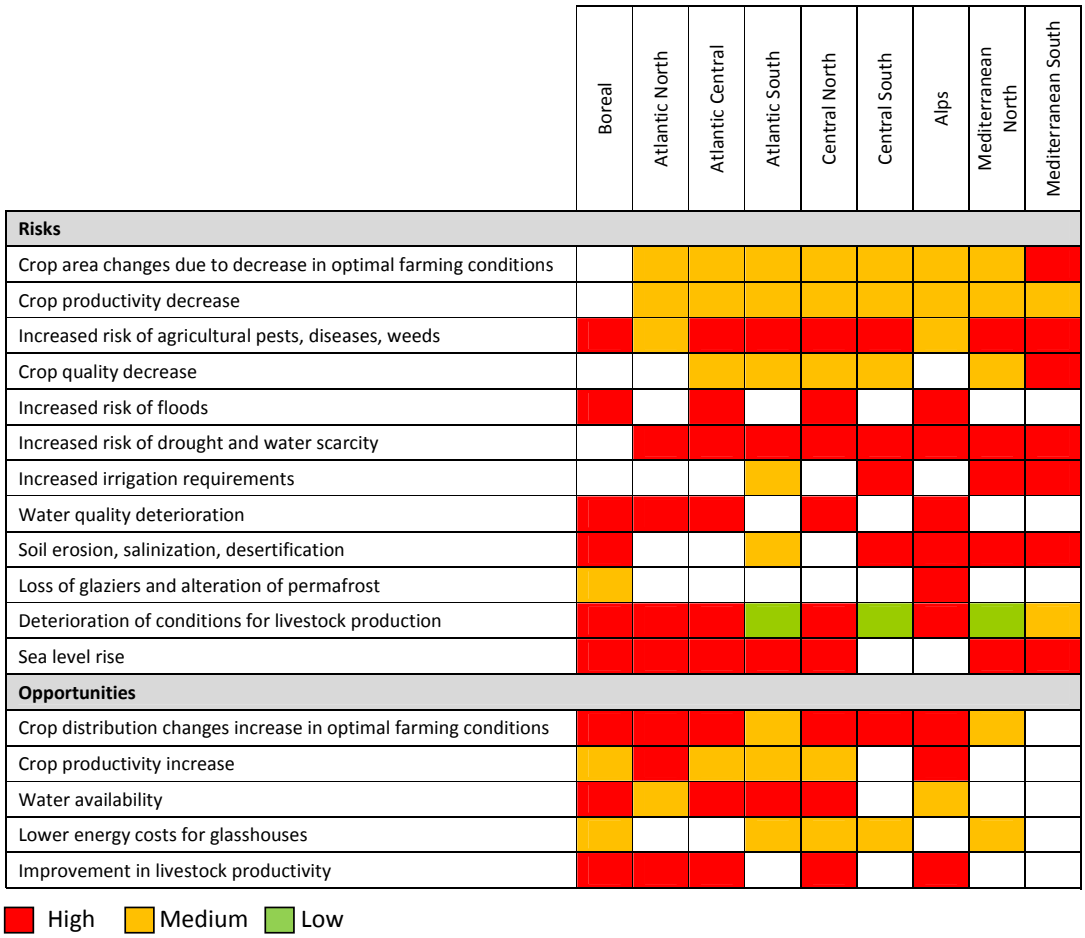
The acronyms in the table are the SERS climate scenarios used by the IPCC (see chapter 2 of this study)

Source: Ciscar (ed.), "Climate Change impacts in Europe – Final Report of the PESTA research project", (European Commission Joint Research Centre - Institute for Prospective Technological Studies, Luxemburg: 2009), 39

Regarding the agricultural sector, it is expected that crop yields and suitable crop areas tend to decrease in southern regions while increasing in northern Europe. Depending on the model, in several Mediterranean regions, France and parts of Central and Eastern Europe, crop yields could be up to 30% lower in 2080.[161] On the other side, yields are likely to increase in most parts of Scandinavia, the Baltics, the northern Balkan regions and parts of southern France. For some regions, the projections on the general trend differ depending on the scenario, e.g. for the British islands.[162] A generalized assessment on the risks and opportunities for the agricultural sector, done in a study for the European Commission came to the following conclusions:

[158] Commission of the European Communities (ed.), "Greenpaper form the commission to the council, the European parliament, the European economic and social committee and the committee of the regions – Adaptation to climate change in Europe – options for EU action", (Brussels: 2007), 5
[159] On the methodology and the chosen scenarios see: Ciscar (ed.), "Climate Change impacts in Europe", 27-36
[160] Ciscar (ed.), "Climate Change impacts in Europe – Final Report of the PESTA research project", (European Commission Joint Research Centre - Institute for Prospective Technological Studies, Luxemburg: 2009), 7
[161] Compared to the 1961-1991 period.
[162] Ciscar (ed.), *Climate Change impacts in Europe*, 39-42

Figure 4.IV: Summary of risks and opportunities for the agriculture by agro-climatic zone



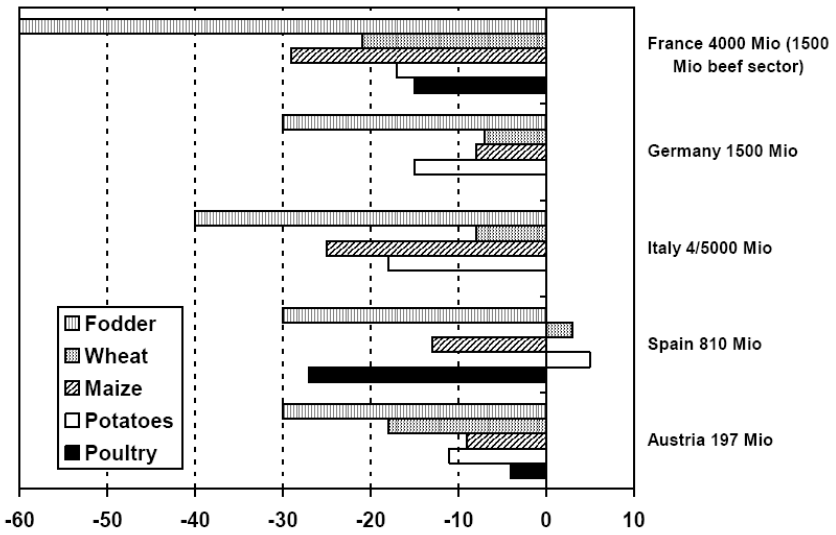
Source: AEA Energy & Environment, "Adaptation to Climate Change in the Agricultural Sector", (Report to European Commission Directorate - General for Agriculture and Rural Development, Didcot: 2007), v

An example of the effects of higher temperatures on agricultural production could be seen already in 2003 when a heat wave caused temperatures in July and August to rise between 3-5 degrees above average and reduced rainfall. The hardest hit sectors were the green fodder supply, the arable sector, the livestock sector, and forestry. Potato and wine production were also seriously affected.[163] Overall, the reduction of cereal production was estimated to be around 23 megatons in the whole EU compared to 2002, forcing several countries to import fodder and cereals for example from the

[163] Olesen and Bindi, "Agricultural impacts and adaptations to climate change in Europe", (Danish Institute of Agricultural Sciences: no year), 7

Ukraine.[164] The following table shows the relative changes in production of certain crops as well as the estimated financial costs.

Figure 4.V: Impact of the summer 2003 heat wave on agriculture



Production change in percent and financial costs (mio. €) for 2003 relative to 2002

Source: Olesen and Bindi, "Agricultural impacts and adaptations to climate change in Europe", (Danish Institute of Agricultural Sciences: no year), 8

Comparing the average temperature of July and August to the data collected between 1864 and 2002, the heat spell of 2003 was absolutely exceptional. But based on the IPCC projections for the period between 2071 and 2100 the average summer heat of 2003 would be in medium range.[165]

The increased risk and intensity of river flooding is especially an issue for central Europe. All scenarios project higher economic damages and a higher number of affected people. In northern Europe, flood risks are likely to decrease, although the second scenario projects increased flood risks in the southern Baltic. Projections differ for the British Isles again, depending on the weather model.[166]

To estimate the potential flood damage, the PESTA study considers only direct damages caused by water depths on land use typologies. But other indirect damages or costs might also occur.[167] Despite the regional distribution, the table illustrates that - compared to the annual average in the past – the

[164] Olesen and Bindi, *Agricultural impacts and adaptations to climate change in Europe,* 7
[165] IPCC (ed.), "Europe. Climate Change 2007: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change", 562
[166] For detailed regional projections (including maps) in all scenarios see: Ciscar (ed.), "Climate Change impacts in Europe", 48-50
[167] Ciscar (ed.), "Climate Change impacts in Europe", 46

number of affected people and the economic damages will increase significantly. The 5.4 scenario would roughly triple the affected people and the economic costs.

Figure 4.VI: Economic impacts of sea level rise

	B2 HadAM3h[1] 2.5ºC		A2 HadAM3h[1] 3.9ºC		B2 ECHAM4[1] 4.1ºC		A2 ECHAM4[1] 5.4ºC		Simulated 1961-1990[4]	
	APA[2]	AED[3]	APA	AED	APA	AED	APA	AED		
Northern Europe	-2	-325	9	20	-4	-100	-3	-95	7	578
British Isles	12	755	48	2,854	43	2,778	79	4,966	13	806
Central Europe North	103	1,497	110	2,201	119	3,006	198	5,327	73	1,555
Central Europe South	117	3,495	101	4,272	84	2,876	125	4,928	65	2,238
Southern Europe	46	2.306	49	2,122	9	291	-4	-95	36	1,224
EU total	**276**	**7,728**	**318**	**11,468**	**251**	**8,852**	**396**	**15,032**	**194**	**6,402**

[1] *Climate Change scenarios from the IPCC* [2]*Additional expected population affected (in 1000s)* [3]*Additional expected economic damage (million Euro/year)* [4]*Estimated average of affected population and economic damage per year*

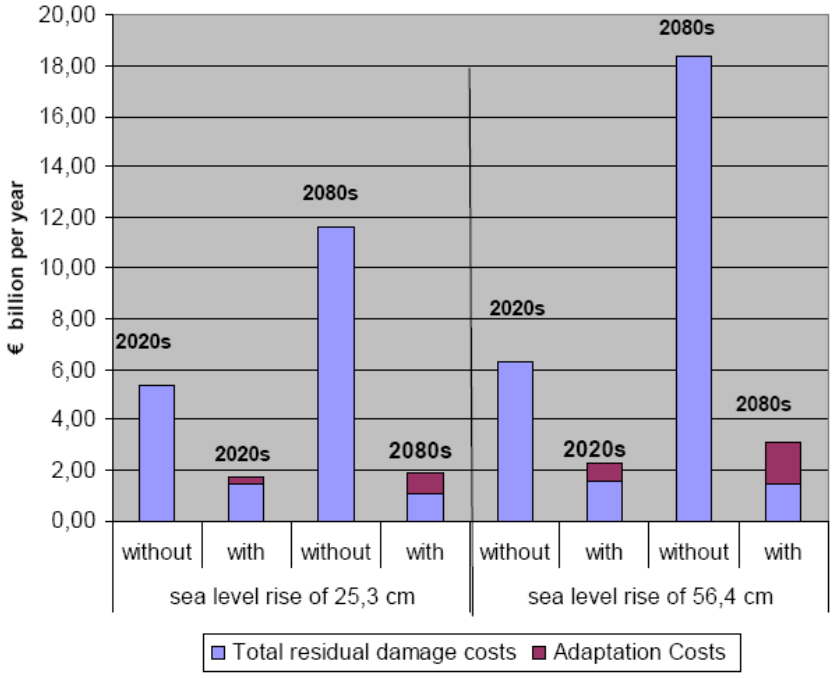
Adapted from: Ciscar (ed.), "Climate Change impacts in Europe", 47-48

Sea level rise threatens huge areas in Europe that are only slightly above or even below today's sea level. The Netherlands are an example of a country especially sensitive since 55% of its national territory lies below sea level with 60% of its population living in this area and 65% of its GDP produced there.[168] Already, between 1998 and 2015 the estimated costs of coastal protection in Europe add up to 15.8 billion Euro.[169] Roughly one-third of these costs were invested in certain hotspots particularly threatened by flooding and erosion. These hotspots contain Venice (population 4.2 billion alone), Hamburg, London, Zwin and Ostende in Belgium, the Danube Delta in Romania and the Slovenian Saltpan.[170] Without adaptation measures, the A2 scenario used in the PESTA study projects a land loss of 0.657% in the EU totally, including nearly 1% in north central Europe and even 1.5% on the British Isles until 2085.[171] In contrast, proper adaptation could limit the loss to 0.026% in total and even to 0.006% on the British Isles.[172]

[168] IPCC (ed.), "Europe. Climate Change 2007: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change" 547
[169] Policy Research Corporation, "The economics of climate change adaptation in EU coastal areas", study done on behalf of the European Commission - Directorate-General for Maritime Affairs and Fisheries (Brussels and Rotterdam: no year), 58
[170] Policy Research Corporation, "The economics of climate change adaptation in EU coastal areas", 65
[171] Ciscar (ed.), "Climate Change impacts in Europe", 57
[172] Ciscar (ed.), "Climate Change impacts in Europe", 57

While in the reference year, an estimate of 36,000 people were affected by floods, the scenarios used in the PESTA study differ between 775,000 in the best case and 5.552 million in the worst case, if no adaptation measures are taken. The British Isles, the central, northern, and southern European regions would be the potentially most affected.[173] The projections of economic costs in the case of no adaptation differ widely, since they have to include the sea flood costs, costs of salt intrusion, as well as potential migration costs. The worst case scenario based on the highest Sea Level Rise (SLR) projection of 88 cm could cause costs of around 44 billion, including 25 billion Euros of migration costs.[174] Although these number are highly uncertain, all projections have in common that they assume an enormous financial benefit if adaptation measures are taken, since adaptation costs and remaining damage costs are projected to be far below the costs of inaction, as the following figure demonstrates:

Figure 4.VII: Costs of sea level rise with and without adaptation measures

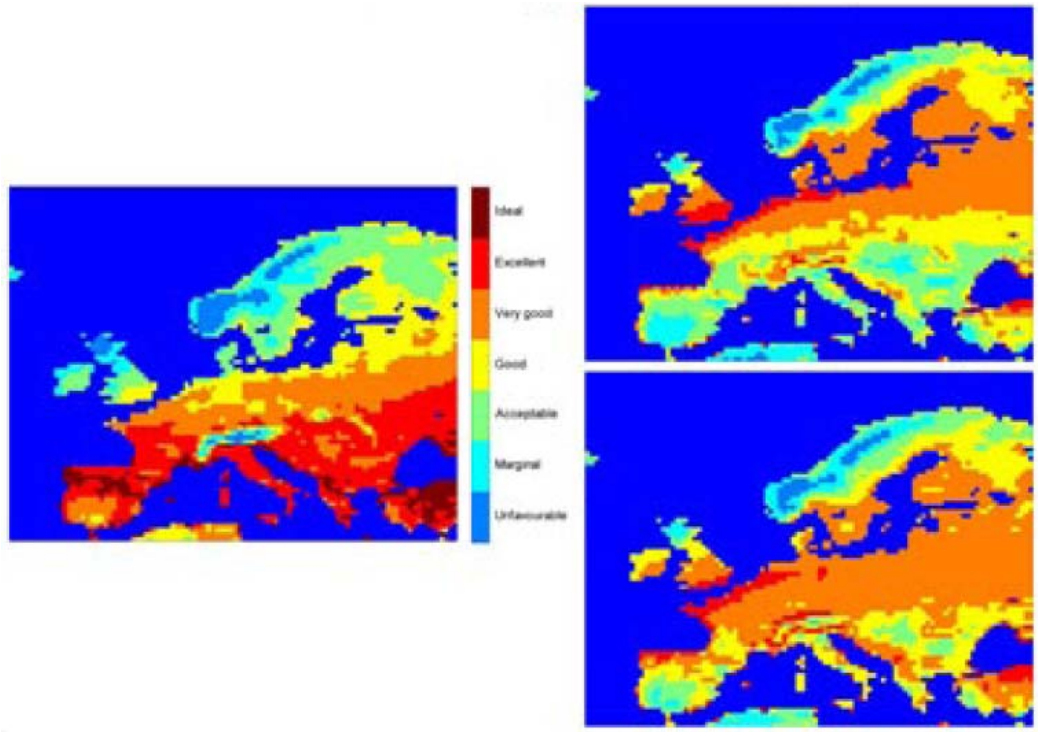


Source: CEC, "Greenpaper – Adaptation to climate change in Europe", 10 – Figure is also based on the findings of the PESTA study. For more projections based on different scenarios and detailed cost distribution see therefore also: Ciscar (ed.), "Climate Change impacts in Europe", *51-58*

[173] Ciscar (ed.), "Climate Change impacts in Europe", 53
[174] Ciscar (ed.), "Climate Change impacts in Europe", 56

The reason why tourism is considered here in the context of land use is, because in some parts of Europe land usage for tourist infrastructure or attractions plays a major role for the local economy. Climate change impacts potentially affect this usage significantly. Through temperature rise, the Alps will see decreasing snow fall and a shorter winter seasons. The areas where snow can be "guaranteed" during the winter are likely to decline and will be located higher. Through this, winter sport possibilities will be constrained. Simultaneously, regions in the Mediterranean area that are major tourist destinations today are likely to become too hot and dry in the future during the summer session, making destinations in northern Europe become more attractive.[175] A projection on this was made with the Tourism Climate Index (TCI), based on the notion of 'human comfort' and consists of a weighted index of maximum and mean daily temperature, humidity, precipitation, sunshine and wind.

Figure 4.VIII: TCI scores in summer in the 1970s and the 2080s



TCI scores in summer in the 1970s (left) and the 2080s (right), according to the RCAO model, 5.4°C scenario (top) and 4.1°C scenario (bottom) – Source: Ciscar (ed.), "Climate Change impacts in Europe", 64

[175] CEC, "Greenpaper – Adaptation to climate change in Europe", 11

According to the scenario, the attractiveness of important summer tourism regions in Spain, Italy, and southeastern Europe that was considered as being ideal or excellent in 1970 is likely to decrease. On the other hand, the British Isles, as well as the coasts of the north and the Baltic Sea might become far more attractive for summer tourism.

Of course the TCI model is limited since tourism is not only related to climate factors, but are a matter of personal preferences. Therefore, the authors of the study emphasize that the results must be regarded carefully.[176] Nevertheless, the model gives a hint of how conditions for tourism are likely to change and generate the need for adaptation as well as opportunities.

[176] Ciscar (ed.), "Climate Change impacts in Europe", 59

4.2. The European Union

When the European Communities were founded in 1957, environmental policies were not addressed by the policies and institutions of the communities. Besides the fact that environmental issues were not considered important, the main goal of the Roman treaties was economic integration. Therefore, environmental issues were only touched indirectly so long as they were considered as "non-tariff barriers to trade". In this sense, environmental policies were seen as flanking measures to support the establishment of a common market, for example, by aligning environmental standards for production or fuel admixing.

The beginning of an independent environmental policy of the European Communities is marked by the Paris Summit of 1972 that adopted a declaration on environmental policy and consumer protection assigning the European Commission (EC) to formulate an environmental protection action plan. One year later, the first Environment Action Program was adopted defining the framework for the development of a common EC environmental policy. Finally, the Single European Act (SEA) of 1987 incorporated environmental policy as an official objective of the Community into the Treaty on the European Economic Commission (EEC). Through the following treaty changes, the importance of environmental policy was continually elevated. The treaty of Maastricht (1992) firstly introduced the term of sustainable development which was defined as a priority goal of the Union in the treaty of Amsterdam (1997) and it was defined that environmental protections requirements also have to be integrated into the other policies of the Union.

4.2.1. Institutional framework of the European Union

The Treaty of Lisbon that entered into force on December 1st 2009 marked the latest changes to the Treaty on the European Union. As a leftover from the failed process to establish a European Constitution, it introduced important changes to the European institutional framework and the decision making processes, particularly strengthening the role of the European parliament. Based on today's consolidated versions of the treaty of the European Union and the treaty on the functioning of the European Union, the fundamentals of the environment and land use related policies are outlined as follows:

- Article 3 of the Treaty on the Functioning of the European Union defines sustainable development as a goal of the Union.

- Article 4 of the Treaty on the Functioning of the European Union names (among others) agriculture, environment, energy, and fishery as policies that are under shared competence between the EU and its member states.

- Article 11 of the Treaty on the Functioning of the European Union adopts the former Article 6 of the Treaty on the Functioning of the European Community demanding that environmental protection and sustainable development have to integrated into the design and implementation of all other EU policies also.

- Article 37 of the Charter of Charter of Fundamental Rights of the European Union, that was adopted together with the Treaty of Lisbon, obligates the European Union to ensure a high level of environmental protection.

- Defining the objectives of EU's environmental policy, Article 191 of the Treaty on the Functioning of the European Union particularly name "combating climate change".[177]

These provisions show that environmental policy, linked to sustainable development and action against climate change, has become a prioritized field of action for the European Union. The obligation to include environmental concerns into the implementation of other policies makes it a crosscutting issue, also touching fields like agricultural, industrial, and energy policy that are crucial for climate change mitigation. When it comes to the formulation and implementation of concrete policies, the EU has developed an institutional framework as well as complex decision making procedures that differ depending on the political subject. Weak at the beginning, power and responsibility of the EU institutions have grown enormously since the treaties of Rome.

Although it is not involved in the day-to-day routine of European legislation, the European Council has to be named as important strategic institution for the development of European integration. Consisting of the heads of state/heads of government of the 27 member states and – according to the treaty of Lisbon – now a permanent president, it represents the member states, which have to ratify the European treaties. Therefore, the introduction as well as the strengthening of environmental and climate change issues as part of the Union policies have depended on and also will continue to be shaped by strategic decisions taken by the Council. Nevertheless, the central actors for actual planning and decision making are the European Commission, the Council of the European Union, and the European Parliament.

[177] Treaty on the functioning of the European Union (TFEU), Article 191, clause 1

At the working level, below the European Council, the Council of the European Union (commonly referred to as the Council of Ministers) meets regularly and is responsible for intra-EU-proceedings and EU-legislation. It is divided into different policy areas and therefore consists of the respective heads of the national departments (ministers). Ten different configurations exist at the moment. The most relevant for environmental issues is the Council on Environment formed by the National Ministers for Environment. But since environmental protection issues are defined as a crosscutting issue as shown above, the other council configurations are affected to, especially in the areas of energy supply and – when it comes to land use issues – agriculture and fishery.

The European Parliament is the successor of the EEC parliamentary assembly and has been directly elected by the EU population since 1979. As integration becomes deeper and deeper, the power of the EU parliament and its influence on the legislative process has been growing constantly. Since the treaty of Lisbon, it has finally received full participation rights in budgetary affairs. It also has the right to reject the nominated president of the European commission as well as the nominated commissioners.

The European Commission can be considered as the "government" of the European Union. It is responsible for proposing legislation, implementing decisions, the general day-to-day running of the Union, and upholding treaties. Due to this function, the Commission is sometimes called the "guardian of the treaties". For the EU's environmental legislation the commission is important because it is – according to the ordinary legislation procedure (see below) – the only institution that has the right to make formal proposals for legislation. Among the 27 commissioners (including the president of the commission - one per EU member state), the fields of environment, agriculture, and rural development, energy, and – since February 2010 – also climate change is represented in the commission. Each commissioner is linked to a directorate general that is the responsible branch of administration for his or her respective field.

Depending on the policy area, the decision making procedures still vary. Since the treaty of Lisbon, the vast majority of EU laws are subject to the "ordinary legislative procedure". To pass a proposal, it needs the vote of 55% of the member states, representing at least 65% of the European population. In the case of ordinary legislative procedures, the respective piece of legislation must also be accepted with a majority vote by the European Parliament. Nevertheless, in sensitive fields, like the Common Security and Defense policy or taxation, decisions can only be taken unanimously. This means, that in general, the EU's legislation that is directly or indirectly linked to environmental protection and climate change apply to the ordinary legislation procedure. But in detail, the Treaty on the Functioning of the European Union defines further exceptions. In addition to measures that

are primarily of financial measures, Article 192, clause 2 also demands special legislation in terms of unanimous vote by the Council for measures that affect town and country planning, management of water resources and land use (excluding waste management). This indicates that the Unions influence on concrete land use policies is more constrained than in other fields.

Unanimous vote is also required if measures are significantly affecting a member state's choice between different energy sources and the general structure of its energy supply.[178] The sensitivity of the matter of energy supplies is also underlined by the following section on the EU's energy policy that clearly states, that energy related EU policies "shall not affect a Member State's right to determine the conditions for exploiting its energy resources, its choice between different energy sources and the general structure of its energy supply."[179] The fact that this provision is mentioned in both sections – environment and energy – demonstrates that this is a very sensitive point for the member states. The reason for that is that positions on national energy supply and also its role in combating climate change widely differ among the Union. States that have access to many natural resources (especially oil and gas), such as Great Britain, the Netherlands, and Denmark, want to avoid that a common European policy which could constrain their sovereignty to use these resources. On the other hand other states, especially Germany and Austria, are very reluctant towards promoting nuclear power as an energy source; while in contrast to that, the European commission and the European parliament share a much more positive view on atomic energy, also in the context of climate change mitigation.[180] Therefore, for the time being, the strategic energy policy is still disputed among the member states.

Finally, in the framework of the European institutions, the European Court of Justice also has to be taken into account. It is responsible for interpreting EU law and ensuring its equal application across the member states. Therefore the court plays a crucial role in implementing European legislation. The importance of this is that it strengthens the credibility of European legislation and the capacity to enforce it. Supporting this assertion, research has shown that court's rulings have stimulated integration, often pushing far beyond the interests of the member states.[181] In contrast to many supranational institutions in regional organizations or on the UN level where often the lack of enforcement capacity is one of the major constrains, this strengthens the bindingness of European legislation.

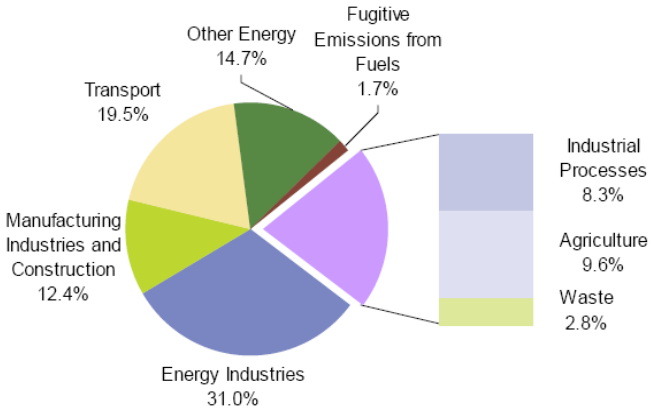
[178] TFEU, Article 192, clause 2(c)
[179] TFEU, Article 194, clause 2
[180] Fischer, Severin „Energie- und Klimapolitik im Vertrag von Lissabon: Legitimationserweiterung für wachsende Herausforderungen" (Integration 1/2009, p.50-62), 60
[181] For an assessment see for example: Alec Stone Sweet, "The European Court of Justice and the Judicialization of EU Governance", *Living Reviews in EU Governance*, (2010), http://works.bepress.com/alec_stone_sweet/37.

The effect is that the influence of European legislation became quite important for the policies of its member states. The Bavarian Ministry for Environment and Health estimates, for example, that up to 80% of Germany's environmental laws are directly or indirectly influenced by EU regulations.[182]

4.2.2. European Union climate change policy

The European Union defines itself as leader in global action against climate change and is commits itself to the goal to limit global warming up to 2% and to achieve a functional worldwide agreement. Under the Kyoto Protocol, the EU-15 has agreed on a collective target of 8% of GHG reduction compared to 1990 until 2012. According to EUROSTAT, in 2008, 6.9% were already achieved.[183] For the future, the larger EU-27 aims to reduce emissions by at least 20% (of 1990 levels) until 2020 as part of the Europe 2020 strategy. This includes the aims of a 20% reduction in energy consumption due to increased energy efficiency, an increase of renewable energy's share to 20% and 10% share of renewable fuels in transport.[184]

Figure 4.IX: Sources of EUs GHGs emissions



Source: Bolla, Viktoria and Pendolovska, Velina, "Driving forces behind EU-27 greenhouse gas emissions over the decade 1999-2008", (EUROSTAT – Statistics in focus 11/2010), 1

[182] Bayrisches Staatsministerium fuer Umwelt und Gesundheit (Bavarian Ministry for Environment and Health)„Zusammenarbeit beim Umweltschutz" http://www.stmug.bayern.de/eu/zusammenarbeit/umwelt.htm (accessed 25.02.2012)
[183] Bolla, Viktoria and Pendolovska, Velina, "Driving forces behind EU-27 greenhouse gas emissions over the decade 1999-2008", (EUROSTAT – Statistics in focus 11/2010), 2
[184] European Commission, "EU action against climate change – Leading global action to 2020 and beyond", (Office for Official Publications of the European Communities, Luxemburg: 2008), 9

Since 1999, emissions have decreased in the sectors of energy use, waste, manufacturing and construction, and agriculture, while emissions from the energy industries, industrial processes, and transport have grown.[185] As it can be seen in Figure 4, the share of land use related emissions, mainly from agriculture and deforestation, is – compared to other regions of the world – relatively low in the European Union. Deforestation is not an issue in the EU's GHG emissions. In fact, forest cover in the EU increased by 7% since 1990. Agriculture is responsible for 9.6% of the EU's emissions, while the energy and the transport sectors are the most relevant for the EU's emissions.

In order to achieve the Kyoto targets, in the year 2000 the European Union launched the European Climate Change Programme (ECCP). In the first phase, from 2000-2004, eleven working groups examined policy sectors and instruments with potentials to reduce GHG emissions, examining potentials for the energy, transport, industry, agricultural sectors, as well as for emission trading and the implantation of the CDM.[186] In Phase II (from 2005 onwards), the program has further focused on aviation, the development of national adaptation strategies, emissions of cars, the possibilities of CO_2 storage, and GHG sinks on forestall and agricultural soil. Based on the programme and its findings, several directives and initiatives have been launched in order to reduce energy consumption and increase energy efficiency.

Despite the sensitivity of the issue of energy supply sources, the EU was already been quite active in the field of energy policy. In the last few years, several directives were passed to reduce energy consumption, GHG emissions or increase energy efficiency. One directive that became exemplary of the EU's efforts was the prohibition of the classic light bulb due to its low energy efficiency, based on the European Ecodesign Directive (Directive 2009/125/EC). Another example, The Directive on the Promotion of the Use of Biofuels and Other Renewable Fuels for Transport (2003/30/EG) was already passed in 2003 aiming to promote the use of biofuels and to replace up to 5.75% of traditional fuels until 2010. This directive was replaced in 2009 by the Renewables Directive (2009/28/EC), aiming to raise the share of renewable energies in the sectors of energy production, heat and cold isolation, and transport. In detail this means, that the EU member states have agreed on individual targets to increase their share of energy from renewable targets. Furthermore, from 2014 onwards, energy efficiency targets on heat and cold isolations has to be met when buildings are redeveloped. In the transport sector, the share of biofuels used is aimed to be raised up to 10%.

[185] Bolla and Pendolovska, "Driving forces behind EU-27 greenhouse gas emissions over the decade 1999-2008", 1

[186] European Commission, „First European Climate Change Programme" http://ec.europa.eu/clima/policies/eccp/first/index_en.htm (accessed: 20.02.2012)

Especially the last two points were widely discussed in the public. Property owners fear the high costs of mandatory additional energy efficient isolation measures and the public acceptance of fuels that contain 10% of bio fuels (in Germany introduced as "E10" in 2011) was severely challenged when it became known that it might damage the engines of several car models. Beyond that, the promotion of bio-fuels in the EU is also generally questioned regarding its effectiveness to lower GHG emissions. This is directly linked to land use, respectively, such as the necessary land use changes to produce biofuels. A study examining the land use implications of the EU bioenergy policy[187] came to the conclusion that the emissions might be as large as or larger than projected GHG emissions savings from using biofuels as a substitute for fossil fuels.[188] The reason for that is directly linked to the land use issue, since the demand for biofuels lead to direct and indirect land use changes in the form of crop changes and expended cultivation. A study, especially examining the effects from indirect land use changes due to increased biofuel consumption (assumed on the basis of the targets of the Renewables Directive and the national action plans), came to the conclusion that between 4.7 and 7.9 million ha of land could be affected in the EU-27. Based on this scenario, the annualized emissions from Indirect Land Use Changes (ILUC) are estimated to be equivalent to between 50 and 83 million tons of CO_2. At the upper end this would be as much as the total GHG emissions generated by either Bulgaria or Hungary in 2007 or just over 8% of total EU transport emissions in 2007.[189] This emphasizes that the promotion of bioenergy has to be examined carefully. Although neither deforestation nor the replacement of food production is a matter of concern within the Union, these numbers indicate that extensive land use changes could foil the climate change mitigation targets by causing more emissions than avoided.

The European Union Emissions Trading Scheme

However, beyond regulatory measures, the most important initiative that has resulted from ECCP is the European Union Emissions Trading Scheme (EU ETS) that was launched in 2005. In the pilot phase (running until December 31st 2007), which was designed as a preparation and test phase to establish a price for carbon, the trading system in emission allowances across the EU, and the necessary infrastructure for monitoring, reporting, and verifying the actual emissions from the covered

[187] Kretschmer, Bettina "The land use implications of EU-bioenergy policy – Going beyond ILUC", (Institute for European Environmental Policy: 2011)
[188] Kretschmer, Bettina "The land use implications of EU-bioenergy policy", 10
[189] Bowyer, Catherine and Kretschmer, Bettina "Anticipated Indirect Land Use Change Associated with Expanded Use of Biofuels and Bioliquids in the EU – An Analysis of the National Renewable Energy Action Plans", (Institute of European Environmental Policy: 2011), 16

sectors.[190] Based on the findings, the national caps for Phase II (2008-2012) were defined, aiming for a cut of 6.5% of emission allowances below the level of 2005.

So far, the EU ETS covers around 11,000 installations from the energy production and heavy energy consuming industry sectors causing more than one-half of the EU's total GHG emissions. From the beginning of 2012, aviation was also included into the ETS. During Phase II, 90% of all certificates are granted for free while 10% are subject to sale to auction. In Phase III, starting 2013, the 27 national caps will be replaced by one single EU-wide cap and up to 50% of the certificates will be auctioned. The aim is to reach full auctioning until 2027, although energy intensive sectors whose competiveness is judged to be at risk could still receive allowances for free as long as no global agreement is reached. So far the agricultural sector is not included into the trading scheme. Nevertheless, since Phase II, credits are accepted which are generated through projects carried out under the CDM KP or so-called "Joint Implementation Projects Outside of Europe". However, this does not include (re-)forestation projects.[191]

Since the EU ETS has not even entered Phase III, a substantial judgment is not possible so far, especially since the great majority of the certificates are so far not subject to the sale by auction. The EU itself defined the first phase as a "learning phase,"[192] but NGOs already criticized that the EU ETS has so far failed to reduce emissions and even rewards emitting companies.[193] In Phase I, price volatility and an over-allocation of certificates were also considered to be problematic since the price dropped from 30 Euros per ton to 0.03 Euro until December 2007. On the economic inputs however, an MIT study came to a more positive conclusion saying that *"*despite its hasty adoption and somewhat rocky beginning—the European Union cap-and-trade system has operated well and has had little or no negative impact on the overall EU economy.*"*[194]

[190] European Commission, "EU action against climate change – The EU Emissions trading scheme", 8
[191] An overview on the EU ETS is give in: European Commission, "EU action against climate change – The EU Emissions trading scheme" (Office for Official Publications of the European Communities, Luxemburg: 2008)
[192] European Commission, "EU action against climate change – The EU Emissions trading scheme", 8
[193] For a critical analysis of the EU ETS see: Gilbertson and Reyes, "Carbon Trading – How it works and why it fails", (critical currents, No.7, Dag Hammarskjöld Foundation: 2009), especially chapter 3
[194] Staufer, Nancy. "*Carbon emissions trading in Europe – Lessons to be learned"* (2008) http://web.mit.edu/mitei/research/spotlights/europe-carbon.html (07.03.2012)

4.2.3. EU Adaptation strategy

In 2009, the European Union also adopted a whitepaper on climate change adaptation.[195] But, referring to the to the regional variability and severity of climate impacts, this paper states, that most adaptation measures have to be taken on the national, regional, and local level. In this context the EU only functions as a coordinator on the supranational level to support and strengthen these measures.[196]

Further the whitepaper states that the EU has to play a "particularly strong role" in cases where climate change impacts transcend national boundaries (e.g. in case of floods). Referring to Article 2 of the Treaty on the European Union, the whitepaper called for solidarity among EU member states to ensure that "disadvantaged regions and regions most affected by climate change will be capable of taking the measures needed to adapt."[197] Beyond that, EU action is defined as necessary in sectors that are closely integrated on the EU level (i.e. supranational level), such as the agricultural and fishery sector.[198] In the same context it is argued that under the framework of the EU single market, the inclusion of the private sector in terms of prevailing market failures and lack of incentives can only be addressed on the EU level.

Nevertheless, this whitepaper is so far only meant to function as a roadmap to prepare and implement a comprehensive European adaption strategy from 2013 onwards. Therefore, such a common strategy has yet to be carried out. The roadmap for the implementation was last updated in September 2011, scheduling the date of adoption to the first quarter of 2013. Meanwhile, the preparation phase between 2009 and 2012 is designed to address four aspects: (1) building a solid knowledge base on the impact and consequences of climate change for the EU; (2) integrating adaptation into key EU policy areas; (3) employing a combination of policy instruments to ensure effective delivery of adaptation; and (4) stepping up international cooperation on adaptation.[199]

An area in which EU is acting already in a coordinating function is the field of coastal and flood protection. Several European Directives relevant to risk reduction and climate change adaptation in this field have been passed in the last years:

- The *Birds Directive (*1979/409/EEC) provides a framework for the conservation and management of wild birds in Europe

[195] Commission of the European Communities (CEC), "Whitepaper - Adapting to climate change: Towards a European framework for action", (Brussels: 2009)
[196] CEC, "Whitepaper - Adapting to climate change: Towards a European framework for action", 6
[197] CEC, "Whitepaper - Adapting to climate change: Towards a European framework for action", 6
[198] CEC, "Whitepaper - Adapting to climate change: Towards a European framework for action", 6
[199] CEC, "Whitepaper - Adapting to climate change: Towards a European framework for action", 7

- The *Habitat Directive (*1992/43/EEC) aims to safeguard biodiversity through the conservation of natural habitats and of wild fauna and flora

- The *Water Framework Directive* (2000/60/EC) specifies the EU requests for the protection of inland surface waters, transitional waters, coastal waters and groundwater

- The *Flood Directive* (2007/60/EC) outlines the requirements related to the assessment and management of flood risks.[200]

Although, the earlier directives were not primarily designed to adapt to climate change they contributed to its goals indirectly. In the flood directive however, climate change was noted directly obligating the member states to undertake a preliminary flood-risk assessment by the end of 2011, taking the impact of climate change into count. It further defines that member states must prepare flood hazard maps and corresponding flood risk management plans by the end of 2015.[201]

Dealing with coastal protection in 2000, the European Commission launched an initiative to implement a European Strategy regarded to the so-called "Integrated Coastal Zone Management (ICZM)."[202] According to Knecht and Archer, ICZM is defined as: "A dynamic and continuous process of administering the use, development and protection of the coastal zone and its resources towards common objectives of national and local authorities and the aspiration of different resource user groups".[203] It's an approach to bring together all relevant stakeholders and recognize the whole range of different economic, ecological, and social implications when coastal management is designed and implanted. As main principals of ICZM, the EU (the Directorate General for environment) defined the following points:

- Adopting a wide ranging view of inter-related problems
- Decision making based on good data and information
- Working with natural forces
- Involving all stakeholders and all relevant parts of the administration

[200] Policy Research Corporation, "The economics of climate change adaptation in EU coastal areas", study done on behalf of the European Commission - Directorate-General for Maritime Affairs and Fisheries (Brussels and Rotterdam: no year), 53
[201] Policy Research Corporation, "The economics of climate change adaptation in EU coastal areas", 53
[202] Commission of the European Communities (CEC), "Communication by the Commission to the Council and the Parliament on Integrated Coastal Zone Management:
a Strategy for Europe", COM/2000/547
[203] Cummins, Mahony and Connolly, "Rewiew of integrated Coastal Zone Management& Principles of Best Practice", (Coastal and Marine Resource Center, University of Cork, no year), 11

- Using a range of instruments (laws, plans, economic instruments, information campaigns, Local Agenda 21s, voluntary agreements, promotion of good practices, etc.) for coastal management[204]

After a demonstration program with exemplary coastal management projects in several countries already started in the nineties, the lessons learned from these projects became a basis for the further IZCE planning. Figure X gives an exemplary overview on the demonstration projects that were carried out on the British Isles and their main findings (see Figure 4.X).

[204] Cummins et al., ”Review of integrated Coastal Zone Management& Principles of Best Practice”, 11

Figure 4.X Examples for ICZM demonstration projects

Country	Project	Partnership	Focus	Lessons learned
England	Isle of Wight - Integrated Management of Coastal Zones	Isle of Wight Council, SCOPAC & English Nature	o To examine mechanisms used to deliver sustainable policy o To highlight 'good practice' in a number of areas leading to integrated management	The local voluntary approach works best within the bounds of national legislation. Employment of a project officer is crucial. Visioning – towards preferred future state of coastal area is often successful.
	South West Peninsula – Devon and Cornwall- Atlantic Living Coastlines	Cornwall and Devon County Councils	o To develop a coastal strategy o To focus on participation, environmental indicators and information	
Scotland	Forth Estuary Programme - A Demonstration of Effective Integrated CZM	Forth Estuary Forum (voluntary partnership of approx. 250 agency & organisation representatives)	o To address the key issues facing the Forth	Integrated coastal zone management can be policy or issue driven. Action plans have a significant role to play in helping to realise specific goals.
	Cromarty Firth Management Strategy	Cromarty Firth Liaison Group (local voluntary partnership)	o To develop policy statements & to set out framework of consensus	
Ireland	Bantry Bay Charter Project	Cork County Council, Coastal and Marine Resources Centre and Nautical Enterprise Centre	o To address the challenge of implementing successful consensus based approach to coastal management in Bantry Bay	Public participation is crucial to building a consensus based approach to ICZM. The involvement of coastal communities was a key feature in the development of management plans that introduced sustainability into the utilisation of beach and dune systems.
	Donegal Sand Dune Management	University of Ulster and Donegal County Council	o To develop beach and dune management systems for seven sites in Co. Donegal	

Source: Policy Research Corporation, "The economics of climate change adaptation in EU coastal areas", study done on behalf of the European Commission - Directorate-General for Maritime Affairs and Fisheries (Brussels and Rotterdam: no year), 31

The lessons learned from the demonstration program led to the formulation of eight principals of best practice for ICZM.[205] These principles became part of the official recommendation that was given by the European Parliament and the Council to adopt an ICZM in 2002.[206] In this recommendation it was requested that all member states should develop national strategies while maintaining intensive cooperation on the European level.[207] There is no EU legislation explicitly dealing with coastal management, but since the ICZM concept is an integrated approach it has (potential) influence and is influenced by several EU policies as listed in Figure 4.XI:

Figure 4.XI: EU policies and legislations with impacts on coastal management

- **EU Policies Impacting on ICZM:**

- EU Structural Funds
- Common Agricultural Policy (CAP)
- Common Fisheries Policy (CFP)
- Fifth Framework Environmental Action Programme
- Sixth Framework Environmental Action Programme
- European Spatial Development Perspective (ESDP)
- Trans-European Transport Network Policy (TEN-T)

- **EU Legislation Impacting on ICZM:**

Horizontal	**Sectoral**
Environmental Impact Assessment (EIA) Directive Strategic Environmental Assessment (SEA) Directive	Water Quality Legislation: Bathing Water Directive Shellfish Water Directive Waste Water Treatment Directive Nitrates Directive Water Framework Directive Nature Protection Legislation: Birds and Habitats Directives

Source: Cummins et al.,"Review of integrated Coastal Zone Management& Principles of Best Practice", 24

When the EU ICZM efforts were evaluated 2006, the implementation process, especially in the member states was still in progress and no country had fully implemented a national strategy at this point. But while 13 of 24 examined members were at least in progress implementing ICZM standards, 11 had not taken significant action.[208] Nevertheless, the authors of the evaluation conclude that the EU strategy had a positive impact on national implementation measures, saying that "the eight

[205] See Annex 4.I
[206] Recommendation of the European Parliament and of the Council of 30 May 2002 concerning the implementation of integrated coastal zone management, 2002/413/EC
[207] Rupprecht Consult – Forschung un Beratung GmbH (ed.), "*Evaluation of Integrated Coastal Zone Management (ICZM) in Europe* - Final Report", (Cologne: 2006), 6
[208] Rupprecht Consult (ed.), "Evaluation of Integrated Coastal Zone Management (ICZM) in Europe", 9

Principles of good ICZM as promoted in the EU ICZM Recommendation have created a new awareness and a higher level of preparedness at the regional level regarding long-term coastal challenges."[209] Further it is acknowledged, that the EU recommendation would have initiated "a rethinking of traditional planning approaches by promoting a reconciliation of economic, social and environmental interests."[210]

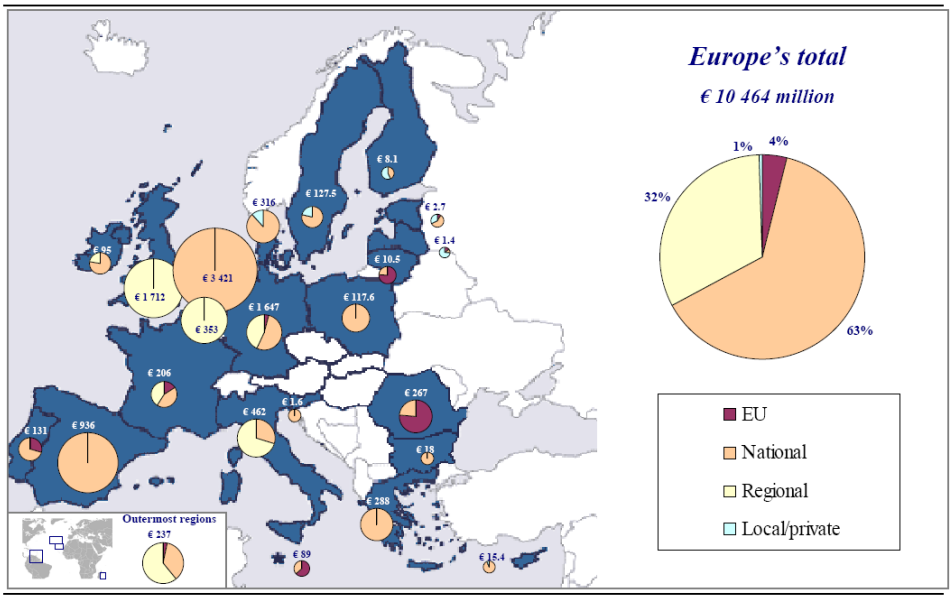
However, a study from the University of York, that includes also a brief evaluation of the projects carried out during the demonstration phase, suggests, European ICZM could be more effective if the EU would take a more active role. Since they identify the EU's contribution to be more supportive than regulatory, they conclude that this approach as being "inadequate as the complexity of coastal issues requires a more comprehensive legislative framework."[211] It is also criticized that no guidelines exist to specify the level of commitment required per member state, potentially leading to unbalanced implementation approach. In contrast they claim that a legal framework on ICZM could lead to greater adherence to the ICZM principles throughout EU member states.[212]

Nevertheless, based on the status quo, coastal protection, especially when it comes to financial issues, is a national responsibility. Figure 4.XII provides an overview on the expenditures of coastal protection among EU member states and the financial responsibility. The figures show that European Union undertakes 4% of the costs of European coastal protection, but with higher shares in certain cases like in Romania and Lithuania. The share depends on how the European structural developments funds are distributed by the national implementation plans. It can also be seen that the national (financial) responsibilities are handled differently. While in the Netherlands, it is completely financed on the national level, in Belgium or Great Britain, it is done on the regional level.

Overall it can be seen that five countries (Italy, the Netherlands, Germany, the United Kingdom and Spain) are responsible for 85% of the total coastal protection expenditure.[213] Nevertheless, this includes hotspot related investments. The additional protection measures in Venice, for example, count for 90% of Italy's expenditures and will cost approximately 4.2 billion Euros during the actual period.[214]

[209] Rupprecht Consult (ed.), "Evaluation of Integrated Coastal Zone Management (ICZM) in Europe", 10
[210] Rupprecht Consult (ed.), "Evaluation of Integrated Coastal Zone Management (ICZM) in Europe", 10
[211] Cummins et al., "Review of integrated Coastal Zone Management& Principles of Best Practice", 42
[212] Cummins et al., "Review of integrated Coastal Zone Management& Principles of Best Practice", 42
[213] Policy Research Corporation, "The economics of climate change adaptation in EU coastal areas", *67*
[214] Policy Research Corporation, "The economics of climate change adaptation in EU coastal areas", *67*

Figure 4.XII: Expenditures for Coastal Protection in Europe



Source: Policy Research Corporation, "The economics of climate change adaptation in EU coastal areas", study done on behalf of the European Commission - Directorate-General for Maritime Affairs and Fisheries (Brussels and Rotterdam: no year), 65

To provide a more concrete example how coastal protection is being implemented in a European member state, the following box outlines the example of coastal protection in the Kingdom of Great Britain:

Example of Member-States Coastal Protection: The case of Great Britain

As an island in the Atlantic Ocean, Great Britain is already exposed to sea related threats like storm floods or coastal erosion making the country particularly vulnerable to the potential impacts of sea level rise. As mentioned, land loss on the British Isles could be up 1.5% until 2085, if no adaptation measures will be taken.[215] Based on the long experience with these issues, coastal protection plans have existed for decades.[216] The basis of the protection efforts are the so-called "Shoreline Management Plans" that are designed to cover a specified part of the coastline, based not on administrative demarcations but on the natural boundaries of the coast. As a result, the plans deliver guidelines on the main strategy options for the different coastal segments covered, distinguishing between "hold the line," "advance the line," and "managed re-alignment or no active intervention." Based on the Shoreline Management Plans, individual schemes are developed, detailing the exact

[215] Ciscar (ed.), "Climate Change impacts in Europe", 57
[216] Policy Research Corporation, "The economics of climate change adaptation in EU coastal areas", 32

measures to be undertaken along each coastal (sub-) segment. So far, 36 SMPs are available for England and Wales and three for Scotland.[217]

Figure 4.XIII: Example for a Shoreline Management Plan

SMP for the coast zone of the River Wyre to Walney Island (England)

Source: Policy Research Corporation, "The economics of climate change adaptation in EU coastal areas", study done on behalf of the European Commission - Directorate-General for Maritime Affairs and Fisheries (Brussels and Rotterdam: no year), 32

As a mentioned hotspot, the Thames estuary is especially vulnerable. Therefore, already in 1984, the Thames barrier was built to protect London from tidal flooding. A project called "Thames Estuary 2010" does not only aim to extend the lifespan of the Thames barrier, but also adapt it to increased sea level rise and more intense storm surges. The permanent maintenance and adaptation is projected to cost at least 1.49 billion Euros until 2035 and 4.46 billion Euros in the following phase until 2075.[218]

With its long coastline and many people living in coastal areas, Great Britain is also particularly vulnerable to the social implications of sea related disasters and climate trends. For private households, it is first of all a financial issue since insurers might withdraw from threatened areas or areas that might be considered to be given up in the future. To cope with this problem, the British

[217] Policy Research Corporation, "The economics of climate change adaptation in EU coastal areas", 32
[218] Policy Research Corporation, "The economics of climate change adaptation in EU coastal areas", 67

government negotiated an agreement with the Association of British insurers (ABI) ensuring that flood insurance remains widely available also in the long terms. To achieve this, the government agrees to develop a long term investment strategy for coastal protection, including the definition of objectives, the assessment of policy options and the funding needs. In return, the insurers make flood insurances available for households and small business, where the flood risk has a maximum return period of 1:75. If the risk is more significant, insurance will be offered if risk reduction plans are available and being implemented within a period of 5 years.[219] In the end it's a deal in which the insurance companies agree to offer coverage under slightly unfavorable conditions as long as the government obligates itself to reduce the risk as far as possible. This might function as an example who agreements and burden sharing between the public and the private sector can contribute to the mitigation of social impacts of climate change related events.

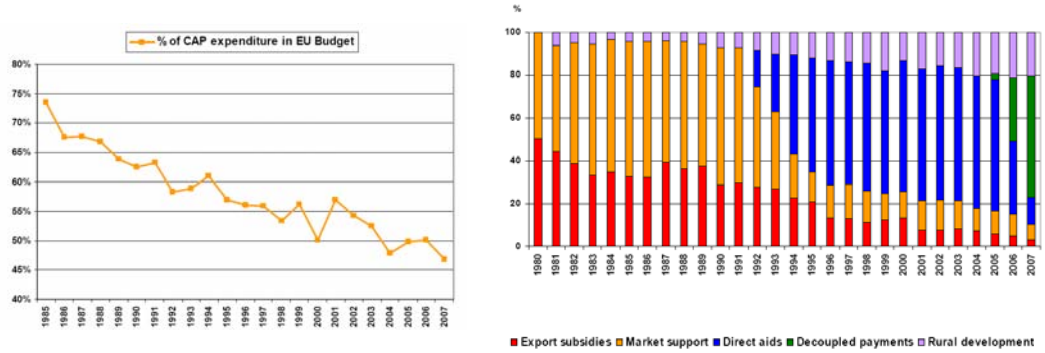
4.2.4. The Common Agricultural Policy (CAP)

Beyond the described measures, land use related policies are rare in the EU, since land use is explicitly named as one of the exceptions in Article 191, clause 2, were the ordinary legislation procedure of the EU does not apply. This indicates that the states' retentions against EU legislation in this fieldmight contradict with their national interests. Therefore, the influence of the EU on land use is limited when it comes to environmental issues. Nevertheless, in practical matters, there is one field, where EU policies have a significant impact on land use and, through this, also on its environmental impacts. Through its Common Agricultural Policy (CAP) the EU has a great influence on the agricultural production in its member states. Also the share is declining, spending under the framework of CAP still represents 42% of the EU's budget.

The original goal of the CAP was to secure prices for agricultural products within the European Community to ensure agricultural productivity and the access to sufficient food supplies. Therefore, the Community established intervention prices. If the production was too high, the Community bought surpluses to stabilize the prices. From 1993 onwards, the system was changed radically. Instead of stabilizing prices, the EU granted premiums per hectare depending of the crops planted. Additionally, premiums were granted for the withdrawal of land from production, the limiting of stocking levels, production from livestock (butter and milk), and measures to encourage retirement and forestation.

[219] Policy Research Corporation, "The economics of climate change adaptation in EU coastal areas", 58

Figure 4.XIV: CAP expenditures in EU budget and per category



Source: European Commission - Directorate General for Agriculture and rural development, "Why do we need a common agricultural policy – discussion paper by the DG for Agriculture and rural development", (Brussels: 2009), Annex 3-4

Because it was projected that the accession of ten new countries in 2004 would massively increase the costs of the system, another reform was introduced to limit spending. Therefore, from 2005 on, premiums are granted as a lump sum per hectare, independent from the planted crops. With the exception of milk producers all premiums for live stock products are meant to be abolished. On the one hand, this allows farmers to orientate more towards the market. The consequence was a continuous decline in the support for products and their prices. The decline in support prices has been significant in all sectors, ranging from 1%-16% in dairy products to 57 % in rice. In some sectors, support prices have been abolished all together.[220]

Figure 4.XV: Cumulative change in CAP support prices (1991-2009)

Product price change	Soft wheat	Durum wheat	Rice	Sugar	Beef	Butter	SMP
In nominal terms	- 48 %	- 61 %	- 57 %	- 39 %	- 29 %	- 16 %	- 1 %
In real terms	- 80 %	- 85 %	- 84 %	- 77 %	- 73 %	- 68 %	- 61 %

Source: European Commission - Directorate General for Agriculture and rural development, "Why do we need a common agricultural policy – discussion paper by the DG for Agriculture and rural development", (Brussels: 2009), Annex 1

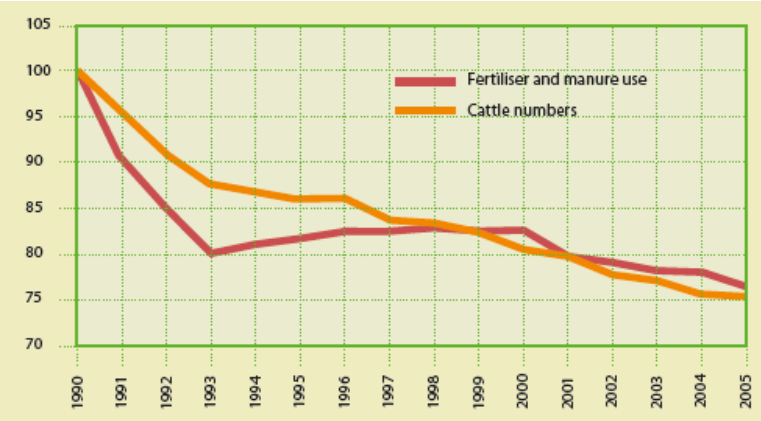
The reform led to a decrease in difference between EU and world market prices. Furthermore, the new instrument of decoupled funding is connected to the fulfillment of standards in environmental protection, animal protection, food security, and feeding are fulfilled (i.e. cross

[220] European Commission - Directorate General for Agriculture and rural development, "Why do we need a common agricultural policy – discussion paper by the DG for Agriculture and rural development", (Brussels: 2009), Annex 3-4

compliance*)*. Additionally, to the premiums, a second pillar was established to fund rural development and ecological issues. [221]

It can be seen, that the (potential) influence of the CAP on land use is enormous. Although the current system does not have direct influence of the sort of crops planted any more, the cross compliance clause forces the producers to maintain certain ecological standards that are set by EU legislation. An example for such a standard is the European Nitrate Directive (91/676/EEC) that was already introduced in 1991 and was aimed to reduce groundwater pollution caused by nitrogen's use in agricultural production. Since then the use of fertilizers in the agricultural sector has decreased so that today, according to the European fertilizers manufacturers association, European agriculture produces more crops with less nitrogen fertilizer than 20 years ago, and its nitrogen use efficiency is the highest in the world.[222] The reduced use of fertilizers and manure is considered to be one reason why emission reduction is already measurable in the agricultural sector. Another reason is a decreased number of livestock.[223]

Figure 4.XVI: Change of fertilizer use and cattle numbers in the EU



Source: European Commission - Directorate General for Agriculture and rural development, "EU agriculture", (Brussels: 2008), 8

In total, from 1990 until 2005, GHG emissions from agriculture decreased by roughly 20%. Although it has to be taken into account that these numbers are also affected by the momentous transitions undertaken by former socialist countries, the agricultural emissions in most of the EU-15 decreased

[221] For a more detailed description of the CAP, CAP reform and actual functioning see for example: Commission of the European Communities (CEC), "The role of European agriculture in climate change mitigation", (European Staff Working Document, Brussels: 2009), 36f.
[222] European Fertilizer Manufacturers Association (EFMA), "Annual report 2008", (Brussels: 2009), 4
[223] European Commission - Directorate General for Agriculture and rural development, "EU agriculture", (Brussels: 2008), 8

during that time. From 1999 until 2008 GHG emissions decreased by 7.4% in the EU-27 reducing the share of agriculture of total GHG emissions from 10.1% in 1999 to 9.6% in 2008.[224]

In the framework of the second pillar of CAP, the rural development fund, climate change mitigation is explicitly addressed.[225] The actual Rural Development Policy (2007-2013) addresses three thematic schemes: improvement of competiveness, improving the environment and the countryside, and improving the quality of life in rural areas.[226] Related to these three "axes" several measures address climate change issues at least partly. This includes the following funded measures:

- Farm modernization (i.e. higher energy efficiency, introduction of new technologies)
- Processing of agricultural biomass for renewable energy
- Improvement and Development of Infrastructure
- Organic farming (i.e. potential for mitigation through efficient nutrient cycles
- and soil management)
- Forestry actions (i.e. aforestation of agricultural land, establishment of agro forestry systems, forest-environment measures)
- Agri-environmental schemes (i.e. improving fertilization and management of soils, especially improving efficiency of nitrogen fertilizer, such as reduced use, accurate timing of application in relation to crop requirements, and use of precision farming techniques)
- Improvement of soil management and land use actions beyond what is required by cross compliance and help to maintain and enhance the carbon sink capacity of agricultural soils[227]

Concretely, the European Union has evaluated 109 programs that are funded beyond the 2007-2013 Rural Development Scheme to examine what certain issues of climate change mitigation were addressed in the project.[228] On average, every examined aspect was covered by 25% of the programs. The most prominent issues addressed were aforestation (48% of the projects) and organic

[224] Bolla, Viktoria and Pendolovska, Velina, "Driving forces behind EU-27 greenhouse gas emissions over the decade 1999-2008", (EUROSTAT – Statistics in focus 11/2010), 2
[225] CEC, "The role of European agriculture in climate change mitigation", 38
[226] European Commission, "Rural Development Policy 2007-2013" http://ec.europa.eu/agriculture/rurdev/index_en.htm (accessed 08.03.2012)
[227] CEC, "The role of European agriculture in climate change mitigation", 38-39 – A complete list of potential mitigation measures linked to the rural development scheme and under which regulation framework there are addressed can be found in Annex 4.II.
[228] CEC, "The role of European agriculture in climate change mitigation", 44-45

farming (60%).[229] A complete overview on the different programs and there targets is given in Annex 4.III

This demonstrates that the CAP is an important framework for the EU to address climate change mitigation issues in the agricultural sector and to support adaptation and mitigation policies through financial funding. Since the CAP is a well established policy of the EU, the capacity of the Union is high to enforce policies and legislation. Nevertheless, the CAP should not be taken blindly as a best practice example. Throughout the history of the EU, agricultural funding was one of the most disputed and most criticized policies of the Union. In the times where CAP was designed to keep the prices stable, the EU systematically funded misallocation and overproduction that it was later forced to buy. This led to the proverbial "butter mountains" or "milk lakes". Although recent reforms were designed to make the CAP more market orientated and product related funding was abolished, the subsidies-driven CAP is still criticized, especially on the international level. Since it allows European farmers to offer agricultural products under the world market price, not only several conflicts within the World Trade Organization (WTO) were caused, but the farmers in developing countries were severely disadvantaged from agricultural price dumping caused by the EU. Therefore a system based on financial incentives or even direct subsidies has to be balanced out very carefully.

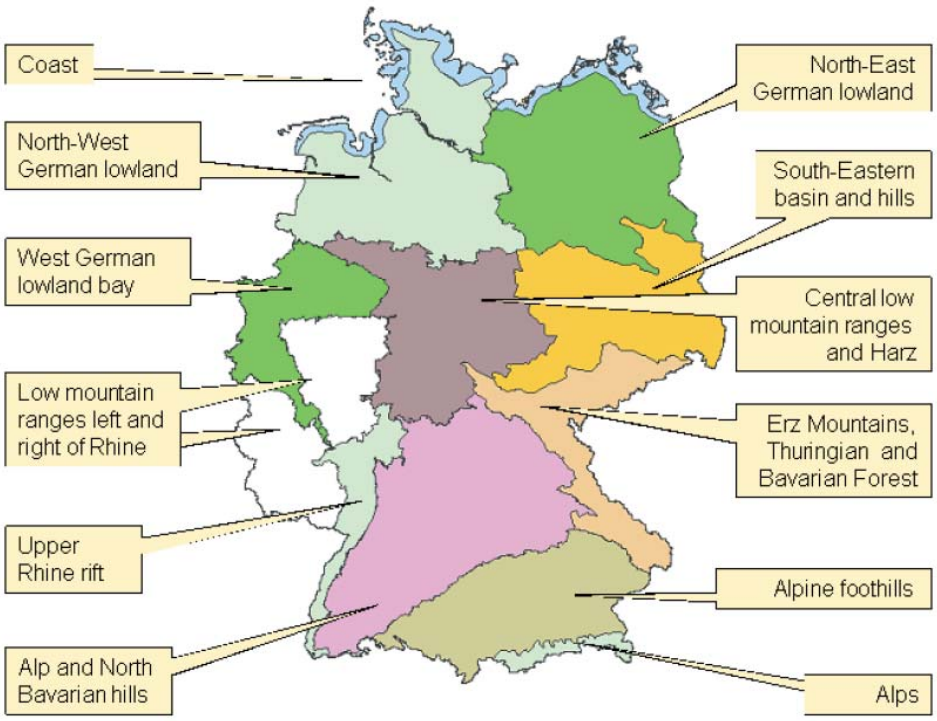
[229] CEC, "The role of European agriculture in climate change mitigation", 44-45

4.3. Germany

4.3.1. Vulnerability

Although Germany is a relatively small country, the microclimatic conditions vary distinctly among the different part of the country. As such, the vulnerability and the challenges are regionally specific. It contains the coastal regions along the North and the Baltic Sea, lowlands in the northwest and north east, medium range mountains, and the alpine and pre-alpine regions in the south. The general climate is temperate and marine with wet winters and summers. Table X provides an overview of the main regions of the country with different microclimatic conditions.

Figure 4.XVII: Different German landscapes categorized

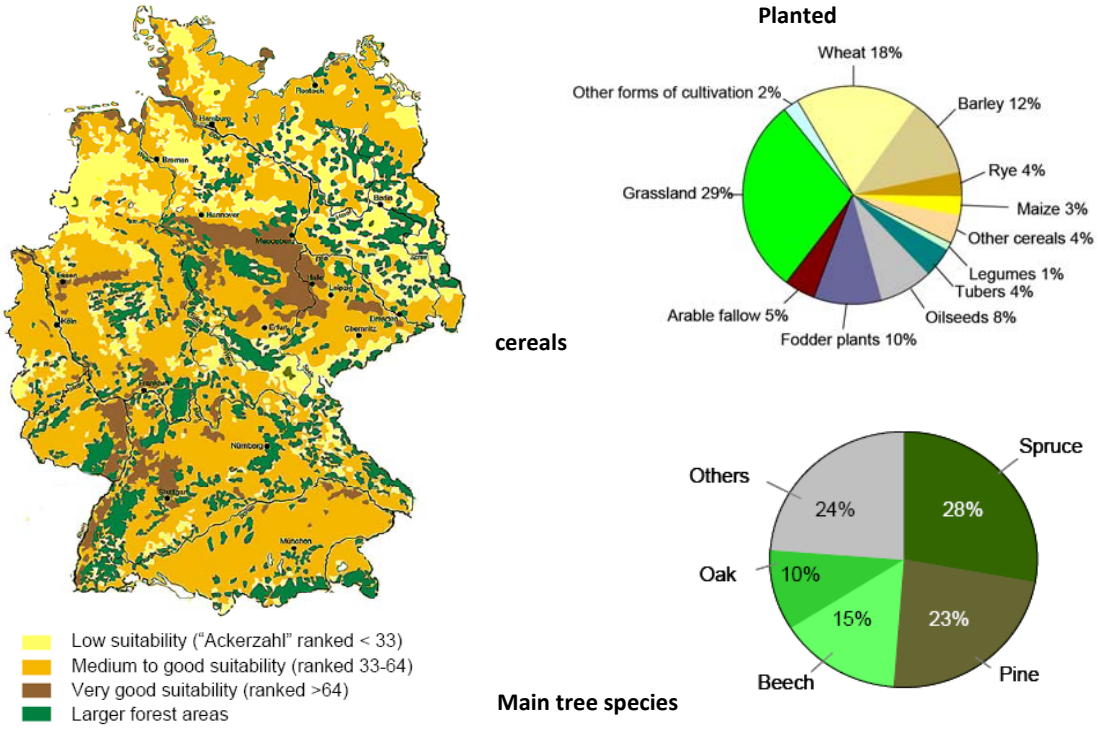


Source: Deutscher Wetterdienst - DWD (German Wheather Service), "Klimastatusbericht 2005", (Deutscher Wetterdienst, Offenbach: 2006), 50

Overall, according the Federal Statistical Office, 52.3% of the available land was used for agricultural purposes in 2010. Compared to 2000, this is a decline of 1.2%, points or roughly 4,000 square

kilometers. In contrast to that, the area covered by forests grew slightly from 29.5 to 30.1%. The share of land used for settlements and transport infrastructure was 13.4% in 2010 and had also grown since 2000 (roughly 4,000 sq km.).[230]

Figure 4.XVIII: German land quality and main plantations



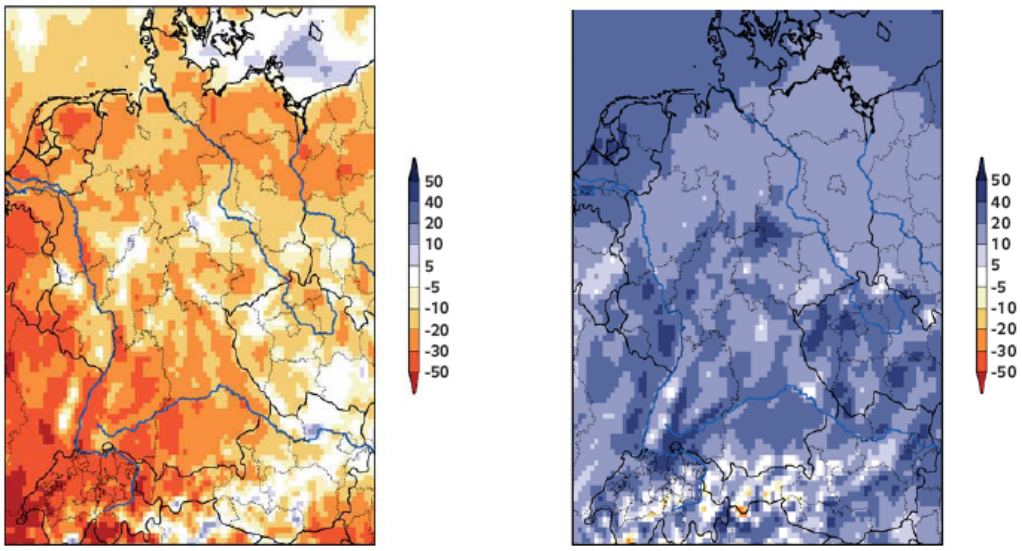
Source: Zebisch et al., "Climate Change in Germany Vulnerability and Adaptation Strategies of Climate-sensitive Sectors", (Potsdam Institute for Climate Change Research: 2005), 70, 71 and 90

In Germany, 53% of the surface area is used for agriculture. Of this land, 29% is grassland and 69% is cropland. As shown above, the most suitable areas for agriculture can be found in north central Germany as well as in the Rhine Basin. The main products produced on croplands are wheat for bread making, barley for fodder and industrial use, as well as other fodder crops (clover, lupine etc.) (see figure above). Four percent of the arable area is under organic farming and the proportion of arable land used to grow renewable primary products is approximately 6%, a two-fold increase since 1998.

[230] Statistisches Bundesamt (German Federal statistical office), „Flaechennutzung – Bodenflaeche nach Nutzungsarten", https://www.destatis.de/DE/ZahlenFakten/GesamtwirtschaftUmwelt/Umwelt/UmweltoekonomischeGesamtrechnungen/Flaechennutzung/Tabellen/Bodenflaeche.html?nn=151670 (accessed 20.03.2012)

Generally, the impacts of climate change on Germany are considered to be rather moderate.[231] The biggest impact is projected to result from a change in precipitation. Although it is considered to be stable in the annual average, rainfall is projected to increase during the winter while decreasing during the summer.

Figure 4.XIX: Projected changes in precipitation



Left side: Summer season, **right side:** winter season – according to IPCC scenario A1

Source: Schwarz, Rixa, Harmeling, Sven and Bals, Christoph "Auswirkungen des Klimawandels auf Deutschland – Mit Exkurs NRW" (Germanwatch e.V. (editor), Bonn: 2007), 6

Among these regions, especially southwestern Germany (the upper Rhine rift), eastern Germany (northeastern German lowland and the south eastern basin and hills) and the Alps are considered to be most vulnerable.[232] For the eastern parts, the biggest issue will be the projected decrease of rainfall of up to 30% (especially in the northeast). In some regions, the average annual precipitation could fall under 400 liters per square kilometer per year, which is considered to be a critical mark. In combination with higher temperatures, these areas could be exposed to substantial heat stress. These conditions will reduce the availability as well as the quality of groundwater and water for the agricultural sector. The following table provides an overview of expected impacts on the different regions (land related impacts):

[231] Swart, Rob et al., „Europe Adapts to Climate Change - Comparing National Adaptation Strategies" (Partnership for European Enivornmental Research – PEER, PEER Report No. 1, Helsinki, 2009),
[232] Deutscher Wetterdienst - DWD (German Wheather Service), "Klimastatusbericht 2005", (Deutscher Wetterdienst, Offenbach: 2006), 49

Figure 4.XX: Vulnerability assessment for the different German regions

	Flood	Drought	Agriculture	Forestry	Overall
Coastal area					
North-West German lowland					
North-East German lowland					
West German lowland bay					
Central low mountain ranges and Harz					
South Eastern basin and hills					
Erz-Mountains, Thuringian and Bavarian forest					
Low mountain ranges left and right of Rhine					
Upper Rhine rift					
Alp and North-Bavarian hills					
Alpine foothills					
Alps					
Germany					

High vulnerability Moderate vulnerability Low vulnerability

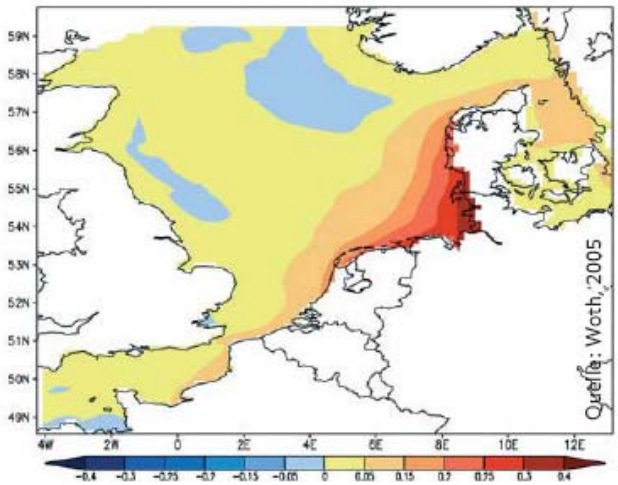
Source: Deutscher Wetterdienst - DWD (German Wheather Service), "Klimastatusbericht 2005", (Deutscher Wetterdienst, Offenbach: 2006), 51

Although some regions are considered to be less vulnerable, the whole country is predicted to experience more heavy weather events, especially floods, storms and generally extreme weather conditions. Southwest Germany (upper Rhine rift), which is already the warmest region of the country today is expected to show the strongest warming in the future. This will especially affect agriculture and forestry and will increase the risk of flooding in the early spring due to a shift of precipitation from summer to winter. Also, extreme rainfall events could become more likely.[233] Rising sea levels of course are considered to have an impact on the coastal regions due to an increased at risk of storm- and flood damages. This especially threatens the north Atlantic coast. Figure 4.XX shows that despite general sea level rise, wind related average sea level highs could increase up to 0.5 meters in the German bight, increasing the threats related to storms and storm floods.

The Alpine regions are especially sensitive in terms of biodiversity. Furthermore, the expected retreat of glaciers would have an impact on water resources and a reduced chance of snow is expected to diminish the attractiveness of the region for winter tourism. This demonstrates, that, although Germany might have the economic and social capability to adapt properly, adjustment and preparation are still necessary.

[233] DWD, "Klimastatusbericht 2005", 50

Figure 4.XXI: Projected increase in storm related sea level rise



Projection for the period between 2071 and 2100 compared to the status quo

Source: Schwarz, Rixa, Harmeling, Sven and Bals, Christoph "Auswirkungen des Klimawandels auf Deutschland – Mit Exkurs NRW" (Germanwatch e.V. (editor), Bonn: 2007), 9

4.3.2. German mitigation and adaptation policies

In the German political sphere, the necessity of actions against climate change is widely accepted, not only among theGreen and left-wing parties but also among the center-right government. In their agreement of 2009, the conservative party of Angela Merkel and the liberal party established the aim to limit global warming to 2°C and formulate ambitious targets for Germany, claiming that GHG emissions should be reduced by 80% (compared to 1990) until 2050 and already up to 40% until 2020.[234] The German Federal Environment Agency (*Umweltbundesamt*) already outlined in 2007 how such a reduction target could be met through reduced energy consumption, increasing the share of renewable energy in use, increased energy efficiency, and enhanced transportation systems (i.e. more fuel efficient cars that produces fewer emissions and an increased emphasis away from traffic and towards railroads and waterways).[235] In order to promote renewable energies and make them competitive, Germany passed the Renewable Energies Act (*Erneuerbare Energien Gesetz* – EEG). To promote the investment in renewable energy systems, the state guarantees fixed fees in tariffs for the suppliers. Furthermore, the grid operators are obligated to feed in the energy from these sources

[234] Coalition agreement between CDU, CSU and FDP, „Wachstum, Zusammenhalt, Bildung – Koalitionsvertrag zwischen CDU, CSU und FDP; 17. Legislaturperiode" (Berlin: 2005), 25-26

[235] For more information on that see: Umweltbundesamt (German Federal Environment Agency), „Klimaschutz in Deutschland: 40%-Senkung der CO2-Emissionen bis 2020 gegenüber 1990", (Dessau: 2007)

preferably. The tariff amounts depend on the different energy sources, like wind, photovoltaic, biogas etc.

Recently, the German policy changed remarkably in 2011 after the tsunami in Japan and the nuclear crisis that followed in Fukushima. After the left wing government of Gerhard Schroeder (1998-2005) had initiated Germany's suspension of nuclear energy by commencing a plan to shut down all nuclear power plants by 2025, the center-right coalition that came into power in 2009 had agreed on an extension of this phasing out period, arguing that the energy supply cannot be replaced quickly enough with renewable energy sources. After the events in Japan, however, the government revoked this decision and sought to speed up the process of discontinuing nuclear power generation. The target to replace nuclear power through renewable energy supply on the short term is considered to be a big challenge for German energy policy in the next few years, since eight nuclear plants were shut down immediately and the remaining nine will be put out of service by 2022.[236]

Concerning agriculture, the German national strategy plan for rural development that implements the measures related to the second pillar of the CAP sets a framework in which climate change mitigation issues are addressed in the agricultural sector. According to this strategy, the following measures should be addressed by the Rural Development Fund in the 2007-2013 period [237]:

- Promotion of organic farming
- Funding for so-called "unproductive" investments. This contains the following:
    - Decrease of cultivation intensity (fewer usage of fertilizers, cutback of livestock per hectare)
    - Maintenance of permanent grasslands
    - Transformation of arable farmland into permanent grassland, especially in areas that are exposed to flood risks
    - Introduction of planting techniques that increase soil quality and mitigates erosion
    - Promotion of setting aside land
    - Improved crop rotation

[236] Dreizehntes Gesetz zur Änderung des Atomgesetzes - 13. AtGÄndG (Thirteenth amendment to the German Atomic Energy Act), article 1

[237] Bundesministerium fuer Ernaehrung Landwirtschaft und Verbraucherschutz – BMELV (German Federal Ministry for agriculture and consumer protection), „Nationaler Strategieplan der Bundesrepublik Deutschland für die Entwicklung ländlicher Räume 2007 – 2013", (Berlin: 2011)

    - Increased cultivation of grasslands, covered with fruit trees

- Increasing the efficiency of fertilizer and manure management
- Maintenance and re-cultivation of swamps and wetlands
- Consultancy-, information-, and qualification measures for relevant target groups
- Promotion of renewable energy production
- Improving energy efficiency of greenhouses[238]

The overall sum of funding that comes from the different European funds will be 9,079 billion Euros in the phase from 2007-2013. Nevertheless, this includes all European funds also those who are granted for disadvantaged regions to reach convergence. The German strategy plan however does not specify what share of this sum is granted to environment and climate change related projects.[239]

Regarding the forestry sector, with its actual budget plan the federal government has set up a forest climate fund that is planned to be implemented in 2013 with an annual funding of 35 million Euros. Measures that should be financed with this money include renaturation of forests, the maintenance of swamps, and the establishment of wet forests, as well as prevention and recovery measures related to heavy weather events.[240]

The German National Adaptation Action plan

While the need to combat climate change is widely accepted among the public and Germany's reduction targets are quite ambitious, the issue of adaptation was given little attention until the middle of the last decade. As a reason for this, the PEER study argues that the political background in Germany has long been dominated by the opinion that climate change policies should focus on mitigation, because adaptation was considered as an "inadequate surrender" to the causes of climate change.[241] After the Elbe Flood in 2002, however, Germany undertook already-extensive

[238] BMELV, „Nationaler Strategieplan der Bundesrepublik Deutschland für die Entwicklung ländlicher Räume 2007 – 2013", 43-45
[239] BMELV, „Nationaler Strategieplan der Bundesrepublik Deutschland für die Entwicklung ländlicher Räume 2007 – 2013", 56
[240] Umweltbundesamt (German Federal Environment Agency), „THEMENBLATT: Anpassung an Klimaänderung in Deutschland - Forstwirtschaft" (2011), 6
[241] Swart, Rob et al., „Europe Adapts to Climate Change - Comparing National Adaptation Strategies" (Partnership for European Enivornmental Research – PEER, PEER Report No. 1, Helsinki, 2009), 218

efforts to improve flood protection but this was not primarily associated with climate change adaptation.[242]

Therefore, the German National Adaptation Strategy was adopted not before 2008,[243] leading to a national adaptation action plan that was passed by the Cabinet in August 2011.[244] Generally speaking, the action plan determines that climate change adaptation goals shall be integrated into relevant legislation in the environmental and planning sector.[245] Related to land use, such references and goals related to Climate Change were already implemented through a reform of the German Regional Planning Act. Article 2, section 2, clause 6, demands, among other environmental restrictions, that imperatives of climate protection has to be taken into account in the planning process in the form of climate change adaptation and mitigation.[246] The effect is that revised regional and local land use plans now have to include this aspect.[247] Also, the building legislation and the urban development planning procedures were named as areas where the climate change issue is planned to be implemented. Although local authorities are basically independent in these kinds of planning issues, the national legislation is meant to enhance the consideration and implementation on local levels.[248]

To further stimulate the incorporation of climate change issues even in areas where the federal government has limited competences, federal support programs are especially designed to address these issues or at least include them. An example named in the climate change adaptation action plan is the federal program to promote biodiversity that was granted with 15 million Euros. Further, the "National Climate Change Initiative" contains a "Community-Directive" designed to support local community based climate change adaptation and mitigation planning.[249]

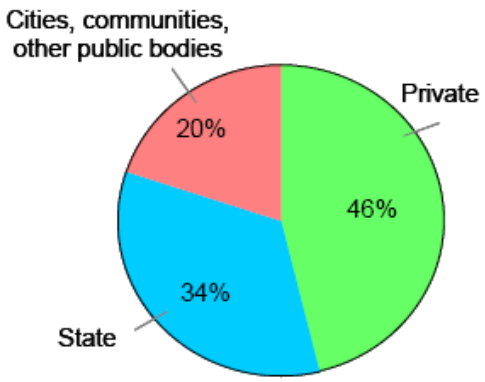
The national action plan also addresses the implementation of adaptation and mitigation planning through the authorities related to property and land directly owned by the state. Despite the claim to address these issues in planning and maintenance of state owned infrastructure and real estate, one land use issue is particularly addressed here concerning the state owned forests. Forests owned by the federal state represent roughly 34% of the whole forested area in Germany. Since this in turn

[242] Swart, Rob et al., „Europe Adapts to Climate Change - Comparing National Adaptation Strategies", 218
[243] Bundesregierung (German federal government), „Deutsche Anpassungsstrategie an den Klimawandel", (releaesd by the federal cabinet: December 2008)
[244] Bundesregierung (German federal government), „Aktionsplan Anpassung der Deutschen Anpassungsstrategie an den Klimawandel", (releaesd by the federal cabinet: August 2011)
[245] Bundesregierung, „Aktionsplan Anpassung der Deutschen Anpassungsstrategie an den Klimawandel" 30
[246] Raumordnungsgesetz – ROG (Federal Regional Planning Act), Article 2, Section 2, clause 6
[247] Bundesregierung, „Aktionsplan Anpassung der Deutschen Anpassungsstrategie an den Klimawandel", 31
[248] Bundesregierung, „Aktionsplan Anpassung der Deutschen Anpassungsstrategie an den Klimawandel", 31
[249] Bundesregierung, „Aktionsplan Anpassung der Deutschen Anpassungsstrategie an den Klimawandel", 33

represents nearly 10% of the whole area of Germany, the states' influence on forestation is quite important. The action plan determines that the responsible department for state properties should enhance the establishment of mixed forests to resist heavy weather and avoid soil erosion.[250]

[250] Bundesregierung, „Aktionsplan Anpassung der Deutschen Anpassungsstrategie an den Klimawandel", 35

Figure 4.XXII: Forest ownership in Germany



Source: Zebisch et al., "Climate Change in Germany Vulnerability and Adaptation Strategies of Climate-Sensitive Sectors", (Potsdam Institute for Climate Change Research: 2005), 90

Coastal and flood protection

Generally the German coastal protection is under the responsibility of the federal states, although the federal government is paying roughly for about 70% of the expenditures. In total, it is calculated that Germany will have invested 1.647 billion Euros for coastal protection between 1998 und 2015. Over one-third of this amount (approximately 660 million Euros) will be invested in Hamburg. The city is located close to the Elbe estuary to the North Sea and inhabits Germany's biggest and economically most important seaport. Being hit by storm floods on a regular basis in the past, Hamburg is considered to be a climate change hotspot, especially vulnerable by extreme weather events. Therefore, the money will be invested to maintain dike lines and building maintenance programs.[251]

An example for the inclusion of flood risk evaluation into the planning of urban development is the city-planning project "*Hafencity*" Hamburg. Replacing warehouses and part of the old harbor, the area is supposed to become a new quarter for living, shopping, and business. Being located between the old historic center and the Elbe River, the area is on the waterside of the existing dike line. Therefore, the issue of flood protection played a crucial role in the planning process. This means that construction sites are being elevated to at least 7.50 meters in compliance with the general safety standards for Hamburg. The foundations of the buildings will function as garages so that they can be

[251] Policy Research Corporation, "The economics of climate change adaptation in EU coastal areas", 66

flooded in severe cases. The elevated sites are also connected to the main dike line through special flood protected roads to ensure that fire fighters and ambulances have access to the area at all times. The whole project is financed as a public-private partnership with a public investment of approximately 1.3 billion Euros.[252]

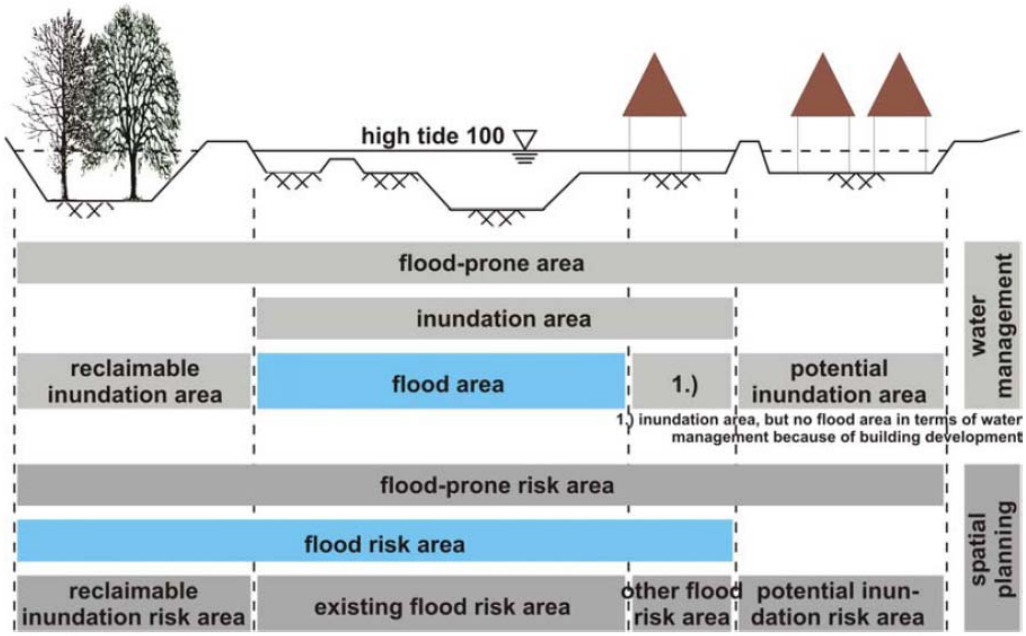
Since Germany's big river basins, especially the Rhine, Elbe and Oder are regularly afflicted by more or less severe river flooding, the German authorities are quite experienced with this issue, and it was already addressed in legislation and development planning before climate change was an issue. The Elbe flood of 2002, however, caused a review of the existing legal and planning framework and led to the adoption of the Preventive Flood Control Act of 2005 (*Gesetz zur Verbesserung des vorbeugenden Hochwasserschutzes)*. The law obligates the federal states to identify and declare flood risk areas and retention areas with the objective to leave more room for rivers, particularly their natural flood plains. This might demand, where possible, measures for moving dikes further away from river banks and the conservation or restoration of flood plains. The law also includes restrictions on construction of buildings in areas classified as "at risk of flooding" and agricultural use in high-risk areas. Therefore, the law also contains clauses to change the Water Management Act, the Federal Building Code, the Federal Regional Planning Act, the Federal Waterways Act, and the Law Governing the German Weather Service.[253]

This indicates that flood protection is already implemented as a crosscutting issue in German legislation and is therefore an issue that has to be considered in urban and rural planning. The basis for the indication of risk areas and the related planning is the occurrence probability of a flood event. In Germany, normally a "100-year-flood" is assumed.[254] Additionally, Germany can rely on a very broad knowledge based on experiences and detailed hazard maps. This is also flanked by initiatives from the private sector. The German insurers, for example, set up the ZUERS Geo zoning system to analyze the threats of water related losses from heavy rain, floods or backwater (see also 4.2.3). Germany also participates in common international implementation programs. Together with the responsible ministers in France, Luxemburg, the Netherlands, Belgium, a common flood protection plan was adopted in 1998 for the Rhine River, aiming to reduce flood risks and flood levels, intensify

[252] Policy Research Corporation, "The economics of climate change adaptation in EU coastal areas", 46
[253] Friesecke, Frank "Precautionary and Sustainable Flood Protection in Germany – Strategies and Instruments of Spatial Planning", (Paper presented at the 3rd FIG Regional Conference Jakarta, Indonesia: October 3-7, 2004), 8
[254] Friesecke, "Precautionary and Sustainable Flood Protection in Germany – Strategies and Instruments of Spatial Planning", 11

the awareness of flooding, and improve flood reporting systems.[255] Therefore, Germany's knowledge, awareness, and technical capacity regarding river flooding can be considered quite high.

Figure 4.XXIII: Overview on different types of flood areas in Germany



Source: North Rhine-Westphalia State Environment Agency (LUA NRW), modified and translated by Friesecke, "Precautionary and Sustainable Flood Protection in Germany – Strategies and Instruments of Spatial Planning", 11

4.3.3. Social Impacts and challenges

Since the overall climate change impacts are projected to be moderate and Germany is among the very high developed countries,[256] its adaptive capacity can be generally considered to be high. This means, that Germany might face shifts in agricultural production and regional heat and water stress, but generally Germany is a water-rich country. Today only approximately 24% of available water resources are used for human purposes. Therefore, in contrast to other regions in the world, climate change is not likely to have severe impacts on basic needs like food security or drinking water

[255] Friesecke, "Precautionary and Sustainable Flood Protection in Germany – Strategies and Instruments of Spatial Planning", 11-12

[256] According to the Human Development Index, issued annually by the United Nations development program (UNDP); For the latest report see: "International Human Development Indicators", http://hdr.undp.org/en/statistics/ (accessed: 27.03.2012)

availability.[257] But still, decreasing precipitation in the summer might affect the availability for water for industrial or agricultural purposes. During the heat wave in 2003 for example, the extraction of cooling water for power plants had to be reduced in some regions.

Nevertheless, the Potsdam Institute for Climate Impact Research predicts that the German water sector should be able to adapt properly. Also the agricultural sector is considered to have a fairly high adaptation capacity, since new technologies are already implemented and measures in this direction are supported by the European Union (see chapter 4.1.) and the German government. Additionally, the implications for the agricultural sector might not be negative in every region. Conditions in terms of an enlarged growing season and higher temperatures could be favorable for wine-growers, allowing the cultivation of more grape varieties in larger areas and producing wine of higher quality. Generally, higher temperatures could favor the planting of maize, millet, and olive trees, while the production of oat, rye, and potatoes might decrease. As a negative impact, the agricultural as well as the forestry sector might face higher risks of diseases and pest outbreaks that might negatively affect the productivity of these sectors.[258]

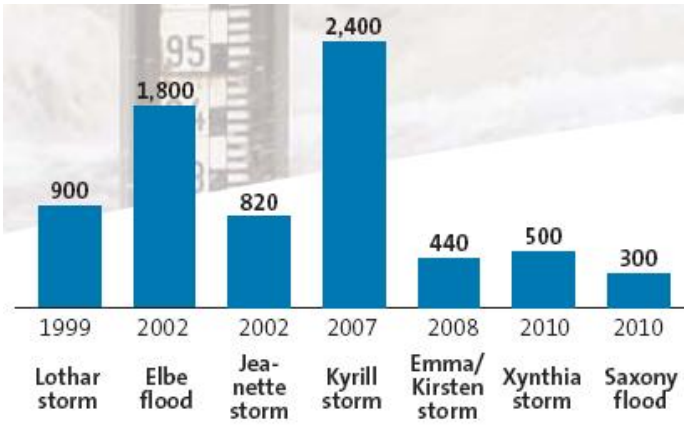
Another issue, however, is the planting and use of crops for biofuels, since they also need cultivatable land and are therefore in competition with food production and renaturation efforts. In 2011, Germany had to import wheat for the first time in 25 years because for many farmers planting maize for biogas production was more lucrative then producing crops for food production. Also, nearly 6% of the cultivated crops of maize and oilseed rape are used to produce biofuel. In combination with a bad harvest in 2011, the production amount of 41.5 million tons of cereals was not sufficient to fulfill the demand of 44 million tons.[259] This did not cause an actual problem for Germany, but it demonstrates that the German mitigation strategy, in which renewable energies play a crucial role, will need to balance the different needs of society since land usage is limited and extending land use could foil mitigation and adaptation targets.

The biggest social issue for Germany is, however, the management of the costs of climate change impacts as well as of the mitigation and adaptation measures. Coastal protection will prevail as an ongoing task in the future with potentially increasing costs. This is especially true for the northwestern coastline and at the climate change hotspot in Hamburg. But based on the current economic outlook, Germany should be able to maintain its protection and adaptation efforts that are

[257] Swart, Rob et al., „Europe Adapts to Climate Change - Comparing National Adaptation Strategies“, 217
[258] Zebisch et al., “Climate Change in Germany Vulnerability and Adaptation Strategies of Climate-Sensitive Sectors”, (Potsdam Institute for Climate Change Research: 2005), 9
[259] T-Online, „Deutschland muss Getreide importieren“ http://wirtschaft.t-online.de/erneuerbare-energie-deutschland-muss-getreide-importieren/id_53007742/index - (accessed 16.03.2012)

managed under state authority. More complex, however, are the costs that result from heavy weather events, including floods, storms, hails, etc. In just the last 13 years, Germany has experienced seven heavy weather events that caused billions of Euros in costs, especially storm Kyrill in 2007 and the Elbe flood of 2002. The following table shows the insurance claims that were related to these events.

Figure 4.XXIV: Insurance claims related to major natural hazards in Germany



Source: Gesamtverband der deutschen Versicherungswirtschaft e.V. (GDV),“ The Climate Change Challenge – Answers and Demands of German Insurers“, (Berlin: 2011), 4

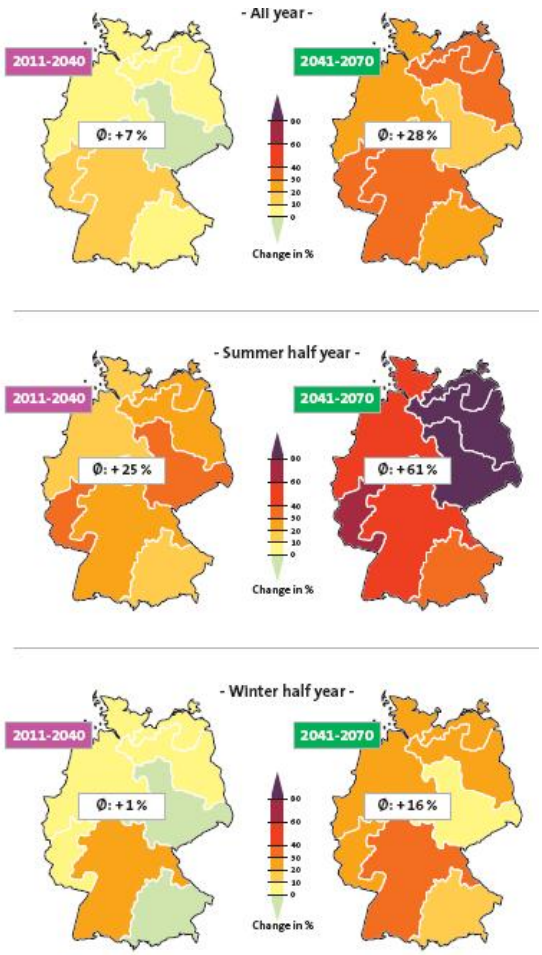
However these costs only represent the claims towards insurance companies. They exclude the damages to private and public properties that were not insured against a certain type of damage. The German Insurance Association states that 72% of German households are not insured against damages from natural hazards so far.[260] Estimations on the total costs of the Elbe flood for example go up to 10 billion Euros.[261]

The storm Kyrill caused an estimated total cost of around 5 billion Euros.[262] In the case of the Elbe flood, the federal government gave financial support to the affected regions. Furthermore, it launched an initiative to improve flood protection, for example, investing 50 million Euros in dike improvement. However, financing a reconstruction program worth billions of Euros is challenging, even for the German government and the projects of the German Insurers Association. To make

[260] Gesamtverband der deutschen Versicherungswirtschaft e.V. (GDV),“The Climate Change Challenge – Answers and Demands of German Insurers“, (Berlin: 2011), 5
[261] Deutsches Komitee fuer Katastrophenvorsorge e.V. – DKKV (German commitee for disaster prevention) Hochwasservorsorge in Deutschland – Lernen aus der Kathastrophe 2002 im Elbgebiet, (Schriftenreihe des DKKV, Bonn: 2003), 5
[262] Deutsche Meterologische Gesellschaft – DMG (German Meteorological Society) (ed.), „Stellungnahme der Deutschen Meteorologischen Gesellschaft zur Klimaproblematik“, (2007), 2

matters worse, the losses from hail and storms are predicted to increase up to 28% by the end of this century.

Figure 4.XXV: Estimated increase of hail and storm loss (compared to the annual loss ratio between 1984 and 2008



Source: Gesamtverband der deutschen Versicherungswirtschaft e.V. (GDV),"The Climate Change Challenge – Answers and Demands of German Insurers", (Berlin: 2011), 10

In the case of floods, the German Insurers Association states that losses couldeven triple, based on the assumption that the frequency of flooding will double in the future. Predictions indicate that flooding recurrence may increase from the current 50-year-cycle to every 25 years in the future.[263] Nevertheless, the association is optimistic that, in general, the climate change impacts in Germany will "stay insurable", although costs for insurance will most certainly increase. To improve the risk

[263] GDV, "The Climate Change Challenge – Answers and Demands of German Insurers", 14

assessment, the insurance industry has initiated the ZUERS Geo zoning system to analyze the threats of water related losses from heavy rain, floods or backwater. From analyzing the data, the conclusion was that 98.5% of the buildings could be insured properly against flood damages, while 1.5% would need specialized insurance protection since they are in the highest risk areas.[264] The insurers also mentioned that farms and farmers are usually insured against hail and storm losses, but normally not against flood damages, droughts, heavy rain, or heat. It is doubted that – if such events occur more regularly and with higher intensity – neither the EU, the German government, nor the German federal states will be able to continue to provide compensation.[265] Therefore, the distribution of the costs will be a growing issue in the coming decades, generating the need for proper adaptation to lower the risks and follow up costs.

The social impacts of the German mitigation policy are also primarily related to the additional costs. Prices for energy and heating are already considered to be high, and although the public opinion generally supports the drop out from nuclear energy supply and its replacement through renewable energies, increasing energy costs are considered to cause social and economic problems. The president of the federation of the German industry (BDI – *Bundesverband der deutschen Industrie*) said in an interview in November 2011 that companies in Germany are very concerned about the increasing energy costs and that this factor might be even more important for the economic outlook than the ongoing financial crisis in Europe.[266]

An overwhelming social and political issue is public acceptance. Although, public support for climate change mitigation is given, the implementation of concrete measures can be a political challenge, especially regarding the construction of the necessary infrastructure, like electricity lines which are needed for the (more decentralized) energy supply through renewable energies. Already, there are 149 construction projects scheduled to start by 2014. A newspaper report from November 2011, however, stated that already 73 of them are delayed due to bureaucratic approval procedures and lawsuits.[267] Since more electrical lines and voltage transformation substations are needed, local action groups have already formed in protest at places where such infrastructure is meant to be built, like in Bielefeld.

[264] GDV, "The Climate Change Challenge – Answers and Demands of German Insurers", 5
[265] GDV, "The Climate Change Challenge – Answers and Demands of German Insurers", 5
[266] Focus Online, „Industrie kritisiert die schleppende Energiewende" http://www.focus.de/finanzen/news/bdi-praesident-keitel-industrie-kritisiert-die-schleppende-energiewende_aid_688455.html (accessed 15.03.2012)
[267] Focus Online, „Probleme beim Netzausbau alarmieren Experten" http://www.focus.de/politik/deutschland/tid-24276/energiewende-probleme-beim-netzausbau-alarmieren-experten_aid_687593.html (accessed 15.03.2012)

Complicating the politics of climate change adaptation and mitigation is that the great majority of bigger infrastructure projects in the last few years were heavily disputed. The most visible example was the conflict around the reconstruction of the main railway station of Stuttgart. The project that was called “Stuttgart 21” was intended to rebuild the station underground in order to enlarge its capacity and shorten travel times. Although it was argued that investments into the railway infrastructure were in accordance with environmental targets, local resistance was catalyzed around the expected negative impacts, at least during the building period. The conflict heavily influenced the state elections in spring 2011, bringing the first Green state prime minister into office. In the end, the issue was resolved by a referendum where the majority approved the project. Although “Stuttgart 21” was not primarily related to environmental and climate change issues, it demonstrates that infrastructure projects have to be handled sensitively and undertake consideration of the local needs and interests. Although the planning laws and regulation in Germany incorporate forms of public participation, these were considered to be too weak and to be not transparent. The lesson learned from the “Stuttgart 21” conflict was that much more communication and local participation is needed to gain public acceptance for infrastructure projects. Therefore, the successful implementation of energy infrastructure will require improved political management.

4.4. Summary

The analysis of the European Union (EU) and Germany has shown that they are in the comfortable situation that their vulnerability to climate change is relatively low, while their capacity for mitigative and adaptive implementation is comparably high. Various adaptation measures are in place, and it seems realistic that the EU as well as Germany will reach their Kyoto targets. One might argue that this depends first of all on the economic wealth of (western) Europe, which allows it to finance costly and extensive adaptation and mitigation measures (e.g. coastal protection).

But beyond this advantage, other aspects are even more important to explain the situation: On the institutional level, the EU’s strength is its high implementation capacity. Legislation that comes from the EU is binding for national legislatures, and the bodies of the Union have the institutional power to enforce the rules and treaty provisions that the member states agreed on. The legal framework defining land ownership, land rights, etc. is well established and also enforced. Another factor is that the EU and the member states have a broad and very detailed knowledge of land use and land conditions. Although designed for other purposes, the CAP not only influenced the Union’s agricultural production, but led to a complete and comprehensive overview of land ownership, agricultural production, market prices, and the shape of forests and dry lands. Based on state-

financed research and assessments, the EU and Germany also have a solid knowledge of vulnerabilities (e.g the shape of coastlines) and potential impacts. This knowledge base allows it to design action plans and adaptation measures that are addressing the aimed targets precisely.

Furthermore, in the formulation of concrete actions, two techniques are favorable for the effectiveness of measures. The first is climate change mainstreaming, meaning that European and German strategies have always defined climate change mitigation and adaptation as overarching issues that cannot be addressed merely by a single law or regulation, but have to be included in the consideration process of wider policy areas that affect land use and environmental issues. Secondly, examples like the ICZM demonstrate that effectiveness as well as acceptance of adaptation measures can be increased if relevant stakeholders are included in the planning and implementation process.

Of course it is generally facilitating the implementation that Europe has a strong commitment to the combat against climate change and that this is also widely accepted and supported in European public. Therefore, policymakers have more flexibility in pursuing publically-funded climate change mitigation and adaptation measures, even despite some higher costs for the European public. Although, it can be understood that such public acceptance is limited when it comes to high increases in personal expenses (e.g. higher fuel prices). At this point, there are still open questions, especially regarding the social balance of increasing costs for energy or fuel that were not addressed properly yet.

A shortcoming of the EU's climate change policy is that the Union has not yet agreed on common strategies in some relevant fields. This particularly refers to the field of energy policy where a common approach and effective action is hindered due to contrasting national interests. The examples discussed for Germany, furthermore, show that the public demand for extensive participation and a tendency to oppose against concrete infrastructure projects might also hinder the implementation of effective policies. Although public support is evident as said, it has not been proved yet, if the (western) European societies can manage the implementation of measures that demand painful decisions.

Chapter 5

The NAFTA and its member states

NAFTA institutions and policies

The United States

Canada and Mexico

5.1. The North American Free Trade Agreement (NAFTA)

When the North American Free Trade Agreement was signed by the United States of America, Mexico, and Canada in 1994, environmental issues were identified as a key concern to be ratified. Within the context of liberalizing trade and investment rules, the issue of environmental standards, including air and water pollution controls, and resource harvesting practices[268], was raised as potential contributors to nontariff trade barriers. Parallel to shaping trade liberalization, the question of whether a country's weaker environmental protection measures or its ineffective enforcement would drive other countries towards lax standards needed to be considered. Critics believed that a paucity of environmental standards would create an unfair competitive advantage and lead businesses to relocate production to the least regulated country. Although significant debate occurred over whether NAFTA was the appropriate forum for applying stricter environmental regulations, negotiators ultimately included language nominally intended to enforce stringent environmental, health, and safety standards for products and production. In September 1993, The NAFTA accords were supported by the North American Agreement for Environmental Cooperation (NAAEC) followed by the establishment of the Commission for Environmental Cooperation (CEC) as the leading institutional framework for furthering environmental cooperation. [269]

Critics in the United States Environment and Natural Resources Policy Division have called attention to the fact that the included environmental measures are inconsistent with other NAFTA regulations such as supporting conditionally to protect a party's stricter environmental standards, while simultaneously promoting the lowering of standards to encourage investment. Thus far, the imposed regulations have not coerced any of the involved countries into changing its own levels of environmental protection. Additionally, the regulations have been cited as supporting companies in challenging environmental measures that are viewed as interfering with investments. To effectively implement environmental enforcement on a regional level, reforms would need to include further harmonization of standards, incentives for the parties to integrate environmental protection, and sustainable development policy to abide by during economic decision-making.

Despite these challenges, there are NAFTA structures in place that are given the task of regulating legal and institutional frameworks to cope with climate change and more specifically for the research purposes, land issues. The three NAFTA partners do share a common environment in North America

[268] Tiemann, Mary . U.S. Department of State, "NAFTA: Related Environmental Issues and Initiatives." Last modified March, 2000. http://fpc.state.gov/6143.htm Section: NAFTA Environmental Provisions
[269] Secretariat of the Commission for Environmental Cooperation (CEC), "The Environmental Potential and Performance of the NAFTA Free Trade Commission and Related Bodies." Last modified 1997, http://www.cec.org/Storage/42/3469_NAFTen_EN.pdf

and have expressed mutual interests in harmonizing climate policy. It has also become more than apparent that human activities, i.e. urban and industrial settlements, have altered the landscapes of North America and have significantly impacted their respective environments. Changes in land use and land cover have been identified as having serious effects on many aspects of environmental stability and the services provided by ecosystems, furthering the effects of climate change. In turn, the communities and inhabitants that depend on this land are starkly impacted. More specifically this includes those who are apart of agricultural or foresting communities that rely on the land for survival or those that are disadvantaged or impoverished minorities, which are more susceptible to the changes in their environment.

5.1.1. Projected Climate Change Impacts and Land Use in North America

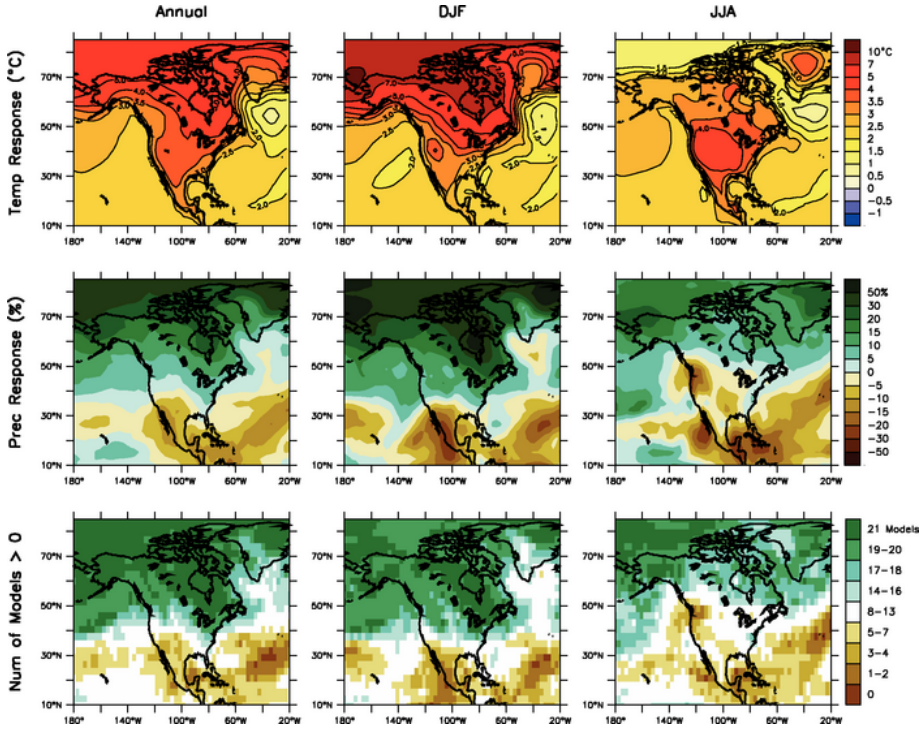
North America, covering a vast area of approximately 25 million square kilometers from the Arctic Circle to the Tropic of Cancer, from the Aleutian Islands in the West to the Canadian Maritimes in the East,[270] has a wide range of different regional climates. Due to this there is also a wide variety of impacts of climate change on this region. In general there are the following major impacts on North America:

- Caused by sea level rise, there will be an increase in inundations, storm surge flooding, and shoreline erosion, which will have an effect on people living on the coast and on coastal ecosystems like salt marshes.
- Furthermore, insect outbreaks and increasing wildfires are likely to intensify.
- Other major impacts of climate change in North America will be the increased risk of death caused by heat waves, water-borne diseases, degraded water quality, respiratory illness, and vector-borne infectious diseases.
- Also the availability of water has become a problem due to diminishing snowfields which will add to the pressure on the availability of the ground water.[271]

[270] **IPCC (ed.), "Special Reports on Climate Change - The Regional Impacts of Climate Change",** Chapter 8**,** http://www.grida.no/publications/other/ipcc_sr/?src=/climate/ipcc/regional/173.htm (accessed March 26, 2012)

[271] "Impacts of Climate Change - Impacts in North America", http://know.climateofconcern.org/index.php?option=com_content&task=article&id=109 (accessed March 26, 2012)

Figure 5.I: Temperature and precipitation changes over North America



Top row: Annual mean, DJF and JJA temperature change between 1980 to 1999 and 2080 to 2099, averaged over 21 models. Middle row: same as top, but for fractional change in precipitation. Bottom row: number of models out of 21 that project increases in precipitation.

Source: IPCC (ed.). "Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change", Chapter 11 (Cambridge: Cambridge University Press, 2007), 890

During this century all of North America is likely to warm up with a projected magnitude increase nearly linearly with time.[272] The surface air temperature warming is projected to vary from 2°C to 3°C along the western, southern and eastern continental edges and to reach more than 5°C in the northern region.[273] The warming in the northern regions is likely to be largest in winter and in the southwest USA largest in summer. In northern North America the lowest winter temperatures are likely to increase the most in the southwest USA the highest summer temperatures are likely to increase the most.

[272] IPCC (ed.). "Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change", Chapter 11 (Cambridge: Cambridge University Press, 2007), 889
[273] IPCC (ed.). "Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change", Chapter 11, 889

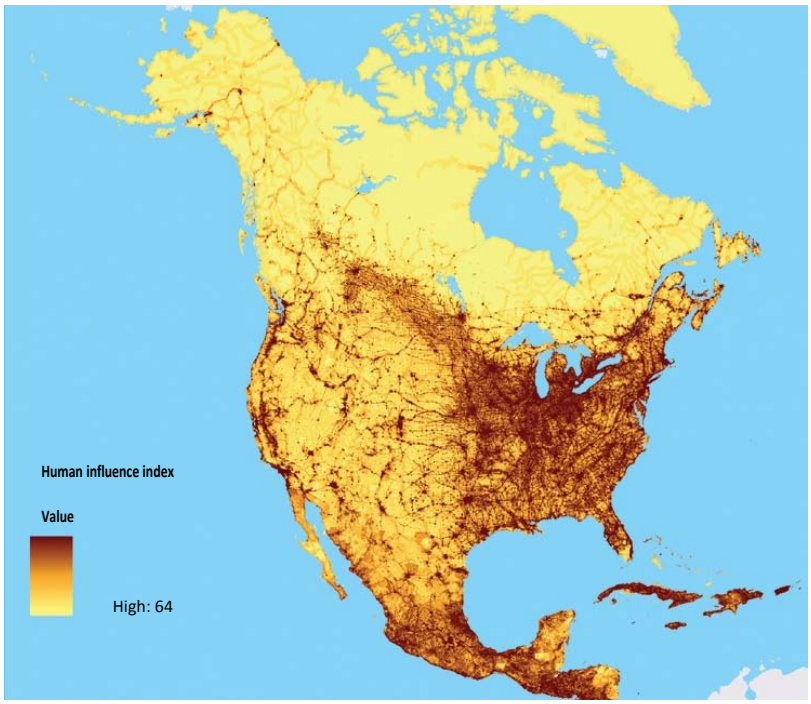
The most extensive warming occurrence is projected for the winter over the northern parts of Canada and Alaska, up to 10°C in the northernmost parts.[274] According to the report "Climate Change 2007: Working Group I" there are uncertainties in the regional climate changes in North America. In the far northeastern part of North America cooling cannot be ruled out completely.[275] There is the expectation that the projected warming will be accompanied by atmospheric moisture flux increase and its convergence and divergence intensity. A general precipitation increase over most of the continent, except the most south-westerly part and over Mexico, will be the result. Furthermore it is likely that the precipitation in southern Canada will increase in winter and spring but decrease in summer.[276]

In North America, humans have extensively altered natural land cover, resulting in changes of vital ecosystem services. As determined by the Commission for Environmental Cooperation of NAFTA, the most important human alterations of the natural land cover include "widespread changes that have reduced and disturbed forested areas, native grasslands and wetlands to allow farming, ranching, resource extraction and human settlements".[277] Although around 16% of North America is protected by nationally mandated nature reserves, there continues to be encroaching human activities. Current annual changes are minor but the rates of deforestation and urbanization in certain areas are affecting local ecological systems and global climate.

Forests cover about one-third of North America's land area with a significant diversity of forest types including boreal, temperate and tropical. North America has almost 20% of the world's forests and over one-third of its boreal forests.[278] Since 1990, Canada has experienced an increase in forested area of less than 1%, and in the United States forest cover has increased by about 1.5%. Contrastingly, in Mexico, between 3.5 and 5 million hectares of temperate and tropical forests have been destroyed.

[274] IPCC (ed.). "Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change", Chapter 11 (Cambridge: Cambridge University Press, 2007), 890
[275] IPCC (ed.). "Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change", Chapter 11, 887
[276] IPCC (ed.). "Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change", Chapter 11, 887
[277] Commission for Environmental Cooperation, "Land Use", 1, http://www.cec.org/Storage/32/2358_SOE_landUse_en.pdf (accessed March 27, 2012)
[278] Commission for Environmental Cooperation, "Land Use", 1, http://www.cec.org/Storage/32/2358_SOE_landUse_en.pdf (accessed March 27, 2012)

Figure 5.II: Human influence index for North America (2000)



Source: Center for International Earth Science Information Network and Wildlife Conservation, Last of the Wild Data Version 2, 2005 (LWP-2): Global Human Influence Index.

In the United States, almost half of all forests are considered highly fragmented or located between boundaries of natural forests and disturbed or developed land. Fragmentation is often responsible for dislocating ecological processes and habitats. In Mexico, the structure and composition of the forests continue to be reduced and affected by the selective removal of certain tree species and by the widespread alteration of forests to pasture.

Agriculture is conducted on almost a third of North America's land surface. Although North America contains only 12% of the world's land used for agriculture, it produces almost 20% of the world's grains and meat. Since 1990, the overall amount of land utilized for agriculture in North America has declined by about 1.5%. However, although growth rates have slowed in the last 50 to 60 years, Mexico's agricultural land use continued to expand by 3.5% a year after 1990 and remains a major contributor to land transformation. In Canada and the United States, the amount of land crops has also declined since the 1950s; however, the environmental effects of agricultural practices are

colossal. Farming is the leading source of pollution in Canada, Mexico, and the United States.[279] Excessive nutrient loading from fertilizer has created a bubble of hypoxia in the northern Gulf of Mexico, leading to vast ecological stress and the death of aquatic organisms. Furthermore, the extreme application of nitrogen contributes to high soil salinity and the presence of pollution in the ozone. It destroys the growth of forests, acidizes water sources, and disintegrates coastal waters and ecosystems through algae blooms and groundwater pollution. It has also led to significant losses of biodiversity, especially species such as grassland birds, bison, prairie dogs and the black-footed ferret.[280] Intensive farming and agribusiness requires using large amounts of energy input to produce, transport, and apply chemical fertilizers/pesticides which furthers the affects of climate change.

Wetlands, including include swamps, bogs and marshes, account for over 10% of North America's surface area and around 40% of the wetland area worldwide. In the United States, almost half of all wetlands have been drained since European settlement while in Canada only 14% of wetlands have been lost. In both countries, agriculture has been identified as the main cause of wetland loss. However, in recent years, urban and suburban developments have become the leading cause. In Mexico, wetland area is estimated at 36,000 km^2, and the country is estimated to have lost 16,000 km^2since earliest records. Causes of Mexico's wetland losses include the building oil infrastructure, urban and tourist development, livestock production and aquaculture.[281]

Human and urban settlements such as cities, towns, and suburbs are estimated to take up almost 5% of the total continental land area. Urban settlements have taken over many traditional agricultural areas, leading to significant changes in land use. Around half of current urban areas in Canada were once agricultural land. From 1982 to 2002, the area of both urban and industrially developed land in the United States has increased rapidly, growing at a rate of 47%. In Mexico, 995 km^2 were converted to urban uses between 1993 and 2000. The losses not only include agricultural land, but deforestation, disappearing wetlands, grasslands and other wildlife habitats. Other side impacts include the spread of wind-driven, wild land fires which can become out of control at a high speed, quickly spreading from the forest to communities.

[279] Audley, John J. et al. "NAFTA's Promise and Reality: Lessons from Mexico for the Hemisphere" (Carnegie Endowment for International Peace, 2004), 67
[280] Commission for Environmental Cooperation, "Land Use", 2, http://www.cec.org/Storage/32/2358_SOE_landUse_en.pdf (accessed March 27, 2012)
[281] Commission for Environmental Cooperation, "Land Use", 2, http://www.cec.org/Storage/32/2358_SOE_landUse_en.pdf (accessed March 27, 2012)

5.1.2 NAFTA's Institutional Framework

During the stages of negotiation (1986 – 1993), the inclusion of environmental provisions was raised after U.S. representatives speculated that lenient enforcement of environmental laws in Mexico would provide an added incentive for U.S. industries to relocate, consequently leading to U.S. job losses.[282] Additional worries included a potential decrease in competitiveness of U.S. products and increasing border-area environmental damage. While some argued that regulation would increase cooperation on environmental matters throughout North America and increase Mexico's resources available for environmental protection, opponents argued that further provisions might increase the regulatory burden on businesses. In January 1993, William Jefferson Clinton became President of the United States and attempted to reduce opposition to NAFTA by implementing side accords on environmental and labor issues. In September 1993, the three NAFTA governments agreed to the side accords and signed the North American Agreement on Environmental Cooperation (NAAEC), which includes provisions to address a party's failure to enforce environmental laws. The side agreements focused on adhering to environmental laws and regulations, fostering protection, and avoiding the creation of trade distortions or new trade barriers.[283] The NAAC was created to signify that the North American countries were not only committed to the liberalization of trade and economic growth but that industrial growth would be accompanied by continuous improvement in the environmental protection. To support the side accords, a dispute settlement process was established within the NAAEC, which reserves the right to impose monetary assessments and sanctions if necessary. To carry out a dispute settlement, "a complaint must concern a party's persistent, systematic failure to enforce its laws, and the alleged failure must be trade-related or involve competing goods or services. Only the NAFTA parties can initiate a NAAEC dispute settlement proceeding".[284]

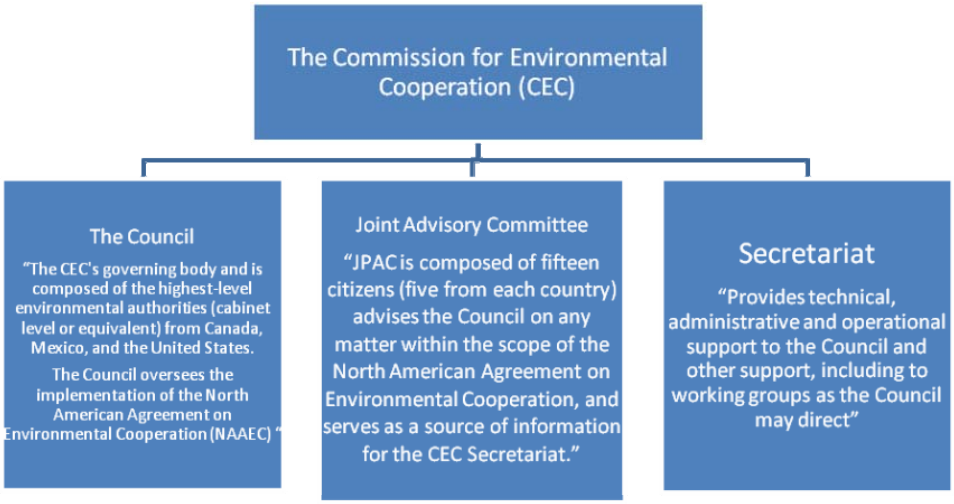
The Commission for Environmental Cooperation (CEC)

The Commission for Environmental Cooperation (CEC) was established to implement the NAAEC and utilizes what is entitled "The Law and Policy Program." The CEC is comprised of a Council, a Joint Advisory Committee, and an independent Secretariat. The Council is composed of cabinet level

[282] Tiemann, Mary, U.S. Department of State, "NAFTA: Related Environmental Issues and Initiatives", Section: North American Agreement on Environmental Cooperation, Last modified March, 2000, http://fpc.state.gov/6143.htm (accessed March, 27 2012)
[283] Tiemann, Mary, U.S. Department of State, "NAFTA: Related Environmental Issues and Initiatives" Section: North American Agreement on Environmental Cooperation, Last modified March, 2000, http://fpc.state.gov/6143.htm (accessed 27, March 2012)
[284] Tiemann, Mary, U.S. Department of State, "NAFTA: Related Environmental Issues and Initiatives" Section: North American Agreement on Environmental Cooperation, Last modified March, 2000, http://fpc.state.gov/6143.htm (accessed 27, March 2012)

representatives of the parties and is delegated with managing the accord's dispute settlement provisions. The Joint Advisory Committee is comprised of nongovernmental organizations, and it advises the Council. The Secretariat's key responsibilities include preparing reports and serving as a resource to the public so anyone may express NAFTA's possible environmental affects. The Secretariat may also consider a submission from any non-governmental organization or person claiming that a party has failed to enforce its environmental law and may request that party to respond.

Figure 5.III: The structure of the Commission for Environmental Cooperation



Source: Commission for Environmental Cooperation (CEC), "About the Commission", Sections: The Council, Joint Advisory Committee, Secretariat, http://www.cec.org/Page.asp?PageID=924&SiteNodeID=310 (accessed March 27, 2012)

The CEC's objective is to broaden environmental cooperation among the parties, including the development and improvement of environmental laws and regulations, as well as promoting congruent, *voluntary* standards in the private sector. It provides a medium for the parties to objectively address multi-lateral environmental issues and to obtain environmental expertise in order to facilitate dispute resolution. These goals are supported by the objective to create compatible technical regulations, standards and conformity assessment procedures consistent with NAFTA. [285]

[285] United Nations Environment Programme, "The North American Agreement on Environmental Cooperation (NAAEC)", http://www.unep.org/dec/onlinemanual/Enforcement/InternationalCooperation/ConsistencyinLawsRegulations/Resource/tabid/1151/Default.aspx (accessed 27, March 2012)

One of the CEC's notable projects was working to develop a methodology to evaluate the positive and/or negative environmental effects of NAFTA. The CEC is mandated to conduct ongoing retroactive environmental law assessments. Despite attempts to identify and empirically document environmental quality changes and policy trends linked to trade liberalization, it was determined that many of the original environmental effects hypotheses were found to be overly speculative and unable to be proved. Toxic pollutants were the only serious impacts that were identified.[286]

What the CEC could determine was a general conclusion that industry relocation is only remotely influenced by environmental regulations, however other factors including wages, market proximity, infrastructure and fiscal policy etc., have shown to have a greater stimulus on the choice of location. "Environmental impacts of NAFTA are neither very bad nor very good, and that they vary considerably from one sector to the next and from one region to another."[287] It was also noted that key stake holders such as government officials' as well as private sector and international experts were disengaged from CEC engagement and outreach efforts which was found to be linked to the perception that the information and conferences did not provide ready-to-use policy recommendations.[288]

Another example of the CEC's projects is the North American Environmental Atlas.[289] The atlas maps North America's shared environment in order to depict continental environmental issues such as watersheds, terrestrial and marine eco-regions, protected areas, industrial pollution, human impact, transportation, and waterways. Through the collaboration of Natural Resources Canada, the United States Geological Survey, and Mexico's Instituto Nacional de Estadística y Geografía, this data is used to solidify environmental priorities, track cross-border pollution, monitor carbon emissions from transportation, and predict the spread of invasive species.[290]

In 1997, the CEC received pressure from private groups to implement Environmental Management Systems ("EMSs") as a systems-based approach to improving an organization's environmental

[286] Reinert, Kenneth A., and David W. Roland-Holst, Commission for Environmental Cooperation (CEC, 2000), "The Industrial Pollution Impacts of NAFTA: Some Preliminary Results.", 1, http://www.cec.org/programs_projects/trade_environ_econ/pdfs/Reinert.pdf (accessed March 27, 2012)
[287] Mayrand, Karel, Marc Paquin, and Sarah Gagnon-Turcotte, "Environmental Assessment of NAFTA: Lessons Learned from CEC's Trade and Environment Symposia", Background Paper for the Experts Roundtable JPAC Public Session (Secretariat of CEC, 2008), 7
[288] Mayrand, Karel, Marc Paquin, and Sarah Gagnon-Turcotte, "Environmental Assessment of NAFTA: Lessons Learned from CEC's Trade and Environment Symposia", Background Paper for the Experts Roundtable JPAC Public Session (Secretariat of CEC, 2008), 8
[289] Commission for Environmental Cooperation (CEC), "Maps Without Borders: The North American Environmental Atlas", http://www.cec.org/Page.asp?PageID=924&SiteNodeID=495&AA_SiteLanguageID=1 (accessed March 27, 2012)
[290] Commission for Environmental Cooperation (CEC), "North American Environmental Law and Policy", Last modified 1998

management. For example, implementing the International Organization for Standardization ("ISO") Standard 14001, standardizing requirements for certification, registration, or self-declaration of an organization's environmental management system. The ISO 14001 is charged with identifying and controlling the environmental impact of applied activities, products or services. The EMS would be implemented to improve a company's environmental performance, and to utilize a systematic approach to setting and achieving environmental objectives and targets.[291] Private organizations wanted to see the CEC endorse EMS as a tool for public policy, including government enforcement and compliance programs. This request was followed by widespread objections by those working in industry and government. Subsequent to the controversy, the CEC released the statement:

Governments must retain the primary role in establishing environmental standards and verifying and enforcing compliance with laws and regulations. Strong and effective governmental programs to enforce environmental laws and regulations are essential to ensure the protection of public health and the environment. Voluntary compliance programs and initiatives developed by governments can supplement strong and effective enforcement of environmental laws and regulations, can encourage mutual trust between regulated entities and government, and can facilitate achievement of common environmental protection goals.[292]

Although the CEC is charged with facilitating cooperation, resolving disputes and providing recommendations for future cooperative action in this area, it is not able to enforce any law that overrides domestic requirements and sovereignty. In 2000, an updated CEC methodology was established: The Analytic Framework for Assessing the Environmental Effects of the North American Free Trade Agreement. The framework is meant for individuals, institutions and governments to better understanding the link between environmental and trade policies and to focus the analysis of environmental impact. The framework contains six criteria:

1) Does NAFTA reinforce existing patterns of comparative advantage and specialization to the benefit of efficiency?
2) Does NAFTA trade liberalization lead to a regulatory/migratory "race-to-the-bottom"?
3) Does NAFTA give rise to competitive pressures for capital and technological modernization?
4) Do liberalized rules under NAFTA serve to increase the use of environmentally friendly products?
5) Does NAFTA lead to upward convergence of environmental practice and regulation through activities of the private sector?

[291] International Organization for Standardization, "ISO 14000 Essentials." http://www.iso.org/iso/iso_14000_essentials (accessed March 28, 2012)
[292] Commission for Environmental Cooperation (CEC), "North American Environmental Law and Policy", Last modified 1998

6) Does NAFTA lead to upward convergence of environmental practice and regulation through activities of the various levels of government, and if so, how?"[293]

From 2000-2010, this Analytical Framework was applied in three case studies: an examination of Mexican corn, beef production in the both the United States and Canada, and the electricity market in all three countries.[294]

The North American Development Bank

Bilaterally, the United States and Mexico agreed in October 1993 to additionally create an institutional framework to support border environmental cleanup, address human health, or environmental needs. The two parties ratified The Border Environment Cooperation Agreement which led to the establishment of the North American Development Bank (NADBank) and the Border Environment Cooperation Commission (BECC). The BECC is intended to help both nations and border communities coordinate, design, and mobilize financing for environmental infrastructure projects. The NADBank evaluates the financial feasibility of these projects and provides the appropriate funding. The BECC Board of Directors is made up of public constituents and is aided by an 18-member Advisory Council. In addition, the public is to be notified of and permitted to comment on proposed projects.[295]

The NADBank is expected to generate between US$2 -3 billion in loans and guarantees for financing border environmental projects. The United States and Mexico each contributed US$225 million over four years to support the financing. As set by the charter, 90% of NADB's authorized capital is used to finance infrastructure projects in the border region, and 10% of the capital finances community adjustment and investment throughout the United States and Mexico. Accordingly, of the US$450 million in paid-in capital, US$405 million is reserved for the environmental infrastructure border programs, while the remaining US$45 million was evenly divided between the two countries for their respective domestic program. Projects include actions relating to wastewater collection, treatment and reuse, water conservation, storm drainage and flood control, sanitary landfills, collection and disposal equipment, dumpsite closure, recycling, solar, wind, biogas and biofuels, hydroelectric, geothermal, public transportation, street paving and roadway improvements, bypasses and ports of

[293] Gehring, Prof. Markus W. Cambridge University / University of Ottawa Faculty of Law, "Sustainability Impact Assessment of Trade Agreements in the Americas: A Tool for Sustainable Development", Eco-Health in the Americas Legal Working Paper Series (2010), 7

[294] Commission for Environmental Cooperation, First. "Analytic Framework for Assessing the Environmental Effects of the North American Free Trade Agreement" (1999), 1-122

[295] The Border Environment Cooperation Commission (BECC) and the North American Development Bank (NADB), "Successful Bi-National Cooperation", http://www.cocef.org/english/GInformation/Index.html, (accessed March 28, 2012)

entry, emissions reduction and methane capture, treatment and disposal facilities, industrial site remediation, equipment replacement, and public lighting and building retrofits.[296] In 1997, the NADBank entered into a cooperative agreement with the Environmental Protection Agency (EPA), after which the EPA contributed US$170 million to the Border Environment Infrastructure Fund established by the Bank. The fund is used to administer grant resources for border water and wastewater projects as well. To qualify for EPA grant funding, a project must be BECC-certified and approved by EPA; it may be located on either side of the border.

Canada and the United States have a long history of bilateral environmental cooperation. Past treaties before NAFTA include the Boundary Waters Treaty of 1909, the Trail Smelter Arbitration of 1941, the Great Lakes Water Quality Agreement of 1978, as amended, the Memorandum of Intent Concerning Transboundary Air Pollution of 1980, the 1986 Joint Report of the Special Envoys on Acid Rain, as well as the ECE Convention on Long-Range Transboundary Air Pollution of 1979. In 1991, and later supported by NAFTA, the United States and Canada entered into an agreement to address trans-boundary air pollution stemming from industrial activities. Both nations agreed that pollutants released at one location can travel long distances, therefore affecting air quality at its sources as well as adjoining border countries. The 1991 bilateral Agreement led to reductions in acid rain in the 1990s, and was expanded in 2000 to reduce trans-boundary smog emissions under the Ozone Annex. In 2011, the two countries celebrated that due the Air Quality Agreement, the U.S. national Acid Rain Program reduced emissions of sulfur dioxide by 67% from 1990 levels. Power plant emissions of nitrogen oxides decreased by over two-thirds from 1990 to 2010, emissions causing acid rain has been cut in half and emissions causing smog were cut by one-third in the protected region.[297]

In addition to the NAAEC / CEC's responsibilities and bilateral agreements, the NAFTA text itself contains a variety of environmental protection and sustainable development objectives: more specifically, mandating institutions to extend its activities to address identified environmental challenges and reduce the impacts of climate change. NAFTA created a ministerial-level Free Trade Commission, supported by a network of at least 39 committees, subcommittees, working groups and subgroups, many of which have distinct and direct relevance to a variety of environmental concerns. This includes: air quality, automotive and energy-generation, emissions, water quality and pesticide use, wildlife habitats and relevant to this paper, land quality, agricultural and transportation

[296] Schot, Jeffrey , and Meera Ficklin, " Revisiting the NAFTA Agenda on Climate Chang", Policy Brief 10 - 19 (2010), 1-11
[297] U.S. Environmental Protection Agency, "U.S.-Canada Air Quality Agreement." http://www.epa.gov/airmarkets/progsregs/usca/index.htm (accessed March 28, 2012)

practices. In 1997, The CEC, during its analysis of the effects of NAFTA, submitted a report on its Committee on Standards-Related Measures and its major environmentally mandated bodies. Several conclusions were made, including on the effectiveness of the land related working groups.

The Committee with ties to the land, and deemed most environmentally conscious, was the Land Transportation Standards Subcommittee Working Group on the Transportation of Dangerous Goods (LTSS V). LTSS V is responsible for environmentally damaging materials such as halogenated organic chlorides (HOCs), polychlorinated biphenyls (PCBs), carbon tetrachloride, and radioactive wastes. As related to land, through the harmonization of the three Parties regulations regarding hazardous materials transport, the avoidance of environmental tanker accidents and oil spills, abandoned waste sites, and industrial accidents and hazardous waste management, is achieved.[298]

The LTSS V has established a long-term vision and has several concrete accomplishments including its Emergency Response Guidebook, based on an example from the *United Nations Economic Commission for Europe* (ECE) Working Paper Number 29. The guidebook is used by the three NAFTA countries in dealing with emergencies stemming from the transport of dangerous substances and the group's work with the Mexican authorities to develop environmental safety regulations compatible with those of Canada and the United States. The guide includes a comprehensive list of all the materials transported in or among Canada, the United States and Mexico. It also includes a detailed explanation of the potential hazards in case of an accident, the emergency measures to be used for each dangerous material, and the steps that should be taken in case listed substances come into contact with humans. As part of the NAFTA technical barriers to trade (Article XI of the GATT)[299], has agreed to comply with standards-related measures to protect human, animal and plant life or health as specifically related to the environment or consumers.

Of the many agricultural committees and component bodies reporting to the NAFTA's Free Trade Commission, there are three that have a direct/indirect environmental relevance to land: the Committee on Sanitary and Phytosanitary Standards (CSPS), the Technical Working Group on Pesticides and the Committee on Agricultural Trade. The Committee on Sanitary and Phytosanitary Standards was praised for meeting regularly and successfully mitigating problems arising among the three countries, in part within its nine technical working groups. The Technical Working Group on Pesticides was specifically recognized as keeping up with NAFTA's broader sustainable development

[298] Jacott, Marisa, Cyrus Reed, and Mark Winfield, "The Generation and Management of Hazardous Wastes and Transboundary Hazardous Waste Shipments between Mexico, Canada and the United States, 1990–2000", 76-80

[299] Jacott, Marisa, Cyrus Reed, and Mark Winfield, "The Generation and Management of Hazardous Wastes and Transboundary Hazardous Waste Shipments between Mexico, Canada and the United States, 1990–2000", 8

goals. On the other hand, the Committee on Agricultural Trade, which is responsible for agricultural issues on a policy level (such as subsidies), was ineffective in incorporating basic sustainable development principles or even recognizing the importance of the environmental dimension in its tenure. The Committee on Agricultural Trade and their subordinate bodies maintained that it is only their responsibility to address barriers to trade, primarily for agricultural and livestock products from and to Mexico, so Mexicans can maintain access to markets that are critical to their economy. [300]

These subcommittees provide an example of how if NAFTA was able to enforce the mandate that institutions address the identified environmental challenges, then infrastructure such as the NAAC and CEC would have a more successful effect. The Free Trade Commission could serve as a strong foundation for lessening factors stemming from liberalization that trigger climate change. The few committees that exemplify success in including environmental provisions prove it is possible to implement these measures. NAFTA's environmental institutions have valuable functions but are insufficiently applying those functions to reduce the pressures on the environment arising from increased trade. Once again, it appears that NAFTA neglects to utilize interagency cooperation and prioritize the importance of climate change impacts.

5.1.3. Impact of NAFTAs policies on Land Use

The development of land use in Mexico provides an example of the impacts NAFTA had on the national land use, resulting in land degradation, furthering climate change. According to government-supplied figures, some 65% of the land area is impacted, while using the FAO data (Table 2) 45% of the country (874,000 km²) is severely or very severely degraded.

When NAFTA was established, a positive expectation was that non-tariff trading could increase Mexico's resources available for environmental protection, however the accelerated NAFTA liberalization led Mexico to phase out tariff-rate quotas for maize too quickly, leading commodity prices to collapse and poverty to increase for the 18 million people who depend on maize. This forced rural farmers to expand into more marginal land to compensate for price declines which led to deforestation at a rate of 630,000 hectares per year, followed by illegal logging for poor-income household's fuel use.[301]

[300] Commission for Environmental Cooperation (CEC), "NAFTA's Institutions The Environmental Potential and Performance of the NAFTA Free Trade Commission and Related Bodies", (Secretariat of CEC, 1997), 46
[301] Audley, John J. et al. "NAFTA's Promise and Reality: Lessons from Mexico for the Hemisphere" (Carnegie Endowment for International Peace, 2004), 7

The original forest and woodland cover in Mexico was 55% to 57% of the country, of which about 60% remains. Recent data estimates that nationally, deforestation continues at a rate of 0.9-1.3% annually with estimates varying by source.[302] Other survival attempts led to poaching for fuel and food, endangering the existence of some of the most important biological reserves in the hemisphere. [303]

Figure 5.IV: Deforestation in Mexico 1976- 1993

	Total % Loss	Annual % Loss
Temperate Woodlands	15.6	0.92
Humid Forests	36.6	2.15
Sub-humid forests	31.5	1.85

Source: Berry, L., and D. Campbell, "Land Degradation in Mexico: Its Extend and Impact", Global Mechanism, last modified 2009, 10

NAFTA has also accelerated and deepened the structural divide between large-scale export-oriented farms and small-scale local farms. The increased farm subsidy payments given by the Mexican government increased pricing and market failures, resulting in the overproduction of some crops[304]. Over production contributed to the excessive application of fertilizers and pollution, magnifying environmental degradation and was complimented by the expansion of survival farming in marginalized areas in the southern regions of Mexico. With a lack of non-land-based economic opportunities, there continued to be increase in clearance of land for agriculture. This results the continual loss of forest and of the habitat for forest species of flora and fauna. Poverty also led to an abandonment of farms where farmers could no longer afford farm inputs (e.g. fertilizer) and a migration to the frontier resulting in further deforestation.[305]

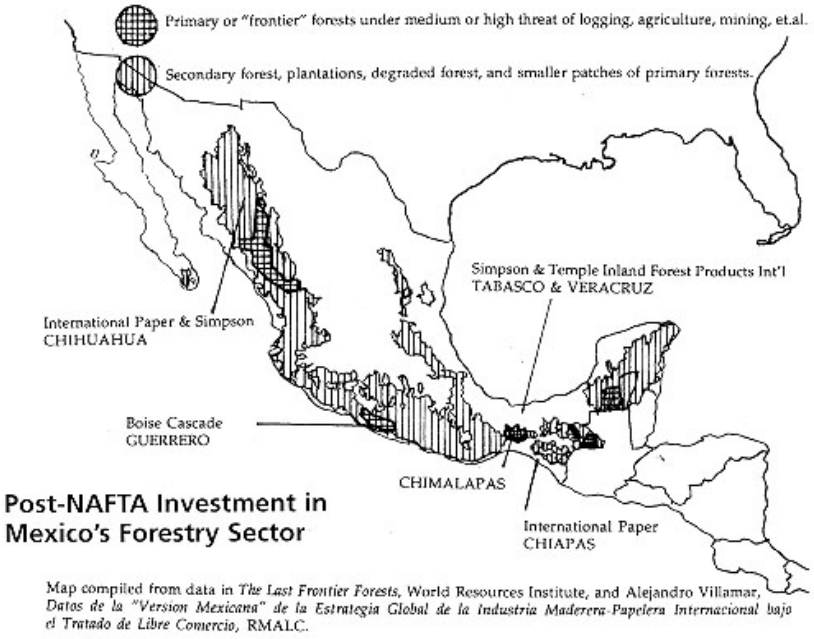
In 1994, due to the collapse of the Peso and the desperation of the Mexican government for foreign investors, The International Paper Corporation was able to influence and reform Mexico's laws governing forest exploitation. The Mexican government awarded The International Paper Corporation federal subsidies and the Environment Secretariat allowed the company to waive protections for biodiversity, soil, and water quality. Simultaneously, The Forest Reform Law was revamped, allowing companies access to private industrial tree plantations. These areas were

[302] Berry Berry, L., and D. Campbell, "Land Degradation in Mexico: Its Extend and Impact" (2009), 10,
[303] Audley, John J. et al. "NAFTA's Promise and Reality: Lessons from Mexico for the Hemisphere" (Carnegie Endowment for International Peace, 2004), 7
[304] Wilkinson, Tracy, "Mexico farm subsidies are going astray", *Los Angeles Times*, March 07, 2010, http://articles.latimes.com/2010/mar/07/world/la-fg-mexico-farm-subsidies7-2010mar07 (accessed March 29, 2012)
[305] Berry, L., and D. Campbell, "Land Degradation in Mexico: Its Extend and Impact", Global Mechanism, last modified 2009, 14

previously closed off as 80% of Mexico's forests were protected as indigenous reserves or part of communal land-holdings. International Paper was able to invest in 100,000 hectares of eucalyptus and pine plantations in Chiapas, an area inhabited by indigenous Mayas. When the Maya's (whom are part of a larger group - Zapatistas) traditional land in Chiapas was taken away, the Zapatistas rebelled, leading to the formation of the Zapatista Army of National Liberation. However, the rebellion was ignored as several U.S. companies – Simpson Corporation, Boise Cascade and Temple Inland Forest Products – continued to set up ventures throughout southern Mexico.

As an example, Boise Cascade exported tropical hardwoods from an area named Guerrero, taking logs from 24 different communal land holdings and planned to export 20 million board feet to the U.S. in their first five years. Local organizations continued to protest, claiming the livelihoods of their members would be seriously threatened by the projects.[306]

Figure 5.V: Post-NAFTA Investment in Mexico's forestry sector



Source: Menotti, Victor, Environment Program at the International Forum on Globalization, "Globalization and the Acceleration of Forest Destruction Since Rio", http://www.ifg.org/programs/forest.htm (accessed March 28, 2012)

[306] Menotti, Victor, Environment Program at the International Forum on Globalization, "Globalization and the Acceleration of Forest Destruction Since Rio", http://www.ifg.org/programs/forest.htm (accessed March 28, 2012)

In June 1995, 17 Zapatista Army of National Liberation members were killed by police while traveling to protest against logging expansions. A year later, to commemorate the anniversary of their deaths, the Popular Revolutionary Army (PDPR-EPR), a leftist guerrilla movement, was formed and announced its condemnation of the economic policies which it said created poverty and despair. PDPR-EPR revealed their plans to declare war against the government. Throughout the last decade, the rebels have launched over a dozen attacks, killing and injuring army, police, government targets and destroying corporate facilities. In July 2007, it was leaked that at least 21 members of the EPR had been kidnapped by government forces after President Calderón came to power.[307]

These developments exemplify that despite NAFTA's target to promote sustainable development, encourage pollution prevention policies and enhancing compliance with environmental laws and regulations, the lack of harmonious and enforced legal provisions (e.g. natural protection laws, cultural protection laws, and land tenure security) had grave implications that could even lead to armed conflicts.

Instead of strengthening the environmental and land protection it seemed that the establishment of NAFTA has rather contributed to rural decline and increased land degradation. Rural migration to frontier areas and encroachment on forestlands has further increased the burden on land. Compounding land degradation with climate change, deforestation and excessive agriculture have a significant amount of environmental affects. Examples include fire danger, damage to crops and soils due to flooding, crop failure and livestock heat stress and even death. As seen in Mexico, there is likely to be a fall in gross regional product and farm incomes. The impact of land losses and changes in land cause rural communities to lose income, which can lead to increased workload, family conflict, and withdrawal from social groups and communities.[308]

Mexico, as the country with the lowest development within NAFTA, has induced a significant portion of industrialization in order to emulate the other two nations. Additionally, in response to NAFTA competitive pressure, Mexico agribusiness has led to an estimated damage of US$36 billion per year in due to pollution, estimated by environmental valuation and green accounting. "This damage to the environment is greater than the economic gains from the growth of trade and of the economy as a

[307] McKinley Jr., James C., "Mexico Plants Still Shut; Army Patrols Pipelines After Blasts", The New York Times, July 12, 2007, http://www.nytimes.com/2007/07/12/world/americas/12mexico.html?_r=1&n=Top/News/World/Countries and Territories/Mexico&orefslogin (accessed March 28, 2012)

[308] Australia's State and Territory Governments, First, "Issues Paper 1 Climate Change: Land use - Agriculture and Forestry", The Garnaut Climate Change Review, 2

whole".[309] If one were to subtract this amount of environmental damages (US$39 billion) from Mexico's gross national product (GNP) and gross domestic product (GDP) estimates (US$30 billion), then Mexico would have an ecological deficit equal to US$9 billion.[310] This would make Mexico, which already less developed than its partners, a net loser of NAFTA integration.

[309] Audley, John J. et al. "NAFTA's Promise and Reality: Lessons from Mexico for the Hemisphere" (Carnegie Endowment for International Peace, 2004), 7
[310] Audley, John J. et al. "NAFTA's Promise and Reality: Lessons from Mexico for the Hemisphere" (Carnegie Endowment for International Peace, 2004), 65

5.2. United States

As a key player in the international community, the indicators and consequences of climate change in the United States have served as a model for the rest of the world. Most notably, the U.S. is known as a top emitter of carbon dioxide (CO_2) fossil fuels. In 2009, the U.S. was the second highest producer of CO_2 worldwide at 5,420 million tons (mt) (17.8% world total)[311], and the second top emitter of all greenhouse gas emissions in 2005, producing 6,930 mt (15.7% of world total). Although CO_2 levels in the U.S. have been declining in the last few years, the United States still stands as a top producing nation in terms of per capita emissions among the big economies, with approximately 18 tons emitted per person.[312] Subsequently, greenhouse gases affect the amount of energy that is absorbed by the atmosphere leading to climate "warming". Average temperatures in the United States have continued to rise since 1901, with an increased rate of warming over the past 30 years. Average global temperatures show a similar warming trend, and 2000– 2009 was the warmest decade on record worldwide.[313] Other indicators of climate change in the U.S. have been reflected in increased heat waves, drought, heavy precipitation, tropical cyclone intensity, rising sea levels, loss of snow cover and an increased growing season time, among others.

The implementation and enforcement of climate change related policies are occurring on both a state and federal level. In an overall sense, the United States has prioritized climate change as having a place within the development agenda including other policy goals such as the alleviation of poverty, the rule of law, investment in people and stable economic institutions. The United States has committed to upholding the United Nations Framework Convention on Climate Change (UNFCCC) (ratified 1992) and has identified the need to take near-term actions, within the context of contributing to economic growth and improving the world's standard of living.[314]

[311] The Guardian, "World carbon dioxide emissions data by country: China speeds ahead of the rest", Last modified January 2011, http://www.guardian.co.uk/news/datablog/2011/jan/31/world-carbon-dioxide-emissions-country-data-co2 (accessed March 29, 2012)
[312] The Guardian , "Which nations are most responsible for climate change?", last modified April 2011, http://www.guardian.co.uk/environment/2011/apr/21/countries-responsible-climate-change?intcmp=122 (accessed March 29, 2012)
[313] United States Environmental Protection Agency, "Climate Change Science Facts" (2010), 2
[314] Watson, Dr. Harlan, "U.S. Climate Change Policy," Presentation: Seminar of Government Experts (2005), 1

5.2.1. Vulnerability

Although there are direct climate change impacts that are equally common to every region of the United States, factors such as specific weather events and effects on ecosystems and habitats change according to region. Some of the impacts of climate change will be irreversible, such as inundation of coastal land areas resulting from sea-level rise or the constrained availability of water due to drought conditions and saltwater intrusion. Other impacts may be just as severe but event-oriented, and potentially repetitive, such as stronger hurricanes, floods, wildfires, and heat waves. The following table outlines the overall direct threatening impacts of climate change in the future of the United States.

Figure 5.VI: Regional Climate Impacts

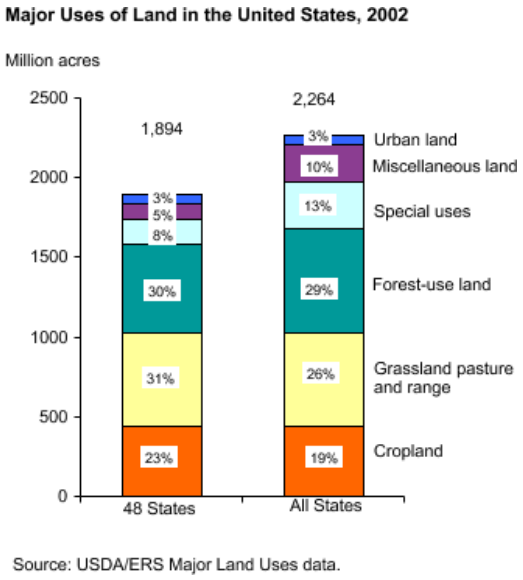
Geographic Region	**Regional Affects**
Northeast Region	• Shorter winters with fewer cold days and more precipitation; significant reductions in the winter snow season • Under higher emissions scenarios, 20 to 30 days in which the high temperature in cities exceeds 100°F; more frequent heat waves; and, on average, six weeks of longer summer conditions • More frequent flooding as a result of sea-level rise and heavy precipitation events • Economic effects including negative impacts on agricultural production, including dairy, fruit, and maple syrup, reduced snow cover adversely affecting winter recreation, and a northward shift of lobster fisheries and diminution of Georges Bank cod fisheries
Southeast Region	• Heat-related stresses for people, plants, and animals • Decreased water availability due to increased temperature and longer periods between rainfall events • Sea-level rise and the potential for increased hurricane intensity, significantly affecting coastal areas and ecosystems
Midwest Region	• In the summertime, increased heat waves and reduced air quality • A longer growing season, potentially generating increased crop yields, provided challenges such as heat waves, floods, and greater numbers and varieties of pests • Increased volatility in precipitation, resulting in more frequent flood and drought conditions • Significant reduction in Great Lakes water levels as a result of higher temperatures that promote greater evaporation, affecting shipping, infrastructure, water-based tourism/recreation, and ecosystems

Great Plains	• Negative impacts on region's water resources resulting from increased temperature and evaporation and frequency of drought • Stresses on agriculture, ranching, and natural lands management resulting from changes in precipitation and higher temperatures • Negative effects on key habitats and ecosystems, especially wetland systems
Southwest Region	• Increasing scarcity of water supply, requiring policy decisions to prioritize allocation among competing uses such as urban populations and agriculture • Increased temperature, drought, and wildfire, significantly affecting ecosystems • Negative effects on tourism/recreation industries, including reduced snowpack in ski resort areas and unique ecosystem degradation
Northwest Region	• Declining snowpack negatively affecting regional water supplies • Higher temperatures increasing risks to forestry from wildfires and insect pests • Negative impacts on coastal areas resulting from sea-level rise • Decreasing habitat for cold-water fish, such as salmon
Alaska	• Higher temperatures increasing risks to forestry from wildfires and insect pests • Longer growing season and longer periods for outdoor tourism due to increasing temperatures • Damages to infrastructure due to thawing permafrost
Islands / Costal Areas	• Negative effects on coastal areas from loss of sea-ice buffers, increasing frequency of strong storms, and thawing permafrost Pacific and Caribbean Islands • Reduction in availability of freshwater supplies due to changing rainfall patterns, including reduced precipitation in the Caribbean region and contaminated groundwater from flooding in the Pacific islands; sea level rise will threaten underground freshwater supplies • Negative effects on marine ecosystems, creating problems for tourism and fisheries industries • Greater frequency of coastal inundation resulting from sea-level rise and increased intensity of storms

Source: U.S. Global Change Research Program, "Global Climate Change Impacts in the United States", L June 2009, 107-149

Land use decisions have played a distinct role in the ratification of United States' climate change policies. In addition to the direct affects of increasing CO_2 and GHGs, private land-use decisions have depended critically on land quality and the anticipated economic returns. These decisions have been significantly affected by the steering and legality confines of public policies.

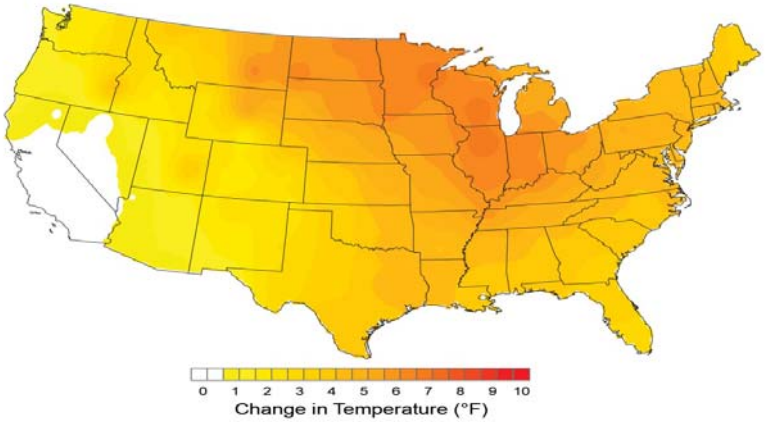
Figure 5.VII: Major Uses of Land in the United States, 2002



Source: United States Department of Agriculture, "Land Use, Value, and Management: Major Uses of Land." http://www.ers.usda.gov/briefing/landuse/majorlandusechapter.htm (accessed March 29, 2012)

Coastal lands have also proved to be some of the most at-risk areas for climate change through the United States, specifically vulnerable to inundation and increased erosion. Thousands of square miles are predicted to be lost in the future and storm damage damages are expected to increase. As exemplified during Hurricane Katrina (known as one of the five deadliest hurricanes in the history of the United States, 2005), some of the most important ecosystems and disadvantaged populations will incur astonishing burdens, particularly in the well-developed and low-lying Atlantic and Gulf of Mexico coasts.

Figure 5.VIII: Change in Temperature



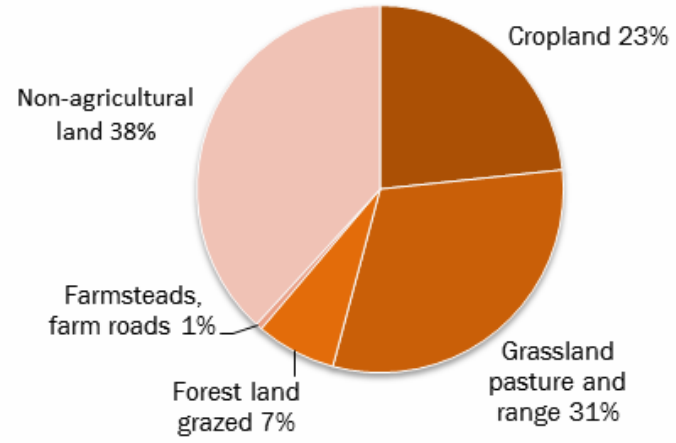
Temperatures are rising faster in winter than in any other season, especially in many key agricultural regions. This allows many insect pests and crop diseases to expand and thrive, creating increasing challenges for agriculture. As indicated by the map, the Midwest and northern Great Plains have experienced increases of more than 7°F in average winter temperatures over the past 30 years.

Source: U.S. Global Change Research Program, "Global Climate Change Impacts in the United States: Agriculture", June 2009, 107-149

Agriculture is one of the most important industries in the United States and the country is a major international net exporter of food. As of the last census of agriculture in 2007, there were 2.2 million farms, covering an area of 922 million acres (3,730,000 km2), and an average of 418 acres (1.69 km2) per farm.[315] The American food industry was estimated to be worth US$ 500 billion in 2011.[316] Agriculture in the United States is extremely diverse in the range of crops grown and animals raised, and is one of the largest producers and exporters of agricultural products worldwide with a 21% share of world farm trade. Therefore, the security of agriculture and the social implications of its success in the United States not only affect Americans, but also potentially the globalized world as a whole.

[315] United States Department of Agriculture, "2007 Census of Agriculture", last modified February 2009
[316] Raghuvanshi, Kulbhushaan, "Importance of Agriculture", http://www.buzzle.com/articles/importance-of-agriculture.html (accessed March 29, 2012)

Figure 5.IX: The U.S. Department of Agriculture classifies 62% of land in the contiguous 48 states as agricultural



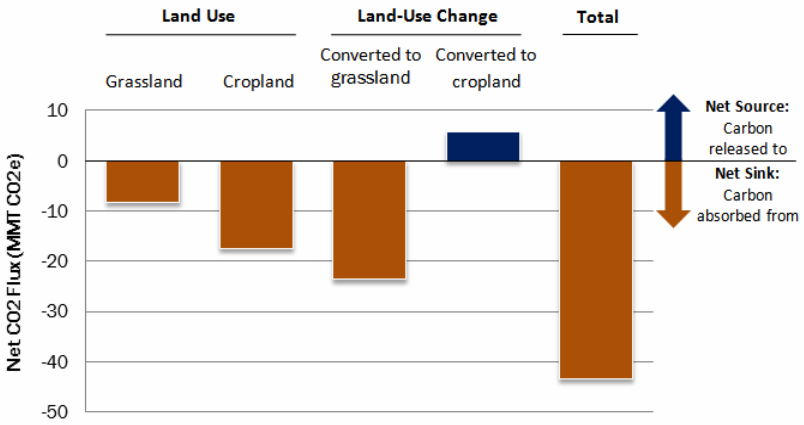
Source: USDA Economic Research Service. Uses of Land in the United States, 2002, Table 1, 2005. http://www.ers.usda.gov/Publications/EIB14/ (accessed March 29, 2012)

Climate change has influenced the American agricultural industry, by increasing productivity in certain crops and regions and reducing productivity in others (see for example Midwest and Great Plains regions). In the future, increased agricultural productivity will be required to supply the needs of an increasing population. However, climate is also affected *by* the agricultural industry. In the United States, agriculture represents 8.6% of the nation's total greenhouse gas emissions, including 80% of its nitrous oxide emissions and 31% of its methane emissions.[317] Specifically in croplands and grasslands, the annual carbon flux values include changes to the amount of carbon stored in soils due to land management and changes in land use, as well as the CO_2 emissions resulting from the application of fertilizers. Land-use practices and land-use cover can create a positive carbon source, contributing to the release of carbon stored in the plants and soil, or create a carbon sink, allowing plants and soil to consume more than they release.[318] Collectively, agricultural lands in the United States act as a carbon sink, storing more carbon than they release (see Figure 3) contributing to the problem of climate change.

[317] U.S. Environmental Protection Agency, 2008,"Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2006", U.S. Environmental Protection Agency, 473, http://www.epa.gov/climatechange/emissions/usinventoryreport.html (accessed March 29, 2012)
[318] EPA, Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2009", 2011, http://www.epa.gov/climatechange/emissions/usinventoryreport.html (accessed March 29, 2012)

Agricultural productivity is dependent upon reacting to climate changes and adapting land resources. Throughout history, the agricultural industry has managed changes in climate through changes in management and in crop or animal selection. A variety of land management practices can help maintain and increase the amount of stored carbon. These practices include agro forestry, improved cropping systems, improved nutrient and water management, conservation tillage, water management, and maintenance of perennial crops. However, under higher heat-trapping gas emissions scenarios, the projected climate changes are likely to over burden the U.S. ability to as efficiently produce food, feed, fuel, and livestock products.

Figure 5.X: Changes in Carbon Storage of Agricultural Land in 2009



Source: EPA, Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2009, Table 7-1, 2011. http://www.epa.gov/climatechange/emissions/usinventoryreport.html (accessed March 29, 2012)

Crop responses in a changing climate reflect the junction of three factors: rising temperatures, changing water resources, and increasing carbon dioxide concentrations. Warming generally causes plants that are below their optimal temperature to grow faster, with understandable benefits. However, for some plants, such as cereal crops, faster growth means there is less time for the grain to grow and mature, exposing crops to the threshold at which quality decreases and vegetable crops fail, as witnessed in corn, wheat, sorghum, bean, rice, cotton, and peanut crops.[319] In periods of drought, without water for cooling, plants will suffer heat stress. In many regions, irrigation water is used to maintain adequate temperature conditions for the growth of cool season plants (such as

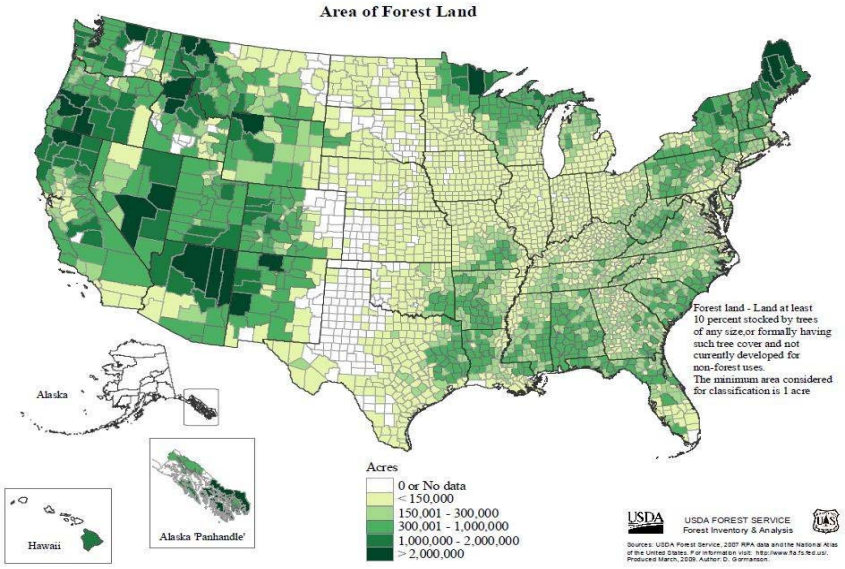
[319] Hatfield, J., et al., "Agriculture" In: *The Effects of Climate Change on Agriculture, Land Resources, Water Resources, and Biodiversity in the United States, Synthesis and Assessment* (U.S. Department of Agriculture, 2008), 21-74

many vegetables). Increase in heavy downpours and field flooding will delay planting or cause crop losses. With increasing competition for freshwater and changes in precipitation patterns, the effects on crops will be critical. Higher carbon dioxide levels generally cause plants to grow larger but this is not necessarily beneficial, as larger crops are often less nutritious, with reduced nitrogen and protein content. Even more so than crops, weeds benefit from increases in CO_2 which contributes to higher levels of diseases and insect pests. Increases in carbon dioxide also reduce the quality of the plant material used to feed livestock, so that animals are not receiving the same nutritional value, resulting in an overall decline in livestock productivity.[320] Decreases in livestock productivity are exacerbated by increases in heat, disease, and weather extremes.

Reacting to climate change in agriculture is one of the largest challenges for U.S. farmers and policy makers. In some cases, adapting to climate change could be as simple as changing planting dates, taking advantage of a longer growing season or avoiding crop exposure to adverse climatic conditions. Another adaptation strategy involves focusing on planting crop varieties with improved tolerance to heat or drought, or those that can be adapted to thrive in longer growing seasons. However, this type of adaption can be extremely expensive and new plantings take several years to reach maximum productivity.[321] The existing knowledge of how climate change and agricultural systems interchangeably function is going to be shifting to predict how agricultural systems will respond to a changing environment, and applying those predictions to managing agricultural systems to society's benefit. One tool researchers are working to utilize is managing the outcome of carbon in agricultural systems, and how long it stays there. These predictions will be based on understanding how different land management practices such as tillage types, crop rotations, fertilizer applications, grazing practices, etc. affect carbon storage in the land.[322] Future research efforts will focus on cost-benefit analysis of development and technologies (for example new seed varieties) that can facilitate farmers' adaptation to weather conditions that may be more variable, hotter, and dryer.

[320] Hatfield, J., et al., "Agriculture" In: *The Effects of Climate Change on Agriculture, Land Resources, Water Resources, and Biodiversity in the United States, Synthesis and Assessment* (U.S. Department of Agriculture: 2008), 21-74.
[321] Hatfield, J., et al., "Agriculture" In: *The Effects of Climate Change on Agriculture, Land Resources, Water Resources, and Biodiversity in the United States, Synthesis and Assessment* (U.S. Department of Agriculture: 2008), 21-74.
[322] United States Department of Agriculture, "Synthesis and Assessment Product 4.3 (SAP 4.3): The Effects of Climate Change on Agriculture, Land Resources, Water Resources, and Biodiversity in the United States", July 15, 2010

Figure 5.XI: Spatial distribution of the nation's forest land in 2007 as a percentage of county land area to county tree density



Source: USDA Forest Inventory and Analysis National Program, "Area of Timberland, 2007." http://www.fia.fs.fed.us/tools-data/maps/2007/descr/tim_land.asp

Forests appear in all 50 states but are most common in the humid eastern United States, the West Coast, and at higher elevations in the Interior West, Southwest and Great Plains. Forested land occupies about 740 million acres, or about one-third of the United States. Forests in the eastern United States cover 380 million acres; most of this land (83%) is privately owned. The 360 million acres of forest land in the western United States are split between public (57 %) and private ownership. The United States is the world's leading producer and consumer of forest products and accounts for about one-fourth of the world's production and consumption. The United States is also the world's largest producer of softwood and hardwood lumber. In 1996, total annual sales for commercial (nonfederal) timber and non-timber forest products were approximately US$3.8 billion. Timber alone accounted for approximately 69% of those sales.[323] Forests provide many ecosystem services, including watershed protection, water quality, and flow regulation, wildlife habitat and

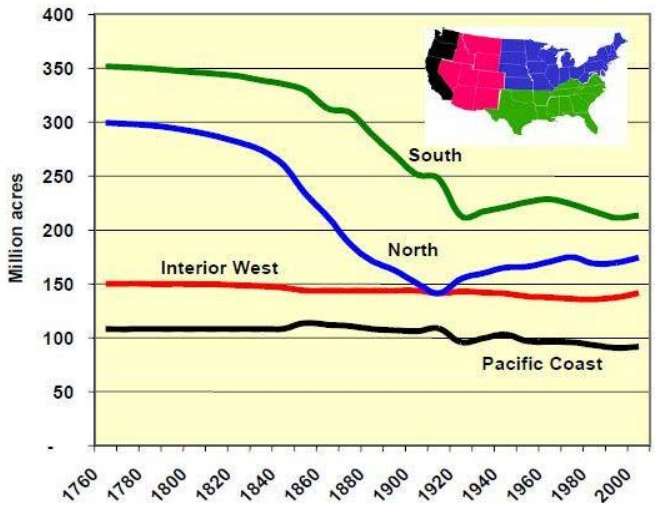
[323] United States Environmental Protection Agency, "Forestry: Facts and Figures." http://www.epa.gov/agriculture/forestry.html (accessed March 30, 2012)

biodiversity conservation, raw material for wood and paper products, climate regulation, carbon storage, and air quality filters.[324]

Land use within forests have been noted for its critical importance to biodiversity. Research has demonstrated that pine plantations in the Southeast accumulate almost 100 metric tons of carbon per acre after 90 years, or roughly one metric ton of carbon per acre per year. Changes in forest management (e.g., lengthening the harvest-regeneration cycle) generally result in less carbon sequestration on a per acre basis.[325] Forest land area declined by approximately 10 million hectares from the early 1960s to the late 1980s; since then, forest area has increased by about 12 million hectares. Through the later part of the 20th century many areas of previously forested land in the United States were allowed to revert to forests or were actively reforested (See Figure 6).[326] Nonetheless, climate change has impacted the shaping of ecological communities and their productivity within forests, therefore affecting the ecosystem goods and services they provide. However, according to the findings of a study on the Effects of Climate Change on Land Resources in the United States published by the Department of Agriculture, "the combined effects of rising temperatures and CO_2, nitrogen deposition, ozone, and forest disturbance on soil processes and soil carbon storage remain unclear".[327] In addition to the direct effects of climate on tree growth and ecological species, climate also affects the frequency and intensity of natural disturbances such as fire, insect outbreaks, ice storms, and windstorms.[328] These disturbances have important consequences for timber production, water yield, carbon storage, species composition, invasive species, and public perception of forest management. Due to warmer and drier climate in the past two decades, forest fires have grown larger and more frequent. Several large insect and invasive species outbreaks have also recently occurred.

[324] Ryan, M.G., and S.R Archer. United States Department of Agriculture, "The Effects of Climate Change on Agriculture, Land Resources, Water Resources, and Biodiversity", last modified July 15, 2010, 75
[325] United States Environmental Protection Agency, "Carbon Sequestration in Agriculture and Forestry", http://www.epa.gov/sequestration/faq.html (accessed March 30, 2012)
[326] Alig, Ralph J., United States Department of Agriculture, "Economic Modeling of Effects of Climate Change on the Forest Sector and Mitigation Options: A Compendium of Briefing Papers", last modified October 2010
[327] United States Department of Agriculture, "The Effects of Climate Change on Land Resources in the United States" (2008), 2
[328] Ryan, M.G., and S.R Archer, United States Department of Agriculture, "The Effects of Climate Change on Agriculture, Land Resources, Water Resources, and Biodiversity", last modified July 15 2010

Figure 5.XII: Forest Clearing and Reforestation Trends by U.S. Region



Source: "U.S. Forest Facts on Forestland", http://forestry.about.com/od/forestresources/tp/forest_fact_USA.htm (accessed March 30, 2012)

From a consumer standpoint, Americans are very much connected to forested ecosystems through the timber market. Changing forest conditions affect the supply of timber available for use in the production of wood products. These changes then affect the quality and costs of timber, the material handling systems and therefore continue to affect the available supplies.[329] It has also been noted that if climate change continues to effects yields and costs of production, land may be continued to be shifted between forestry and agriculture. Given that the agricultural and forestry sectors sometimes compete for the same land, shifts in productivity of agricultural land could affect the ultimate distribution of forest land, and vice versa, furthering the influence of land use on climate change.

Modeling of carbon dioxide cycling and management techniques for enhanced carbon sequestration in forests has been identified as a potential solution to the negative effects of climate warming in the United States, one of the key reasons in the United States' commitment to reforestation. Rising CO_2 and nitrogen deposits combined with warmer temperatures will likely increase photosynthesis for forests. But this increase will likely only enhance wood production in young forests on fertile soils where water is available.

[329] United States Environmental Protection Agency, "Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2009: Chapter 7 Land Use, Land Use Change, and Forestry", April 2011 http://epa.gov/climatechange/emissions/usinventoryreport.html (accessed March 30, 2012)

The United States Forest Service already has a restoration forestry system. The Forest Service recognizes that forests are important for carbon storage and aims to sustain the carbon sequestration capacity of both public and private lands. The Forest Service is working to implement rapid reforestation of forests damaged by fires, hurricanes, and other catastrophic events, provide technical assistance to regional and state climate action programs for understanding carbon sequestration potential, providing information and tools to assess carbon stocks, and demonstration projects that support development of private markets for ecosystem services, such as carbon sequestration.

Coastal Lands

The United States' coastline stretches for approximately 158,000 kilometers (93,600 miles), bordering some of the most valuable and heavily developed areas, including communities, agriculture and infrastructure. Within these coastal areas lie natural and human resources of significant value including about 38,900 square kilometers of coastal wetlands, which provide habitats for wildlife and filters toxins from rivers, and 6,500 km²of developed barrier islands, which support recreational areas.[330] U.S. coastal areas also supports a variety of important economic activities, including fisheries and aquaculture, tourism, recreation, industry, and transportation contributing more than US$1 trillion to the nation's gross domestic product.

U.S. coastal areas are experiencing increased pressures as a result of rapid population growth and development. In combination with development, costal lines are being damaged as a result of nutrient and bacteria pollution from urban and agricultural runoff, changes in hydrology and salinity to naturally balanced systems and shore erosion. The effects of climate change are expected to only add to these stresses. The United State's Federal Emergency Management Agency (FEMA) has estimated that the number of homes in the coastal floodplain would more than double under the highest of sea-level rise scenarios given by the Intergovernmental Panel on Climate Change (IPCC).[331] A two foot rise in sea level would eliminate approximately 10,000 $m^2$of land,[332] particularly in low-lying areas such as the Mississippi delta, where land is also subsiding at a rate of approximately one

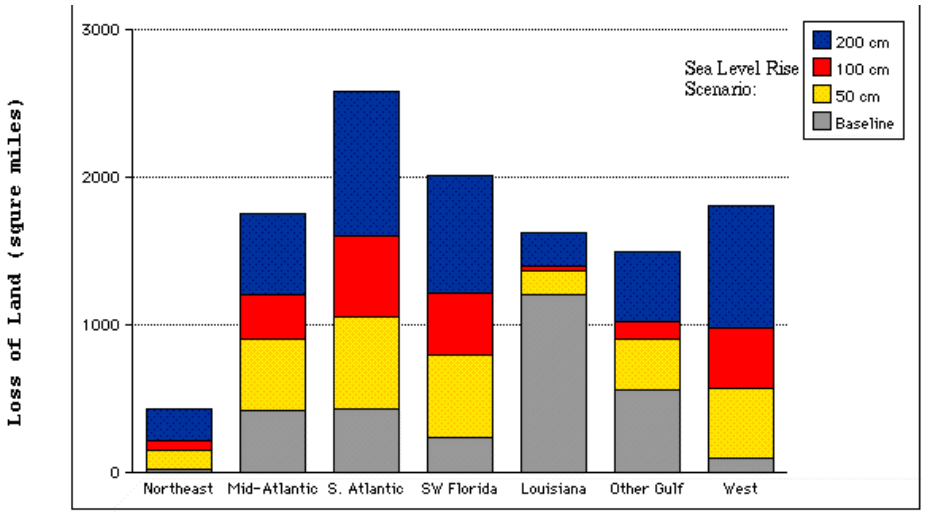
[330] Year of the Ocean, "IMPACTS OF GLOBAL CLIMATE CHANGE— WITH EMPHASIS ON U.S. COASTAL AREAS" Section: Global Climate Change Impacts on U.S. Coastal Areas, last modified 1998, http://www.yoto98.noaa.gov/yoto/meeting/climate_316.html (accessed March 30, 2012)
[331] Year of the Ocean, "IMPACTS OF GLOBAL CLIMATE CHANGE— WITH EMPHASIS ON U.S. COASTAL AREAS" Section: Global Climate Change Impacts on U.S. Coastal Areas, last modified 1998, http://www.yoto98.noaa.gov/yoto/meeting/climate_316.html (accessed March 30, 2012)
[332] United States Environmental Protection Agency, "Coastal Zones and Sea Level Rise", last modified April 14 2011, http://epa.gov/climatechange/effects/coastal/index.html (accessed March 30, 2012)

meter per century.[333] If global sea levels continued to rise, major coastal cities such as New Orleans, Miami, New York, and Washington, DC, will have to upgrade flood defenses and drainage systems or risk adverse consequences. The Mid-Atlantic, an area that will most likely incur some of the highest impacts of sea level rises, has a population between approximately 900,000 and 3,400,000 people that live on land less than one meter above the monthly highest tides (between 3-10 %of the total population in the mid-Atlantic coastal region).[334] Estimates show that the impacts of a 50-cm sea-level rise by 2100 on coastal property range from about US$20 billion to about US$150 billion. However, this estimate does not include the potential effects on coastal wetlands and does not reflect the distribution of impacts. Without preparing appropriate policy, the impact of rising seas could disproportionately influence select communities in the most vulnerable areas, leaving the poorest of Americans to suffer the consequences.[335]

Several states have laws or regulations requiring impeding construction, based on the planned life of the development and observed erosion rates. Michigan, North Carolina, Rhode Island, and South Carolina are using these erosion rates to guide planning. Rules prohibit buildings of a certain size that are unlikely to remain stable with a sea level rise of two feet.[336] The Massachusetts Coastal Hazards Commission is preparing a 20-year infrastructure and protection plan to improve hazards management.[337] Governments and private interests are beginning to take sea-level rise into account in planning levees and bridges, and facilities such as sewage treatment plants. However, due to high costs associated with elevating homes or building floodwalls, in many coastal communities, the only viable option will be to gradually abandon properties and relocate further inland.

[333] Year of the Ocean, "IMPACTS OF GLOBAL CLIMATE CHANGE— WITH EMPHASIS ON U.S. COASTAL AREAS" Section: G-27, last modified 1998, http://www.yoto98.noaa.gov/yoto/meeting/climate_316.html (accessed March 30, 2012)
[334] United States Environmental Protection Agency, "Coastal Sensitivity to Sea Level Rise: A Focus on the Mid-Atlantic Region", 331, last modified January 2009, http://www.epa.gov/climatechange/effects/coastal/sap4-1.html (accessed March 30, 2012)
[335] Neumann, James E, Gary Yohe, Nicholls Robert, and Michelle Manion. Pew Centeron Global Climate Change, "Sea Rise & Global Climate Change: A Review of Impacts to US Coast Lines", last modified February 2000
[336] Approximately 61 centimeters
[337] United States Global Change Research Program, "Global Climate Change Impacts in the United States: Coasts", last modified 2009, 149-152

Figure 5.XIII: Dry Land Loss by 2100 without Shore Protection by U.S. Region



Source: Year of the Ocean, "Impacts of Global Climate Change— with Emphasis on U.S. Coastal Areas", Section: G-28 Last modified 1998, http://www.yoto98.noaa.gov/yoto/meeting/climate_316.html (March 30, 2012)

In addition to direct effects on shorelines and water quality, increasing severe weather events is one of the biggest risks to the United States social and economic security. On August 29, 2005, Hurricane Katrina, a category-three storm with peak winds in excess of 200 kilometers per hour, hit the Gulf Coast of the United States, specifically affecting Louisiana and Mississippi. Overall, Hurricane Katrina generated more than US$34 billion in damage, making it "the most expensive natural disaster in U.S. history."[338] With more than 1,300 deaths, Katrina also contributed to the highest number of storm fatalities since 1928.[339] Hurricane Katrina's forced tens of thousands of displaced residents to resettle in approximately 1,042 shelters in 26 states after receiving assistance from federal, state, and private organizations. It is estimated that between 100,000 to 300,000 Louisiana residents were displaced permanently as a result of Hurricane Katrina and, to a lesser degree, Hurricane Rita, which struck about a month later. More than a year after the disaster, a quarter of a million people did not return to their homes along the Gulf Coast.[340] Although the United States is not predicted to incur destabilizing levels of internal migration as much as some other less developed countries, however, it

[338] Smith, P.J., "Climate change, mass migration and the military response", *A Journal of World Affairs,* 51. no. 4 (2007), 617-633
[339] Smith, P.J., "Climate change, mass migration and the military response", *A Journal of World Affairs*, 51. no. 4 (2007): 617-633
[340] Smith, P.J., "Climate change, mass migration and the military response", *A Journal of World Affairs* . 51. no. 4 (2007): 617-633

will be affected. The United States is also expected to experience border stress due to the effects of climate change in parts of Mexico and the Caribbean. As drought and rising sea level increases, so will the flow of immigrants from these areas. All of these factors will contribute to rising health costs associated with more frequent heat waves, a deterioration of air quality, and an increase in water-borne disease.[341]

5.2.2. Policy response

The international efforts to address climate change on global level, resulting in the Kyoto Protocol, were seen very critically in the United States from the beginning. On July 25, 1997, the United States Senate unanimously (95-0) passed Senate Resolution 98 which notified the Clinton Administration that the "United States should not be a signatory to any protocol to, or other agreements regarding, the United Nations Framework Convention on Climate Change of 1992, at negotiations in Kyoto in December 1997 or thereafter which would: (1) mandate new commitments to limit or reduce greenhouse gas emissions for the Annex 1 Parties, unless the protocol or other agreement also mandates new specific scheduled commitments to limit or reduce greenhouse gas emissions for Developing Country Parties within the same compliance period; or (2) result in serious harm to the U.S. economy".[342] Thus, at the end of the Clinton Administration, the Kyoto Protocol became a latent issue with little likelihood of being ratified. In March 2001, President George W. Bush abandoned any plans to establish carbon dioxide emissions reductions for U.S. power plants and subsequently announced that the United States would not be supporting the Kyoto Protocol.

Claims about the existence of global warming became more contested in the United States policy arena in the late 1990s resulting in stunting effective policy making. The Obama administration (elected in 2008) made a great deal of promises concerning climate change and established a new office in the White House to address climate change, the Office of Energy and Climate Change Policy. The White House Council on Environmental Quality Interagency Climate Change Adaptation Task Force worked to develop regional climate change adaption syndication so that Federal agencies would harmonize the efforts of decision makers and information providers to avoid the duplication of efforts. However, the most significant federal climate change effort by President Obama, the American Clean Energy and Security Act, a cap and trade bill, failed to pass the Senate. Despite an

[341] Ogden, Peter, and John Podest, "The Security Implications of Climate Change", *THE WASHINGTON QUARTERLY*, 31. no. 1 (2007), 115-138

[342] Library of Congress, "Bill Summary & Status 105th Congress (1997 - 1998) S.RES.98 CRS Summary", http://thomas.loc.gov/cgi-bin/bdquery/z?d105:SE00098:@@@D&summ2=m& (accessed March 30, 2012)

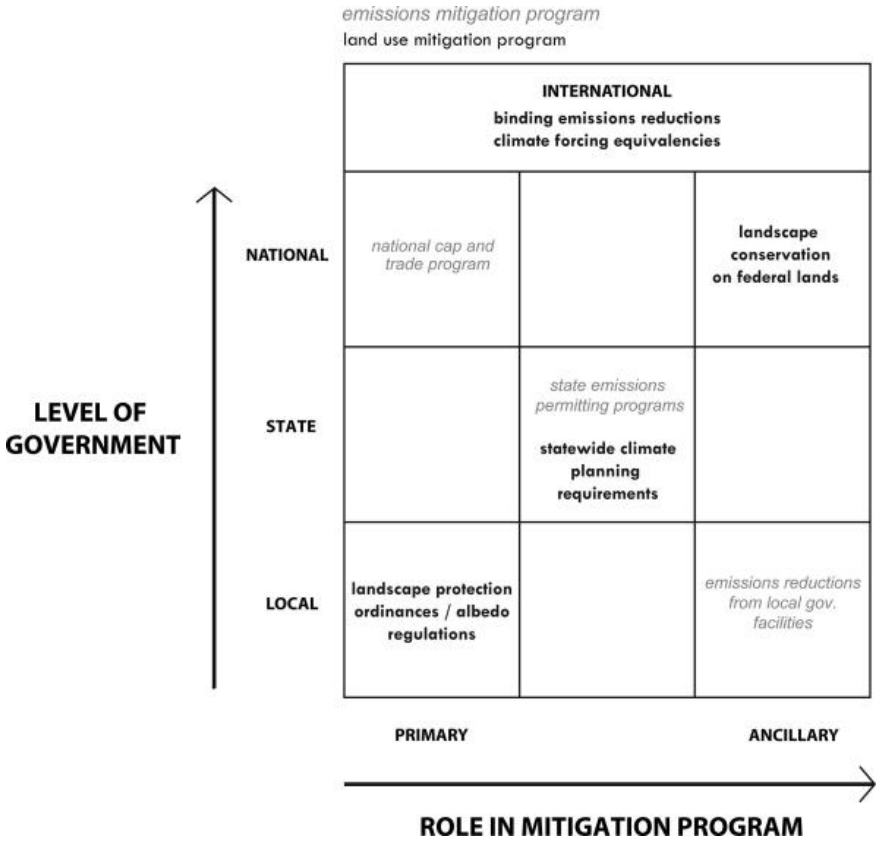
ineffective start, international pressure related to treaty obligations, success in reducing emissions, business demands for a coherent long range national strategy, mounting national energy policy problems, and a significant amount of state and local leadership actions have paved the way for climate change policy in the United States. Modifications to the United States policy and limits on greenhouse gas emission have been proposed, but such efforts have made limited progress. Significant achievements in environmental regulation thus far include increases in air and water quality and, to a lesser degree, control of hazardous waste.

In the United States, markets are the primary means for determining land use. Impacts of climate change on land-use distribution are expected to affect urban and developed areas differently by region. Regional patterns of growth and decline in the United States have shifted population and property value to more vulnerable areas, and concerns about climate change and severe weather events could alter land function entirely. Decisions concerning land use arise from needs to accommodate growth and development such as enhancing agricultural and forest production capabilities but also preventing unwarranted and costly sprawl, and avoid unnecessary conversion of farm, range, forest lands and wetlands. It is also vital to maintain habitats, assuring adequate supplies of suitable-quality water, and providing or improving community services and facilities. American policy, on both a state and federal level, is working towards creating this balance.

Administrative responsibilities for an emissions mitigation program are presented in gray text, and administrative responsibilities for a potential land-based mitigation program are presented in black text. The horizontal axis displays the primacy of each governmental level in program administration, with the federal government principally responsible for the development of a national carbon trading program, while local governments assume principal administrative responsibility for the development of land-based mitigation programs. The vertical axis displays the level of government associated with each program element. International agreements establish the goals for both types of mitigation programs but are external to program implementation.[343]

[343] Stone, Jr., Brian, "Land Use as Climate Change Mitigation", *Environmental Science and Technology Viewpoint*, 43. no. 24 (2009), 9052–9056, http://pubs.acs.org/doi/pdfplus/10.1021/es902150g (accessed March 30, 2012)

Figure 5.XIV: Implementation framework for land-based mitigation in the U.S. context



Source: Stone, Jr., Brian, "Land Use as Climate Change Mitigation", *Environmenta Science and Technology Viewpoint*. 43. no. 24 (2009), 9052–9056, http://pubs.acs.org/doi/pdfplus/10.1021/es902150g (accessed March 30, 2012)

5.2.3. Federal Climate Change Policy

At the federal level, climate change is primarily addressed in four areas: research and development; standards, incentives and regulations; policy development and implementation; and national and international leadership.[344] Research and development is the leading action taken federally thus far. Climate research and information-sharing by the US Environmental Protection Agency (EPA), and

[344] American Planning Association, "Policy Guide on Planning and Climate Change", last modified April 27, 2008, 18

other federal agencies have formed the basis to encourage climate change action on the international level to local level, as well as attempting to reduce uncertainties about scales of impacts and effectiveness of mitigation and adaptation measures. Federal grants and agencies research alternative programs and practices to help mitigate climate change through development of renewable energy sources. Identification of best carbon sequestration practices in the areas of agriculture and forestry, utility emissions, and green infrastructure are aiming to mitigate climate change while also working to identify appropriate responses to impacts through hazards management, public health, and infrastructure standards. Federal grants fund new technology, leading to development of standards, and incentives and regulations.

Recent research program examples under the last two presidents (George W. Bush and Barack Obama) include the Climate Change Science Program (CCSP), Climate Change Technology Program (CCTP), and the U.S. Global Change Research Program (USGCRP). The CCSP combined over 20 U.S. cabinet departments and federal agencies to investigate climate change and coordinating integrating research on global warming from February 2002 to June 2009. In May 2008, the final report, *The Effects of Climate Change on Agriculture, Land Resources, Water Resources, and Biodiversity,* was published.[345] The CCTP was responsible for climate-related technology research, development, demonstration, and deployment. It has six goals and includes a broad portfolio of technology options related to infrastructure, reducing emissions from energy use and infrastructure, advancing CO_2 capture and sequestration, reducing emissions from non-CO_2 gases, enhancing measurement & monitoring and bolstering the contributions of basic science.[346] The CCTP and CCSP was developed into the USGCRP which now coordinates and integrates federal research on changes in the global environment, focusing on observing and understanding changes in climate, the ozone layer, and land cover, identifying the impacts of these changes on ecosystems and society, estimating future changes in the physical environment, and vulnerabilities and risks associated with those changes, and providing scientific information to enable effective decision making.[347]

In addition to research and technology efforts, there are two major policy tools used to directly impact the environment: rules and inducements.[348] The United States has applied rules primarily through regulation. Regulation can be implemented in two forms, design standards and performance standards. Performance standards specify emission levels and design standards specify exactly how

[345] U.S. Climate Change Science Program, "The Effects of Climate Change on Agriculture, Land Resources, Water Resources, and Biodiversity in the United States", last modified May 2008
[346] Watson, Dr. Harlan, "U.S. Climate Change Policy," Presentation: Seminar of Government Experts (2005), 6
[347] United States Global Change Research Program, "USGCRP Activities", http://www.globalchange.gov/what-we-do (accessed March 30, 2012)
[348] United States Environmental Protection Agency, "Economic Incentives", last modified February 07, 2012, http://yosemite.epa.gov/ee/epa/eed.nsf/pages/EconomicIncentives.html (accessed March 30, 2012)

performance standards will be met. It is assumed that companies have better information than regulators regarding the relative cost and value of alternative mitigation technologies, so the government allows market actors to dictate their own regulations.[349] Additionally, the government uses inducements, or market reform. Inducements are rewards and punishments used to influence people or groups under what has been labeled the "cap and trade system". The two major types of market reforms are charge systems (such as emissions taxes) and tradable permit systems. One type of tradable permit system is an auction of pollution rights in which the amount of allowed pollution is auctioned by unit, giving environmental organizations the opportunity to buy the units to create a cleaner environment.[350] Such a plan was implemented for sulfur dioxide (SO_2) emissions in the 1990 Acid Rain Program and has been undertaken for greenhouse gases on a regional scale as a way to mitigate global warming.[351]

The United States Congress has passed a number of landmark environmental regulatory systems in addition to other (less comprehensive) federal laws. These state and federal systems are also layered with administrative regulation. The U.S. Environmental Protection Agency (EPA or sometimes USEPA) is an agency of the federal government of the United States charged with protecting human health and the environment, by writing and enforcing regulations based on laws passed by Congress. Other federal agencies, such as the U.S. Fish and Wildlife Service and National Park Service pursue primarily conservation missions, while still others, such as the United States Forest Service and the Bureau of Land Management, tend to focus more on beneficial use of natural resources. In tandem, the legislatures of the 50 states have passed numerous similar sets of laws. The U.S. judicial system reviews not only the legislative enactments, but also the administrative decisions of the many agencies dealing with environmental issues. Subsequently, limited regulations are supported by common law to resolve environmental disputes. The following table is a short list of key environmental federal laws that have been enacted throughout the history of the United States, with both direct and indirect ties to land.

[349] Hueth, Brent, and Tigran Melkonyon, "Standards and the Regulations of Environmental Risk", 2
[350] Flat World Knowledge, "Tradable Permits and Auctions", http://www.flatworldknowledge.com/node/20426 (accessed March 30, 2012)
[351] United States Environmental Protection Agency, "Economic Incentives", last modified February 07, 2012, http://yosemite.epa.gov/ee/epa/eed.nsf/pages/EconomicIncentives.html (accessed March 30, 2012)

Figure 5.XV: Federal Policy History

Environmental Law	Goals[352]	Effect on Land
National Environmental Policy Act (1970)	Known as the first of the modern environmental statutes. NEPA created environmental policies and goals for the country, and established the President's Council on Environmental Quality. It's most important feature is its requirement that federal agencies conduct thorough assessments of the environmental impacts of all major activities undertaken or funded by the federal government. Many states have enacted similar laws governing state activities.	NEPA outlined the process to ensure that any actions proposed on public lands are evaluated and the impact to the environment is looked at and analyzed. NEPA procedures ensure that land information is available to public officials and citizens before decisions are made and actions are taken.
Clean Air Act (1970)	Sets goals and standards for the quality and purity of air in the United States. The aim to "protect and enhance the nation's air resources so as to promote the public health and welfare and the productive capacity of the population."[353] By law, it is periodically reviewed. A significant set of amendments in 1990 toughened air quality standards and placed new emphasis on market forces to control air pollution.	Mandated that metropolitan planning organizations integrate metropolitan land use and transportation planning, and lead to subsequent legal challenges to the traditional approach to transportation planning. The act additionally mandated protection for certain national parks and wildernesses (National Parks over 6,000 acres and Wildernesses over 5,000 acres)
Clean Water Act (1972)	Establishes and maintains goals and standards for U.S. water quality and purity. It has been amended several times, most prominently in 1987 to increase controls on toxic pollutants, and in 1990, to more effectively address the hazard of oil spills.	The two most relevant provisions to the development of land are the wetlands protections (section 404) and the national pollutant discharge elimination system (NPDES) permit requirement (section 402). Section 404 requires any person desiring to dredge or fill a navigable water of the United

[352] Natural Resources Defense Council, "U.S. Environmental Laws", http://www.nrdc.org/reference/laws.asp (accessed March 30, 2012)
[353] United States Environmental Protection Agency, "Clean Air Act (CAA)", last modified October 20, 2011, http://www.epa.gov/agriculture/lcaa.html (accessed March 30, 2012)

		States to acquire a permit from the Army Corps of Engineers. The NPDES permit sets effluent limitations, which are parameters of how much of a given pollutant a source can release into surface water without negatively affecting the quality of the water
Coastal Zone Management Act (1972)	Provides a partnership structure allowing states and the federal government to work together for the protection of U.S. coastal zones from environmentally harmful overdevelopment. The program provides federal funding to participating coastal states and territories for the implementation of measures that conserve coastal areas.	Encourages states to exercise their full authority over the lands and waters in the coastal zone by assisting the states, in cooperation with Federal and local governments and other vitally affected interests, in developing land and water use programs for the coastal zone, including unified policies, criteria, standards, methods, and processes for dealing with land and water use decisions of more than local significance
Safe Drinking Water Act (1974)	Establishes drinking water standards for tap water safety, and requires rules for groundwater protection from underground injection; amended in 1986 and 1996. The 1996 amendments added a fund to pay for water system upgrades, revised standard: setting requirements, required new standards for common contaminants, and included public "right to know" requirements to inform consumers about their tap water.	Includes watershed monitoring where land uses surveys around every source water area (surface or groundwater), delineates the source-area boundaries, identify potential contaminant sources within them, and determines the susceptibility of the water supply to harmful contamination
Resource Conservation and Recovery Act (1976)	Amended the Solid Waste Disposal Act, established regulations to manage the generation, transport, treatment, storage, and disposal of hazardous wastes while simultaneously ensuring the protection of human health and the environment.	Developed the Land Disposal Restrictions Program (LDR) under which land disposal of untreated wastes is prohibited and the EPA must establish treatment standards for all listed and characteristic hazardous wastes destined for land disposal. Secondly, the LDR mandates that facilities are required to satisfy minimum technology requirements for surface impoundments, waste piles,

		land treatment units, and landfills
Federal Land Policy and Management Act (1976)	Provides for protection of the scenic, scientific, historic and ecologic values of federal lands and for public involvement in their management.	Created a single, unified statutory scheme for management of public lands. FLPMA guides Bureau of Land Management of the public lands with several statements of general policy. Most importantly, these public lands are retained within federal ownership while still allowing for land exchanges and even for the sale of discrete tracts. The BLM takes into account three major categories of use: commercial activities, public recreation, and conservation. Livestock grazing and minerals extraction are the principal commercial uses, although the BLM issues permits for everything from beehives to electrical transmission lines. Public lands also provide a wide range of recreation opportunities, including fishing, boating, hunting, hiking, biking, and off-highway vehicle (OHV) travel
Comprehensive Environmental Response, Compensation and Liability Act (CERCLA/Superfund (1980)	Requires the cleanup of sites contaminated with toxic waste. This law is commonly referred to as "Superfund." In 1986 major amendments were made in order to clarify the level of cleanup required and degrees of liability. CERCLA is retroactive, which means it can be used to hold liable those responsible for disposal of hazardous wastes before the law was enacted in 1980	Measured and reported sites that have successfully been cleaned up and are ready for potential future use. Under the program, Sitewide Ready for Anticipated Use (SWRAU), Superfund reflected on the importance of considering future land use as part of the cleanup process. Secondly, Superfund had an impact on surrounding residential property values, shaping further development.
Proposition 65 (1986)	Is a California law passed by voter initiative. Known as the Safe Drinking Water and Toxic Enforcement Act, Prop. 65 is designed to provide public warnings about the risk of exposure to toxic chemicals and to eliminate toxins from drinking water supplies. It is	Outlaws for anyone to discharge or release a listed chemical into water or into or land where it will pass into a source of drinking water.

	responsible for California having some of the strongest environmental protections in the nation, and thus has helped make the state a model for other regions seeking to address environmental hazards.	
Oil Pollution Act (1990)	Enacted a year after the disastrous Exxon Valdez oil spill in Alaska's Prince William Sound, this law streamlines federal response to oil spills by requiring oil storage facilities and vessels to prepare spill-response plans and provide for their rapid implementation. The law also increases polluters' liability for cleanup costs and damage to natural resources and imposes measures designed to improve tanker safety and prevent spills.	Protects against the death of organisms, loss of animal insulation and buoyancy and smothering. Oil spills cause significant economic impacts and chemical cleanup methods are often utilized which further impacts land use.

In relation to direct land regulation, there are several different programs from varying entities of the federal government to monitor climate change and contribute to policy making. From the U.S. Environmental Protection Agency there have been a number of acts which have shaped land use.

- 1947 - *Federal Insecticide, Fungicide, and Rodenticide Act* – "provides federal control of pesticide distribution, sale, and use. All pesticides used in the United States must be registered (licensed) by EPA. Registration assures that pesticides will be properly labeled and that, if used in accordance with specifications, they will not cause unreasonable harm to the environment"[354]
- 1964 - *Wilderness Act* - It created the legal definition of wilderness in the United States, and protected some 9 million acres (36,000 km²) of federal land creating the National Wilderness Preservation System. The current amount of areas designated by the NWPS contains nearly 109 million acres covering 5% of U.S. land base.[355]

[354] United States Environmental Protection Agency, "Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA)", http://www.epa.gov/agriculture/lfra.html (accessed March 30, 2012)
[355] Pew Environment Group, "The National Wilderness Preservation System", last modified February 15, 2011, http://www.pewenvironment.org/news-room/other-resources/the-national-wilderness-preservation-system-85899363003 (accessed March 30, 2012)

- 1977 - *Surface Mining Control and Reclamation Act* – "To provide for the cooperation between the Secretary of the Interior and the States with respect to the regulation of surface coal mining operations, and the acquisition and reclamation of abandoned mines, and for other purposes." SMCRA also created the Office of Surface Mining, an agency within the Department of the Interior, to promulgate regulations, to fund state regulatory and reclamation efforts, and to ensure consistency among state regulatory programs.[356]
- 1980 - *Alaska National Interest Lands Conservation Act*- The law provided for the creation or revision of 15 National Park Service properties, and set aside other public lands for the United States Forest Service and United States Fish and Wildlife Service. "The statute protected over 100 million acres of federal lands in Alaska, expanded the national park system in Alaska by over 43 million acres, creating 10 new national parks and increasing the acreage of three existing units."[357]
- 1994 - *California Desert Protection Act* – "established the Death Valley and Joshua Tree National Parks and the Mojave National Preserve in the California desert"[358]
- 1996 - *Food Quality Protection Act*- "Under the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA), the EPA registers pesticides for use in the United States and prescribes labeling and other regulatory requirements to prevent unreasonable adverse effects on human health or the environment. Under the Federal Food, Drug, and Cosmetic Act (FFDCA), EPA establishes tolerances (maximum legally permissible levels) for pesticide residues in food."[359]

One of the most significant U.S. federal land program is the Farm Bill which is, according to observers, the "single most influential piece of legislation affecting agriculture in the United States."[360] The Farm Bill provides billions of dollars in subsidies for commodity crops like corn, soybeans, and wheat. For several decades, farm programs have been designed to encourage intensive farming of few crops, at a serious environmental cost. However, the Farm Bill also funds conservation and on-farm energy programs that have aided the transition of more efficient, climate-

[356] United States Congress, "Surface Mining Control and Reclamation Act of 1977", last modified December 20, 2006
[357] National Parks Conservation Association, "Alaska National Interest Lands Conservation Act", last modified October 27, 2011, http://www.npca.org/news/media-center/fact-sheets/anilca.html (accessed March 30, 2012)
[358] National Park Service, "California Desert Protection Act", http://www.nps.gov/jotr/parkmgmt/caldesprotect.htm (accessed March 30, 2012)
[359] United States Environmental Protection Agency, "The Food Quality Protection Act (FQPA) Background", last modified February 16, 2011, http://www.epa.gov/pesticides/regulating/laws/fqpa/backgrnd.htm (accessed March 30, 2012)
[360] The National Association of Conservation Districts (NACD), "Farm Bill", http://www.nacdnet.org/policy/agriculture/farmbill/ (accessed March 30, 2012)

friendly agriculture systems. The Farm Bill not only determines much of what is grown in the U.S., but also how farmers grow crops and raise livestock. Though no Farm Bill program identifies preventing climate change as a specific goal, many of the encouraged practices support emissions reductions and carbon sequestration.

As part of the Farm Bill, The Farm Service Agency has implemented the Conservation Reserve Program (CRP) and the Conservation Reserve Enhancement Program (CREP). As the nation's largest private lands conservation program, CRP is a voluntary program for agricultural landowners, which offers participants the opportunity to reduce atmospheric green-house gas (GHG) concentrations and encourage environmental benefits. The goal is to reward farmers who convert marginal cropland to grassland, boosting soil carbon levels. The CRP is also being used to encourage farmers to plant trees in windbreaks, shelterbelts and small wood lots, which can store carbon for decades to come. Through CRP, farmers can receive annual rental payments and cost-share assistance to establish long-term, resource conserving covers on eligible farmland. By reducing water runoff and sedimentation, CRP protects groundwater and helps improve the condition of lakes, rivers, ponds, and streams. By shifting cropland into long-term grasses, trees, or restored wetlands, the quantity of carbon stored in soils and biomass is increased. Taking cropland out of production also reduces nitrous oxide emissions related to fertilizer use and reduces field operations, lowering carbon dioxide emissions from fossil fuel combustion and tillage. As of March 2008, CRP included 34.7 million acres of grass cover, trees, and wetlands. In 2007, CRP sequestered more than 50 Tg of carbon dioxide (1 Tg =1 million tons).[361] The FSA has committed to more than US$1.02 billion in State matching funds toward enrollment goals of more than 2.86 million acres within CREP agreements. The main objective is to conserve agricultural irrigation water, water quality, soil sedimentation, and wildlife. Incentives from State and local water use authorities pay to retire the water from agricultural irrigation. [362]

In addition to CRP AND CREP, The Environmental Quality Incentives Program (EQIP) is offered through the Farm Bill as a voluntary program that provides financial and technical assistance to agricultural producers through contracts up to a maximum term of ten years in length. These contracts provide financial assistance to help plan and implement conservation practices to protect natural resources and to create opportunities which improve soil, water, plant, animal, air and related resources on agricultural land and non-industrial private forestland.[363] EQIP provides

[361] United States Department of Agriculture, "Farm Service Agency and Climate Change", 1
[362] United States Department of Agriculture, "The Conservation Reserve Program and the Conservation Reserve Enhancement Program", 3
[363] United States Department of Agriculture, "Environmental Quality Incentives Program", http://www.wi.nrcs.usda.gov/programs/eqip.html (accessed March 30, 2012)

payments to farmers who adopt farm and ranch practices that increase soil carbon levels. EQIP payments can help farmers transition to organic farming systems and encourage farmers to adopt no-till cropping systems. Payments are meant to help farmers adopt better grazing management systems that can boost carbon stored in the soil and resource-conserving crop rotations. Farmers are also gaining access to soil testing, nutrient plans, pest scouting and integrated pest management to reduce their use of energy-intensive fertilizers and pesticides In addition, a purpose of EQIP is to help producers meet Federal, State, Tribal and local environmental regulations. The result is less use of carbon-based energy overall, and fewer direct emissions of ammonia and other greenhouse gases given off by nutrient application. This program has been deemed successful for landowner as it is user-friendly, with a focus on habitat restoration, but does not require long-term commitments. [364]

To mitigate the effect of natural disasters on land, USDA Farm Service Agency's (FSA) provides the Emergency Conservation Program (ECP) which contributes to emergency funding and technical assistance to farmers and ranchers to rehabilitate farmland damaged by natural disasters and for implementing emergency water conservation measures in periods of severe drought. The ECP was also recently amended to include the Emergency Forest Restoration Program (EFRP) which provides payments to nonindustrial private forest (NIPF) land owners in order to carry out emergency measures to restore land damaged by a natural disaster. Conservation practices might entail debris removal from farmland, restoring livestock fences and conservation structures and providing water for livestock during periods of severe drought. Additional indirect conservation programs include The Farmable Wetlands Program (FWP), The Grassland Reserve Program (GRP) and The Source Water Protection Program. [365]

The future of cap and trade programs has been widely discussed within the context of land as well. Although cap and trade is not currently applied to the agricultural or forest industry, these policies could have significant impacts on net income via higher production costs due to higher prices for fossil fuels, fertilizer, and other energy-intensive inputs. There could also be additional income opportunities with increased demands for agricultural biofuel and bioelectricity feedstock. The mitigation of potential greenhouse gas-induced changes in climate policy is itself emerging as a potential driver of land cover change as well. Biofuel and sequestration markets (and mandates) could influence climate not only through changes in greenhouse gas concentrations, but also through changes in surface energy and water budgets.

[364] National Sustainable Agriculture Coalition, "Environmental Quality Incentives Program", http://sustainableagriculture.net/publications/grassrootsguide/conservation-environment/environmental-quality-incentives-program/ (accessed March 30, 2012)
[365] United States Department of Agriculture, "Conservation Programs", http://www.fsa.usda.gov/FSA/webapp?area=home&subject=copr&topic=landing (accessed March 30, 2012)

Forests continue to be recognized as having important roles in comprehensive policies and legislation to address climate change and increase renewable energy use. Much of the discussion around forests in the context of those topics has related to better understanding key physiological processes, developing projections of future markets for carbon or bio energy, and examining the physical and economic outcomes of alternate policies. An important layer of complexity in considering the use of forests to address climate change and renewable energy development is forestland ownership. In the United States, at the highest aggregation, forest ownership is divided into those lands owned by private individuals and entities and public land. However, there are very few climate change policies or programs on a federal level directly affecting this sector.

The Healthy Forests Initiative, a federal program, focuses on reducing the risk of catastrophic fire by thinning dense undergrowth and brush in priority locations that are on a collaborative basis with selected Federal, state, tribal, and local officials and communities. The initiative also provides for more timely responses to disease and insect infestations that threaten to devastate forests.[366] The United States Department of Agriculture provides several landowner assistance programs and partnerships to assist private landowners and rural communities maintain environmentally sensitive forest lands and strengthen local economies. This includes the Forest Legacy Program and the Forest Stewardship Program which are complemented by sub contributions from the Natural Resources Conservation Service (NRCS) Financial Assistance Programs, Environmental Quality Incentives Program, Wildlife Incentive Program, and Conservation Stewardship Program. The Forest Legacy Program protects "working forests" which provides water quality, habitat, forest products, opportunities for recreation and other public benefits. It does this through helping individual states develop and carry out their forest conservation plans. It encourages and supports acquisition of conservation easements, legally binding agreements transferring a negotiated set of property rights from one party to another, without removing the property from private ownership.[367] The Forest Stewardship Program provides technical assistance, through State forestry agency partners, to nonindustrial private forest (NIPF) owners to encourage and enable active long-term forest management. A primary focus of the Program is the development of comprehensive, multi-resource

[366] Forests and Rangelands, "Progress Report on Implementing President Bush's Healthy Forests Initiative and the Healthy Forests Restoration Act of 2003" (2004), http://www.forestsandrangelands.gov/resources/overview/hfra-progress12-2004.shtml (accessed March 30, 2012)
[367] USDA Forest Service, "Forest Legacy Program" (2010), 10

management plans that provide landowners with the information they need to manage their forests for a variety of products and services.[368]

5.2.3. State Climate Change Policy

States having to contend with drier conditions have different regulatory and policy issues than states facing wetter conditions; coastal states have sea-level rise concerns which are not necessarily shared by inland states. Action at the state level can also make up for the lack of federal response. The question of how and to what degree the federal government and the states should share responsibility for tackling the problem is continual. Although the federal level plays an important role in climate change action, perhaps a focus on further decentralization could contribute to more effective responses, as states bring an understanding of the unique circumstances within their boundaries and a familiarity with their stakeholders. States can serve as laboratories and have historically acted more quickly for developing new, innovative policies. States have also had a history in driving federal action, sometimes insisting that policies be strengthened even after the federal government has acted.

Although adaption roles vary depending on the unique specifications of each area, mitigation roles are not substantially different from one state to another, centering on the reduction of greenhouse gas emissions. Land planning specifically occurs in state and local municipalities, which often serve as policy initiators, developing models for federal action. State climate action plans will typically cover energy efficiency in procuring and operating vehicles and buildings and promotion of land use patterns. There is promotion of energy efficient transportation systems, and regulation of utilities to minimize carbon sequestration. Additionally, in the area of climate change adaptation, state climate plans will cover hazards management issues which are of specific concern, for example, the saltwater intrusion in Florida.

Within each state, there are varying levels of cooperation, regionally and locally. Regional and interstate cooperation addresses issues such as water supply and drought response. Failure to achieve cooperation can result in legal actions, such as the recent lawsuits between Georgia, Tennessee and Florida concerning access to water basins in river systems.[369] Even more rapidly than federally and regionally, local efforts to mitigate climate change are occurring. Local jurisdictions are

[368] United States Department of Agriculture, "Forest Stewardship Program", http://www.fs.fed.us/spf/coop/programs/loa/fsp.shtml (accessed March 30, 2012)
[369] A. Appel, Peter, University of Georgia School of Law, "Water Wars -- Will Georgia, Alabama and Florida Ever Agree?" (2007)

where streets and homes are flooded, where infrastructure is installed, where potable water is supplied, and were building permits are issued. When storms and droughts occur, citizens look to their local governments for answers and solutions, as well as for protection. When citizens desire more energy-efficient buildings and development patterns, local plans, incentives and regulations help build these proposals. While some communities have adopted climate change mitigation and/or adaptation plans, almost every community has some land use, capital improvement and hazards management planning activities or programs. These plans and programs can form the basis for responses to climate change at the local level, compensating for and contributing to the overall national and state climate change gaps.

One interesting up-and-coming example is the "Smart Growth" program. The purpose of these programs is to implement creative strategies to develop ways that preserve natural lands, protect water and air quality, and reuse already-developed land. The program works to conserve resources by reinvesting in existing infrastructure and reclaiming historic buildings, designing neighborhoods that have shops, offices, schools, churches, parks, and other amenities near homes and communities. Relevant to land, these programs preserve open space, farmland, and critical environmental areas, improve transportation choices and redirect development to be predictable, fair, and cost effective. Smart Growth is meant to enhance local residents' participation in development decisions and the community remains economically competitive, while creating business opportunities and improving the local tax bases.

One example of a land use / land cover Smart Growth initiative in the state of Maryland is their Land Use & Cover map,[370] used to show development trends on landscape. The map classifies the land area of Maryland into 13 distinct types of land use such as residential, commercial, industrial density, or land cover, such as agricultures and forest. The map is used by other state agencies and public and private stakeholders to follow trends in land development and consumption of resource land over time. For example "The rate of development in Maryland continues to outpace population growth", "The number of developed acres per person has increased by more than 80% since 1973", and "Over 1 million acres of forest and agricultural lands have been developed since 1973."[371] From these trends, the state of Maryland has been able to determine impacts on the environment, economy and communities such as "Low density development results in the loss and fragmentation of forest land which decreases ecological diversity, economic benefits and recreational value. "Low density residential development converts agricultural land and diminishes the viability of operating

[370] Maryland Department of Planning, "Land Use/Land Cover", last modified August 16 2011, http://www.mdp.state.md.us/OurWork/landuse.shtml (accessed March 30, 2012)
[371] The Maryland Department of Planning, "A Summary of Land Use Trends in Maryland" (2010), 5

agricultural uses by inserting incompatible uses nearby"[372] etc. allowing the state and local communities to better plan climate change and land use policies. The following examples provide a more detailed overview on some state policy responses.

The Commonwealth of Massachusetts

Climate change in Massachusetts is currently endangering local rivers and wetlands, forests, fisheries, agriculture, recreation/tourism and infrastructure/developed land. The Massachusetts Environmental Policy Act (MEPA) has required that all major projects proposed with state involvement (in the form of state permits, land transfers or financial assistance, for example) must perform an assessment of project impacts and alternatives in an effort to avoid, minimize, and mitigate damages to the environment. More specifically, the MEPA Green House Gas (GHG) Policy requires that certain projects undergoing review by the MEPA office quantify their GHG emissions and identify measures to mitigate such emissions which are applied to commercial and residential real estate development projects in addition to industrial and energy generation projects. Buildings consume more than 50% of the energy used in Massachusetts and are therefore responsible for the greatest GHG emissions of any sector. Transportation is second only to buildings in responsibility for GHG emissions in the state. The MEPA GHG Policy supports the development of industries and jobs to promote energy efficiency upgrades, fuel switching, incorporation of renewable energy measures and reduction of vehicle miles traveled. To date, more than 90 projects have been at least partially reviewed in accordance with the MEPA GHG policy, and 32 projects have completed MEPA review with a finding that their GHG analysis adequately complied with the MEPA GHG Policy. Projects that have completed review have achieved an average reduction of 19.5% in stationary-source GHGs below an equivalent inefficient energy project. In total, the MEPA GHG Policy has resulted in reducing GHG emissions by over 70,000 tons per year to date.[373]

Oregon

The State of Oregon is currently facing several climate threats including increases in average temperatures, possible changes in precipitation, increased storm intensity, rising sea levels and related changes in snow packs, stream flows, and flooding.[374] Oregon has undertaken specific policy and rulemaking work to advance land use and transportation scenario planning to achieve greenhouse gas emission reduction targets. The bill HB 2186, still working to be implemented, will result in a Metropolitan Planning Organization Greenhouse Gas Emissions Task which enforces the

[372] The Maryland Department of Planning, "A Summary of Land Use Trends in Maryland" (2010), 6
[373] A. Bowles, Ian. Secretary of Energy and Environmental Affairs, "Massachusetts Clean Energy and Climate Plan for 2020" (2010)
[374] The State of Oregon, "The Oregon Climate Change Adaptation Framework" (2010), 29

preparation of land use and transportation scenario plans illustrating potential future land use patterns that achieve greenhouse gas emission reductions.[375] This policy is unique because there are numerous parties involved on a local, state and national level including The Oregon Transportation Commission (OTC) and LCDC chairs which make up the vice chairs of the 16-member task force. State agencies working with the task force include the Department of Environmental Quality, Agriculture, Energy, Department of Transportation, Department of Fish and Wildlife, Forestry, Water Resources and Global Warming Commission. Local government organizations include the Oregon Coastal Zone Management Association, County Planning Directors, City Planning Directors Association. Environmental groups also are included such as 1000 Friends, Oregon Environmental Council, Goal 1 Coalition, Nature Conservancy and Defenders of Wildlife. Each sector has their own abilities and expertise, and are cooperating to develop state-level adaptation plans, pilot planning efforts with communities in different regions of the state to develop local adaptation plans and implementation of the mitigation efforts. Oregon has focused on adaption partnerships strategy to allow the legislative to create an interim agreement on climate change.[376]

California

Political leaders and climate change researchers in California argue that California is leading the United States in disseminating policies to reduce greenhouse gas (GHG) emissions. Its policies are intended to substantially reduce the amount of fossil fuels used in the state and the carbon intensity of the state's energy usage. California is also cited as a model for coordinated actions in other western states and adjacent Canadian provinces, specifically after leading policies being adopted in the European Union. Current land policy and activities have focused on encouraging the development of sustainable communities and the Senate Bill 375, requires Metropolitan Planning Organizations (MPOs) to prepare Sustainable Community Strategies (SCS) and include them in their Regional Transportation Plans (RTPs). The Climate Change Land Use and Infrastructure (CCLU-In) working group is a multi-agency subcommittee that advises the Climate Action Team (CAT) on the implementation of climate change adaptation and mitigation measures as they relate to land use and infrastructure.

Annex X gives an overview on California land policy and programs by agency, description, and the sectors which are impacted.

[375] Senate Bill 1059, enacted by the to adopt and implement "plans for reducing greenhouse gas emissions caused by motor vehicles with gross vehicle weight rating of 10,000 pounds or less" http://www.leg.state.or.us/10ss1/measures/sb1000.dir/sb1059.en.html (accessed March 30, 2012)
[376] Oregon Department of Land Conservation and Development Commission, "Planning for Climate Change" (2009)

Questions of effectiveness of policies also come into play. The Sonoran Institute-Lincoln Institute of Land Policy Joint Venture did a study on five Western states and their land use policies (see Table 4) to determine if land use policies were contributing to green house gas emission reduction and which type of policies were the most effective.

Figure 5.XVI: Summary of key figures from the five state climate action plans in regards to land use analyzed

	Arizona	California	Montana	New Mexico	Washington
	Arizona Climate Action Plan – August 6, 2006	California Climate Action Team Report – March 2006	Montana Climate Change Action Plan – November 2007	New Mexico Climate Change Advisory Group Final Report – December 2006	Washington Climate Advisory Team Technical Working Group (Agriculture; Energy Supply; Forestry; Residential, Commercial, and Industrial; and Transportation) Final Draft Priority Documents – December 21, 2007.
Total Number of Climate Action Policies	35	39	48	64	58
Total Potential GHG Emissions (MMTCO2e)	645.3	138.5	125.5	322.9	448.2
Total Land Use Planning-Related Policies	11	8	10	19	13
Total Potential GHG Emissions Reduction Potential from Land Use-Related Policies	5	25.32	12.75	56.50	110.87
Percentage of Total GHG Reductions Possible from Land Use Planning Policies	19.9	18.3	10.2	17.5	24.7

Source: Carter, Rebecca, Sonoran Institute-Lincoln Institute of Land Policy Joint Venture, "Land Use Planning in the Changing Climate of the West", last modified May 2008, http://www.southwestclimatechange.org/feature-articles/land-use-planning (accessed March 30, 2012)

The authors were able to determine that in these five states, the most effective greenhouse gas emissions reduction policies were related to green building and other building energy efficiency

policies, accounting for about 6% of total emissions reductions needed. These policies are also among the most cost effective, providing savings of nearly US$20 for every metric ton of CO_2 avoided. Improved transportation and land use policies, most related to smart growth, were the second most effective land use-related polices to implement and would result in a slight cost savings. Support for combined heat and power, which involves the development and dissemination of more efficient building power systems, would also be an effective policy in terms of emissions reduction potential and cost savings. On the other hand, policies to preserve open space and agricultural land from development would be less effective and more costly, despite the large benefits, such as open space protection and species habitat. Conversely, as outline in the impacts section of this report, these areas (agriculture, forestry, wetlands) are some of the most significant impacting factors in land use and climate change and essential in making a substantial environmental difference in the United States. One can conclude that despite the imperative nature to revamp the agricultural and forestry sectors to reduce greenhouse gases, the costly and time consuming nature prevents states and local authorities, where most of the climate change preventive action is occurring, to make these areas a priority. There is a disconnect on a federal, state and local level of prioritizing threats and contributing to transformation, allowing climate change to continuously negatively affect the country and local citizens.

5.2.5. Social Implications

Similar to most countries, the poorest communities in America will be receiving the brunt of climate change impacts, as those who are vulnerable are the ones who are least able to anticipate, cope with, resist and recover from the worst consequences. To further examine California, in a study on nine California counties from May through September of 1999–2003, researchers found that with a 10°F increase in apparent temperature, there was a 2.3% increase in non-accidental deaths. The risks were higher for the elderly, young children and especially modified by race/ethnic group, particularly with a focus on African Americans.[377] During a July 15–August 1, 2006 heat wave in California, 16,166 more people visited the emergency room and that there were 1,182 additional hospitalizations statewide, than a comparable time period when there was no heat wave. Other studies have pointed out that there was a six-fold increase in heat related emergency department visits and a more than 10-fold increase in heat-related hospitalizations. These various result indicate that increases in ambient temperature have important public health impacts on death.

[377] Ostro, Bart D, Lindsey A Roth, Rochelle S. Green, and Bas Rupa, California Climate Change Center, "ESTIMATING THE MORTALITY EFFECT OF THE JULY 2006 CALIFORNIA HEAT WAVE" (2009)

Low-income urban neighborhoods and communities of color are particularly vulnerable to increased frequency of heat waves and higher temperatures because they are often segregated in inner cities[378], where there is a positive relationship between the presence of concrete, heat-trapping surfaces and community poverty. This suggests the potential for a disproportionate burden of exposure to heat for low-income populations, specifically for people of color which are amongst the poorest communities in America.[379] Additionally, California's agricultural and construction workers, who are predominantly Mexican and Central American immigrants, have experienced severe heat-related illness and death with a potential increase in recent years. These workers are vulnerable because of the cumulative impacts of their long workdays under strenuous conditions, limited capacity to protect their rights, and exposure to chemicals such as pesticides. Studies have also showed the increased rates of illnesses statewide only among Latinos/Hispanics which may be related to occupational heat exposures among Latino/Hispanic crop workers.[380]

In addition to increased heat, climate change will affect the United States' resources which will largely affect citizen's ability to access those resources. The Natural Resources Defense Council (NRDC) has predicted that between the years 2025 and 2100, the cost of providing water to the western states in the United States will increase from US$200 billion to US$950 billion dollars per year, representing an estimated 0.93–1% of the United States' gross domestic product (GDP). Further, it is predicted that, under the same scenario, annual U.S. energy expenditures (excluding transportation) will be US$141 billion higher in 2100 than they would be if today's climate conditions continued throughout the century. Four climate change impacts: hurricane damage, energy costs, real estate losses, and water costs, alone are projected to cost 1.8% of the GDP of the United States, or, just under US$1.9 trillion in 2008 U.S. dollars by the year 2100.[381] The burden of rising costs will fall disproportionately on lower-income households. Low-income families spend a significant portion of their income on food, energy and other household needs and with climate change, that spending gap will grow. Low income families are less able to afford investments that can reduce their energy demand, such as a more efficient car or a new heating and cooling systems. There is no question that higher energy prices affect households with limited incomes the most.

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[378] Schulz, Amy, et al., "Unfair Treatment, Neighborhood Effects, and Mental Health in the Detroit Metropolitan Area." *Journal of Health and Social Behavior*, 41. no. 3 (2001), http://www.jstor.org/stable/2676323 (accessed March 30, 2012), 314-332

[379] Applied Research Center, "CHECK THE COLORLINE: POVERTY FACT SHEET" (2008),

[380] Luginbuhl, RC, LL Jackson, DN Castillo, and KA Loringer. Morbidity & Mortality Weekly Report, "Heat-Related Deaths Among Crop Workers -- United States, 1992-2006", last modified August 18, 2008 http://www.medscape.com/viewarticle/576721 (accessed March 30, 2012)

[381] Ackerman, Frank, and Elizabeth A Stanton, Natural Resources Defense Council, "The Cost of Climate Change" (2008), 4

Many of those working in industries that will be affected by climate change, such as agriculture, will face job insecurities. Increases in the frequency and the intensity of extreme weather events will reduce productivity and potential revenue losses in farms that could lead to layoffs. Changing weather and precipitation patterns could require expensive adaptation measures, such as relocating crop cultivation, changing the composition or type of crops. Changing of agricultural systems may lead to the revamping of economic opportunities and again, job loss. The disproportionate impact of extreme weather events on low-income families and people of color could exacerbate homelessness, due to the lack of access to insurance and emergency credit, less savings, fewer personal resources, and disproportionate suffering from previous economic stress. Furthermore, when government spending is relocated to manage disaster relief, low-income communities may suffer as funds may be diverted away from education, social programs, public transportation programs, health, and other economic sectors.[382] Low-income and minority communities are also disproportionately live near highways, industrial estates and goods transport corridors and will continue to bear the burden of increasing green house gases,

Thus far, there have not been significant mitigation measures legally implemented to avoid these social implications. However, there have been possible strategies identified to be explored that may contribute to reducing climate related illnesses and deaths, particularly in the most vulnerable communities. One of the most stressed solutions includes encouraging a cap-and-auction or the sale of emission credits to polluters versus a free system. A fee based market could generate sizable revenues that could be used to offset higher costs particularly for those who are most vulnerable to rising prices, contributing to tax cuts, investments in clean energy, high-value investments such as transportation, or through direct periodic dividends to consumers. Another solution proposed is more focused planning in poor and minority neighborhoods, distributing preparedness strategies which include information about avoiding extreme heat exposure and addressing land planning that prioritizes vulnerable groups who live in neighborhoods and face high climate risks. To support proactive solutions there is a need for new mapping technologies to identify vulnerable neighborhoods, research on energy sources to avoid the dangers of food shortages and food price increases associated with the production of ethanol and other biofuel crops, mitigation feedback on infrastructure protection, efficient and effective air-cooling technologies, and surveillance for emerging infectious diseases. Fields to explore for policy may include the pollution reductive and economically sound systems, the anticipation of inevitable job shifts, and functions that absorb the higher prices for energy and other basic necessities.

[382] Morello-Frosch, Rachel, et al. "The Climate Gap", http://dornsife.usc.edu/pere/documents/ClimateGapReport_full_report_web.pdf (accessed April 02, 2012)

5.3. Canada

By early spring of 2006, the once verdant forests of British Columbia were turning a deathly reddish hue. A common forest insect, the pine beetle, was ravenously feasting on the region's lodgepole pine trees and spreading into neighboring Alberta and northern Washington in the United States. The rate of infestation was unprecedented. "This is an all-out battle", declared David Coutts, Alberta's minister of sustainable resource development. Scientists were shocked at how the pine beetle was attacking younger trees and at higher altitudes than ever before. By March 2006, the infestation, which had killed 411 million cubic feet of trees and infested 21 million acres, was deemed the largest known insect infestation in North American history by the Canadian Forest Service. [383]

The pine beetle population had historically been kept in check by Canada's frigid winters. But due to increasingly mild cold seasons, common forest pests are thriving more than ever before. The consequences for Canada's abundant forests are serious. As global temperatures are expected to continue to rise, the effects will play out and change our environment and the way we live. Hence, it is worth examining how climate change will affect Canada's land territory and the vast implications it has socially and economically.

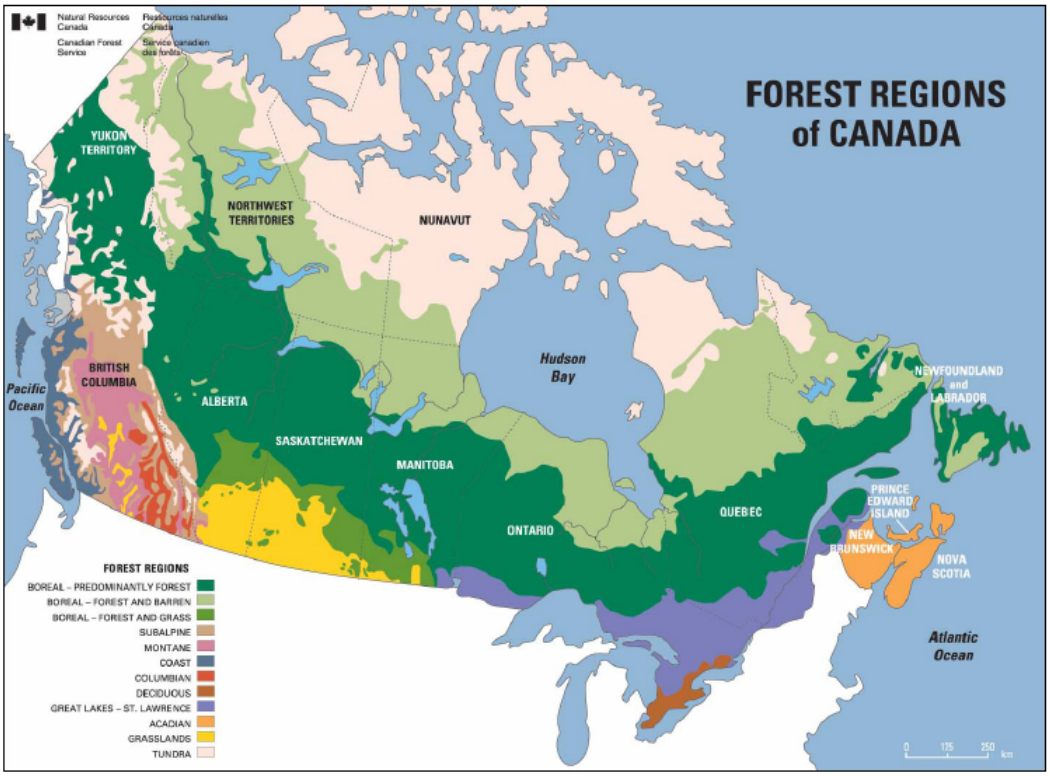
5.3.1. Climate Change Impacts

With 10% of the world's forests, nearly half of Canada's territory is forested.[384] Canada is also home to 30% of the world's boreal forests, second only to Russia.[385] Together, these boreal forests form the world's largest terrestrial biome. And with 20% of the world's freshwater, Canada's forests play an important role protecting this vital resource.[386] Thus, it is without difficulty to conceive that ecologically speaking, Canada stands to be affected greatly by climate change. Due to its northerly latitude, warming models project even greater rises in temperature in Canada than the global average.[387] For the boreal forests of Canada, this is especially troubling, as the IPCC's Second

[383] Struck, Doug , "Beetle Wiping Out Pines in Canadian Forests", The Washington Post, March 2, 2006, http://news.google.com/newspapers?nid=A7-hzOuI2KQC&dat=20060302&printsec=frontpage&hl=en, 2
[384] Johnston, Mark, *et al.,* "Adapting Forest Management to the Impacts of Climate Change in Canada", BIOCAP Canada, March 2006, 3
[385] Williamson, Tim, *et al.*, "Climate Change and Canada's Forests: From Impacts to Adaptation", Sustainable Forest Management Network, 23
[386] Johnston, Mark, *et al.* "Adapting Forest Management to the Impacts of Climate Change in Canada", 3
[387] Williamson, *et al.*, "Climate Change and Canada's Forests: From Impacts to Adaptation", 1

Assessment had concluded that boreal forests are more vulnerable to climate change than temperate or tropical forests.[388]

Figure 5.XVII: Distribution of Forest Types in Canada



Source: Lemmen, Donald and Fiona Warren, "Climate Change Impacts and Adaptation: A Canadian Perspective", Government of Canada, 2004, 73

Projections indicate that the southern extent of Canada's boreal forests will move 150 to 200 kilometers northward, leaving a 100-kilometer grazing belt in the short term.[389] Climatically suitable habitats for boreal plant species will migrate northward and toward higher elevations. However, the actual rate of species will lag behind the movement of climatic niches within the forest ecosystem. This is due to an array of reasons: first, the rate of species migration is slower than climatic development; second, current species are still on-site, crowding out new species; third, complex interactions between organisms must occur to prepare a site for new species; and fourth, the soil chemistry may be inappropriate.[390] Over time, tree species will acclimate, adapt, and migrate.

[388] Williamson, *et al.*, "Climate Change and Canada's Forests: From Impacts to Adaptation", 23
[389] Stennes, Brad, *et al.*, "Climate Change and Forestry: What Policy for Canada?", Canadian Public Policy (Vol. 24) Special Supplement 2, May 1998, http://www.jstor.org/pss/3551883 (accessed April 02, 2012), S98
[390] Williamson, *et al.*, "Climate Change and Canada's Forests: From Impacts to Adaptation", xiii

However, the rate at which climate change affects local conditions and the complex interactions that form a tree's lifecycle may outpace natural adjustment. If so, climate change will cause trees to become increasingly maladapted to their own ecosystem. The general implications are reduced vigor, less successful regeneration, reduced net productivity, and reduced species ranges.[391] Climate change will likely affect the composition and coverage of tree species in the boreal forests. Two important trees in the boreal forests are the white spruce and black spruce. In areas that become wetter, white spruce is expected to dominate; whereas in areas that will become drier, black spruce will prevail. However, various studies suggest that these two tree varieties are among the most sensitive to climate change and will decline between 20-50% as temperatures rise.[392]

Over the previous century, Canada has warmed by an average of 1 ° C, causing plant growth at mid to high elevations to increase, as well as prolonging the growing season.[393] Between 1981 and 1999, researchers observed an average 12-day increase in the growing season in North America. And in the North American boreal forests, spring thaw advanced forward 13 days between 1988 and 2001. Trees' response to climate change is also evident: bud bursts of sugar maple trees is occurring much earlier than it did a hundred years ago; the flowering period of the aspen poplar is occurring 26 days earlier than a hundred years ago; black spruce trees have been growing taller since 1970. The tree elevation in the Yukon has moved north and risen in elevation over the last century, encroaching on alpine ecosystems.[394]

Climate interacts with several factors in an ecosystem to affect the growth and well-being of tree and plant species. Higher temperatures could positively influence plant productivity (measured as biomass) if temperatures had been limiting growth previously, and if there are ample products for the plant to consume (e.g. soil nutrients) during cellular respiration. However, if there is more plant respiration than photosynthesis, climate change would exacerbate a decline in plant productivity. [395]

Soil capacity for retaining water is another important factor to consider in how climate change will affect Canada's forests. Most of central and western Canada is predicted to experience temperature increases without significant precipitation increases. This heightens the risk of moisture deficits.[396] Research in Saskatchewan found that soils with low water capacity (less than 100-mm storage) would likely lead to productivity declines under all climate change scenarios. Moderate capacity (100-200-

[391] Johnston, *et al.,* "Vulnerability of Canada's Tree Species to Climate Change and Management Options for Adaptation", 4
[392] Williamson, *et al.*, "Climate Change and Canada's Forests: From Impacts to Adaptation", 24
[393] Lemmen, Donald and Fiona Warren, "Climate Change Impacts and Adaptation: A Canadian Perspective", 74
[394] Williamson, *et al.*, "Climate Change and Canada's Forests: From Impacts to Adaptation", 3
[395] Williamson, *et al.*, "Climate Change and Canada's Forests: From Impacts to Adaptation", 16
[396] M. Johnston, *et al.,* "Vulnerability of Canada's Tree Species to Climate Change and Management Options for Adaptation", Canadian Council of Forest Ministers, 2009, 16

mm storage) soils would experience productivity increases initially under higher temperatures, but would decline over decades. High capacity soils (over 200-mm storage) would experience increased growth throughout the next century because there would be sufficient water to support higher productivity. [397]

In addition to maladaption, a warmer atmosphere is expected to generate increased environmental disturbance in the form of extreme weather and climatic events. One such climatic event is drought. For example, from coast to coast, nearly all of southern Canada was warmer at the end of the 20th century than it was at the beginning.[398] As such, increased evaporation and drought has had a severe effect on Canada's southern boreal forests, especially in the case of British Columbia, where drought, among other climate-related factors, is contributing to a massive die-out of lodgepole pine trees.[399] There could be a vast reduction in the northern boreal forests as permafrost thaws under warmer temperatures. By 2050, as much as half of the permafrost will have melted, giving way to treed wetlands, with drastic implications for the ecosystem. [400]

Drier conditions and warmer temperatures also exacerbate forest fires, which will have especially harsh consequences for Canada. Significant changes in Canada's forest fires are projected to occur by mid century, and may reach a tipping point in overwhelming Canada's current fire management capacity. Reduced moisture not only improves general burning conditions, but provides additional fuel in the form of dead vegetation. One analysis in 2005 estimated that climate change in Canada will increase the area burned overall by forests fires between 74%-118% by 2080-2100. However there is wide variation in the extent of increased forest fires over each area. The boreal northern cordillera ecozone, which occupies the northern third of British Columbia and the southern half of Yukon, is expected to see an increase between 233%-240% in burned area; whereas the average annual burn in the western boreal shield, which covers a wide swath between Alberta and Newfoundland, will see an increase between 67%-92%. As for the eastern boreal shield, which is moister, the lower range of the burn increase is only 9%, while the upper range under some models is 245%.[401] Additionally, warming may increase lightning activity, which researchers suggest is related to climate change. If so, the previous burn figures may already be conservative estimates.[402]

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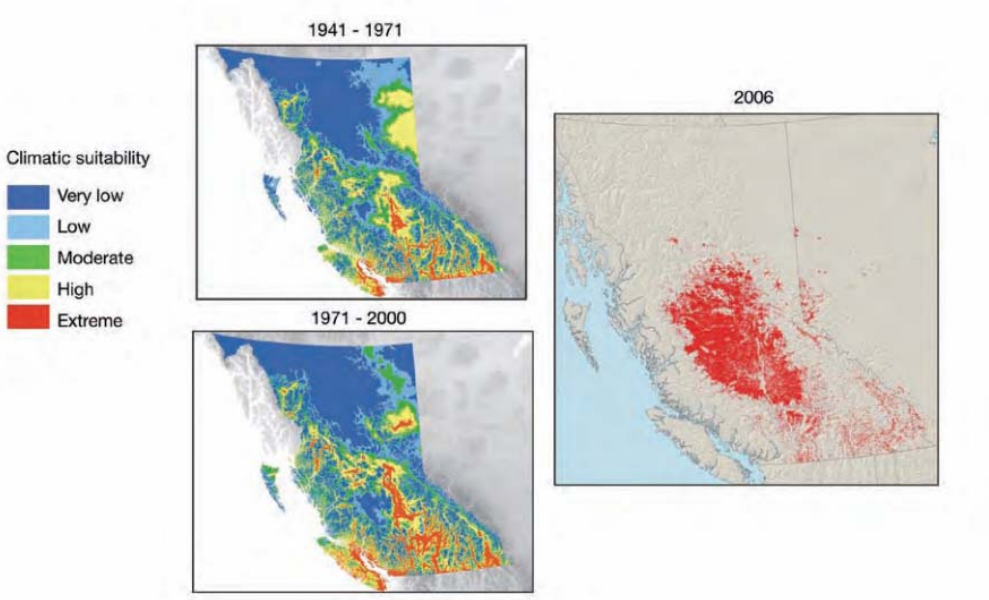
[397] Williamson, *et al.*, "Climate Change and Canada's Forests: From Impacts to Adaptation", 17
[398] Mark Johnston, *et al.* "Adapting Forest Management to the Impacts of Climate Change in Canada", 6
[399] M. Johnston, *et al.,* "Vulnerability of Canada's Tree Species to Climate Change and Management Options for Adaptation", 8
[400] M. Johnston, *et al.,* "Vulnerability of Canada's Tree Species to Climate Change and Management Options for Adaptation", 31
[401] Williamson, *et al.*, "Climate Change and Canada's Forests: From Impacts to Adaptation", 12-13
[402] Williamson, *et al.*, "Climate Change and Canada's Forests: From Impacts to Adaptation", 30

Another highly damaging consequence of warmer temperatures is increased forest pests. Higher temperatures can directly enhance reproduction of insects.[403] Increased summer temperatures will accelerate insect regeneration rates and may cause some insects to change from two-year regeneration cycles to one-year regeneration. Also, a warmer climate improves the overwinter survival rate of insects.[404] The mountain pine beetle, which feeds on the mature lodgepole pine, was generally considered a relatively innocuous forest pest until quite recently. There had been only four major outbreaks over the previous 120 years in British Columbia.

However, the current outbreak, which began in 2005, is over ten times larger than any previous infestation, and is predicted to kill 77% of the province's mature pine by 2014. The outbreak is currently spreading into neighboring provinces and establishing new populations.[405] Effects of climatic change are cited as the most likely causes of the mountain pine beetle outbreak in British Columbia. Abnormally warm winters in decades preceding the outbreak and the abundance of mature lodgepole pine have vastly optimized the mountain pine beetle's habitat. [406]

Figure 5.XVIII: Distribution of Climatically Suitable Habitats of the Pine Beetle in British Columbia



[403] Williamson, *et al.*, "Climate Change and Canada's Forests: From Impacts to Adaptation", 14
[404] [404] M. Johnston, *et al.,* "Vulnerability of Canada's Tree Species to Climate Change and Management Options for Adaptation", 21
[405] Williamson, *et al.*, "Climate Change and Canada's Forests: From Impacts to Adaptation", 6
[406] Williamson, *et al.*, "Climate Change and Canada's Forests: From Impacts to Adaptation", 7

Figure 5.XVII shows the distribution of climatically suitable habitats for the pine beetle across British Columbia between 1941-2006. Areas classified as "very low" are unsuitable for the mountain pine beetle, whereas areas considered "extreme" are climatically optimal.[407] Also the progression of climatically suitable conditions for the pine beetle across habitats in British Columbia between the years 1941-2006 can be seen. In the final image, the intensely colored region represents a large mass of territory classified as extremely suitable for the mountain pine beetle.

In another case, the Yukon is experiencing its largest outbreak of spruce pine beetle. Its numbers had been traditionally low, kept in check by cool wet summers and cold winters. However, the spruce pine beetle has infested over 340,000 trees in southwest Yukon and killed 1.6 million hectares of trees in Alaska. The rate of infestation in Alaska is on the decline, but this is due to the dwindling number of host trees. [408] The current outbreak is blamed on droughts and unusually warm winters, which have caused the spruce pine beetle's 2-year regeneration cycle to quicken into a single year.[409]

Climate change also influences forest diseases and pathogens. Elevated levels of CO_2 could result in higher canopy humidity and accelerate the reproduction of diseases, such as mildew, rusts, fungi. Meanwhile, as trees become less physically adapted to climatic conditions, their ability to combat diseases is weakened. In this state, trees are less able to produce chemical defenses needed to ward off pathogens. At present, 36 million cubic meters of timber is lost to disease annually (equivalent to one-third of annual harvest).[410] The advent of climate change in its effect on diseases and pathogens could, therefore, have a large impact on Canadian forestry in terms of decreased productivity and lower quality timber.

To adapt to the effects of climate change on Canada's forests, a number of measures can be implemented in the reforestation process. At present 48% of crown forest land is reforested following harvest. The process involves fertilization and implantation of genetically improved trees that had been raised in greenhouses for one to two years. However, to improve their adaptability to the effects of climate change, emphasis can be put on identifying and planting genotypes that are resistant to drought and common forests pathogens. Meanwhile, studies have suggested that breeding programs could be set up to select for pest resistance and greater toleration of climate change-induced stress. And in order to aid migration, commercially important species can be

[407] Allain Bourque, "From Impacts to Adaptation: Canada in a Changing Climate 2007", Government of Canada (2007), 8
[408] Williamson, *et al.*, "Climate Change and Canada's Forests: From Impacts to Adaptation", 7
[409] Allain Bourque, "From Impacts to Adaptation: Canada in a Changing Climate 2007", 22
[410] Johnston, Mark, *et al.* "Adapting Forest Management to the Impacts of Climate Change in Canada", 15

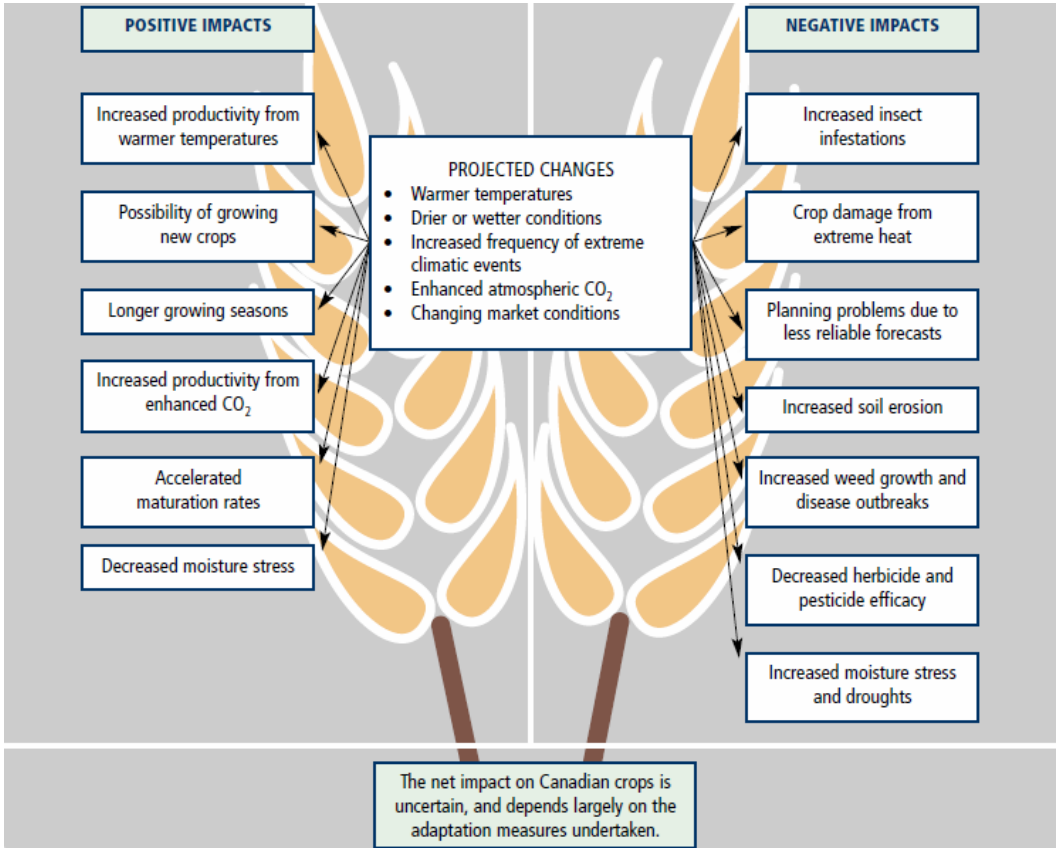
artificially migrated to areas where conditions are becoming more hospitable as a result of climate change. [411]

Agriculture

Due to limitations imposed by climate and soil conditions, only 7% of Canada's land is used for agricultural purposes. Experts from the IPCC agree that climate change would bring both positive and negative consequences for Canadian agriculture and effects would vary by region.[412] Warmer temperatures would lengthen frost-free growing seasons in northern regions and possibly expand areas suitable for agriculture. However, such effects will depend on the character of precipitation changes and soil quality (which is quite poor in the north). In southern regions, warmer temperatures and increased CO_2 could open up suitability for growing specialty crops, such as apples. However, such conditions may improve regeneration of common pests and increase evaporation.[413] Moisture constraints are already a limiting factor to agriculture in the Prairie Provinces (e.g. British Columbia, Alberta, Saskatchewan, and Manitoba). These limitations are expected to be significantly higher by mid century and irrigation requirements are predicted to rise 35% from historic values by the end of the century.[414] Figure 5.XVIII shows the potential impacts of climate change on Canadian agriculture.

[411] Johnston, Mark, *et al.* "Adapting Forest Management to the Impacts of Climate Change in Canada", 25-26
[412] Lemmen, Donald and Fiona Warren, "Climate Change Impacts and Adaptation: A Canadian Perspective", 53
[413] Lemmen, Donald and Fiona Warren, "Climate Change Impacts and Adaptation: A Canadian Perspective", 55
[414] Lemmen, Donald and Fiona Warren, "Climate Change Impacts and Adaptation: A Canadian Perspective", 57

Figure 5.XIX: Potential Impacts of Climate Change on Canadian Agriculture



Source: Lemmen, Donald and Fiona Warren, "Climate Change Impacts and Adaptation: A Canadian Perspective", 57

Using various climate models, researchers cited by a study commissioned by the Canadian government came up with predictions on the effects on specific crop yields under future climate change scenarios. To get a sense of how climate change may affect yields, it is worth considering the following projections:

- Canola, corn, and wheat would increase in Alberta by between 21%-124%.
- Sorghum and corn in Quebec would increase by 20%, while wheat and soybean would decline by 20%-30%. Canola, sunflowers, potatoes, tobacco, and sugar beets would benefit, while green peas, onions, tomatoes, and cabbages would decline.

- There could be an increase in grain corn and soybean yields in the Atlantic Provinces (e.g. Nova Scotia, New Brunswick, Prince Edward Island, and Newfoundland), while barley yields are not expected to change. Meanwhile, 50% of land seeded to small grain cereals and silage corn may shift production to grain corn and soybeans to maximize the gains of production. [415]

As these projections show, climate change would affect each crop differently based on the type and region it is grown in. For example, warmer winters would increase winter damage to some crops due to reduced cold hardening in the fall, increased thaw, and less protective snow cover, while other crops, such as fruit trees, would benefit from reduced cold stress and less bud damage.[416]

There are currently more than 90,000 livestock operations in Canada. Like farm agriculture, climate change is expected to bring both benefits and disadvantages to livestock production. Temperature is considered a highly important factor in livestock. Warmer temperatures reduce feed requirements, save energy, and increase survival rate of the young. However, heat waves can kill large numbers of animals. Additionally, increased heat negatively affects milk production, meat quality, and dairy cow reproduction. Warm summer temperatures have also been shown to reduce appetite and thus reduce weight gain.[417]

In regions with moderate to high water retention capacity in the soil, grassland pastures would experience a rise in productivity that would be beneficial to livestock grazing. On average, if the level of CO_2 in the atmosphere doubled, grassland pastures would increase by 17%. However, in the case of extreme weather events, increased temperatures could promote the invasion of alien species into grasslands. And in the case of droughts, moisture deficits would severely curtail grassland productivity and thus livestock production, as it did during 2001-2002.[418]

Adaptation options for Canada's agriculture industry range from changes in farm management to technological development to government policies. Farmers can diversify their crops to favor those that are expected to fare the best under future conditions. Water conservation, such as using snow management to increase the water storage, and improved irrigation can reduce water shortages. As well, to adapt to reduced moisture in pastures, cattle farmers can release livestock for grazing earlier and allow a longer grazing season. Development of heat-resistant and drought resistant varieties of crops could also play a big role in adaptation. At the government level, policies can be pursued to

[415] Lemmen, Donald and Fiona Warren, "Climate Change Impacts and Adaptation: A Canadian Perspective", 55
[416] Lemmen, Donald and Fiona Warren, "Climate Change Impacts and Adaptation: A Canadian Perspective", 58
[417] Lemmen, Donald and Fiona Warren, "Climate Change Impacts and Adaptation: A Canadian Perspective", 59
[418] Lemmen, Donald and Fiona Warren, "Climate Change Impacts and Adaptation: A Canadian Perspective", 59

encourage crop diversification, such as restructuring insurance programs that traditionally reduce farmers' propensity to adapt.[419]

Transport

Rising temperatures threaten the stability of Canada's roads in a number of ways. In the southern region, warmer summers would stress the structural integrity of pavement and roads. There would be more traffic-related rutting as a result of the roads softening and increased migration of liquid asphalt. Such problems would be costly in terms of repairs, disrupt supplies and services, as well as pose safety risks to drivers. However, an upside to warmer temperatures would be lessened damage from cracking pavement related to low-temperature frost action.[420]

Railways are also vulnerable to warmer climate. Extreme heat accelerates deterioration and may cause tracks to buckle. This has been suggested as a contributing factor to the Amtrak rail incident on July 29, 2002 in Marlyand, United States. However, as with roads, there would be less damage to railways associated with colder temperatures, such as frozen switches and the frequent need for wheel replacement.[421] In the case of the northern region, rising temperatures pose an even more serious problem for land transportation. Half of Canada is underlay with permafrost, with much of it in the north. This layer of permafrost provides a great deal of the structural integrity of the roads, airstrips, and rail lines. As warming increases thaw among the permafrost, the load-bearing capacity of the North's transportation infrastructure will decline. The problem is especially severe with asphalt roads, as these absorb solar energy and intensify the thawing of the permafrost. [422]

Ice roads also play an important role in transportation in the North, and as temperatures rise they will become less useful. The yearly window for which roads can be used would be shortened and/or costly alternatives would have to be utilized. Already, shortened ice road seasons have had serious social and economic implications, as the governments of Manitoba and Alberta have had to spend millions of dollars to fly supplies to communities that are normally serviced by ice roads. [423]

Decisions in design and construction can offset the intensity of climate-related damage on transportation infrastructure. To accommodate warmer temperatures, higher-quality asphalts, which are more expensive but more resilient, can be used in constructing roads. In the case of disappearing

[419] Lemmen, Donald and Fiona Warren, "Climate Change Impacts and Adaptation: A Canadian Perspective", 62-64
[420] Lemmen, Donald and Fiona Warren, "Climate Change Impacts and Adaptation: A Canadian Perspective", 136
[421] Lemmen, Donald and Fiona Warren, "Climate Change Impacts and Adaptation: A Canadian Perspective", 137
[422] Lemmen, Donald and Fiona Warren, "Climate Change Impacts and Adaptation: A Canadian Perspective", 137
[423] Lemmen, Donald and Fiona Warren, "Climate Change Impacts and Adaptation: A Canadian Perspective", xix-xxi

ice roads, where possible, transport could be replaced by barges. As for protecting infrastructure built on thawing permafrost, polystyrene insulation has been shown to improve the longevity of structures on permafrost. The insulation can be placed between the structure and the permafrost to reduce the transfer of heat into the permafrost. Another option is to construct temporary facilities that can be moved easily. [424]

5.3.2. Economic and social implications

As the world's leading exporter of forestry products, the forestry industry is an important part of the Canadian economy. Annually, it contributes 80 billion dollars to gross domestic product and US$34.5 billion to the trade balance.[425] At present the forestry industry directly employs 370,000 Canadians.[426] However, Canada's forests have been identified as uniquely vulnerable to climate change,[427] and in an analysis of projected market impacts of climate change on the forestry sector among major producers, Canada is the only one predicted to experience a net negative effect (see Figure 5.XIX). [428]

It is predicted that there will be a general increase in the global supply of timber and a restructuring of the global trade of forestry products. Canada's high labor and wood costs have already caused Canada to lose some global market share in recent years, but the effects of climate change are expected to increasingly favor countries whose forestry sectors will benefit more from a rise in temperatures.[429] Under current models, Canada's timber supply will decline, with the western region suffering more losses than the eastern region (see Figure 5.XX). As Figure 5.XIX shows, the loss to Canadian timber producers from climate change by the year 2040 is over US$13 billion per year.

[424] Lemmen, Donald and Fiona Warren, "Climate Change Impacts and Adaptation: A Canadian Perspective", 142-143
[425] Johnston, Mark, *et al.* "Adapting Forest Management to the Impacts of Climate Change in Canada", 3
[426] Lemmen, Donald and Fiona Warren, "Climate Change Impacts and Adaptation: A Canadian Perspective", 73
[427] Williamson, *et al.*, "Climate Change and Canada's Forests: From Impacts to Adaptation", 47
[428] Perez-Garcia, *et al.* "Impacts of Climate Change on the Global Forest Sector", Climatic Change (54) (2002), 453
[429] Williamson, *et al.*, "Climate Change and Canada's Forests: From Impacts to Adaptation", 47

Figure 5.XX: Market impacts of climate change in the year 2040

Market impacts of climate change in the year 2040 (Million $ 1993 U.S.)

Country	PS: Logging	PS: Products	CS	Total
Canada	- 408	-13,015	2,674	-10,749
Chile	3,879	394	351	4,624
West Europe	-644	120	1,701	1,177
Finland	-353	114	76	164
Japan	-1427	325	2,524	1,422
New Zealand	1,851	334	294	2,478
Sweden	-240	294	103	157
U.S. North	-758	-84	6,474	5,633
U.S. South	-5,149	69	6,937	1,720
U.S. West	1,069	6,354	7	5,292

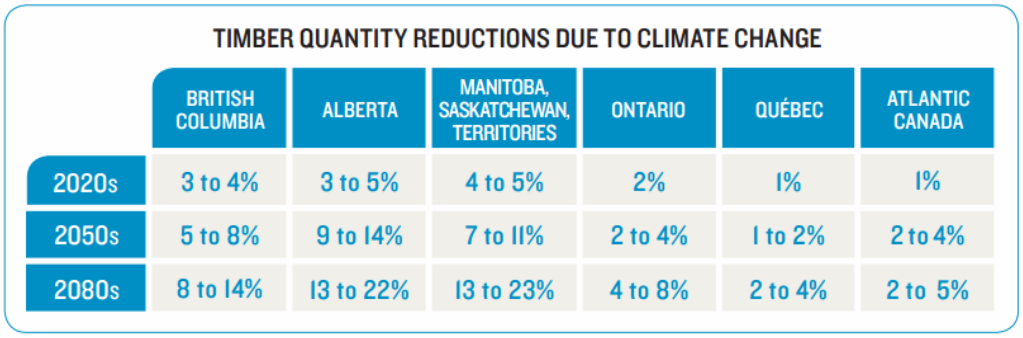
Source: Perez-Garcia *et al.* 2002

Market impacts of climate change in the year 2040

Note: The above results are from Perez-Garcia *et al.* 2002. The paper presents results for six separate scenarios. The results reported above are based on one of the scenarios (i.e. the mid range scenario - RRR-Intensive).
PS: Logging is producer surplus impacts for the logging industry
PS: Products is producer surplus for primary producers (e.g. lumber, pulp and paper)
CS is consumer surplus or consumer benefits.

Source: Johnston, Mark, *et al.* "Adapting Forest Management to the Impacts of Climate Change in Canada", 31

Figure 5.XXI: Timber quantity reductions due to climate change



Source: National Roundtable on the Environment and the Economy, "Paying the Price: the Economic Impacts of Climate Change for Canada" (2004), 52

Figure 5.XX shows the predicted decline in timber supply as a result of climate change from the 2020s through the 2080s. The trend of decline is even greater in the western provinces of the country.[430]

The predicted increase in forest fires will also be costly and affect society through property loss and the need for evacuations, negative health impacts from increased particulate matter, timber

[430] National Roundtable on the Environment and the Economy, "Paying the Price: the Economic Impacts of Climate Change for Canada" (2004), 52

shortages, and disruption or delays of harvests.[431] There is a consensus among studies that forest fires have increased over the last 20-40 years. To get a sense of how costly forest fires already are, consider that between the years 1990-2000, the average annual property loss from forest fires was US$7 million, and forest fire protection cost 400 million dollars per year.[432]

Though it is uncertain whether climate change will produce a net positive or negative effect on Canadian agriculture, it is worth considering that Canada's agriculture industry is the third largest employer with US$95 billion of revenue in the domestic market and earns another US$23 billion in exports.[433] Any change, therefore, on agriculture as a result of climate change will have an effect economically and socially.

Tourism, as an industry, in Canada is expected to experience some benefit from climate change through longer tourism seasons. Studies suggest that longer tourism seasons would result in increased revenue. This is especially relevant for Canada's northern region, where economic development has been a driving force behind tourism but has been traditionally limited by short travel seasons.[434] Revenue and visitation of Canada's 15 national parks will increase. At present, spending related to visiting national parks contributes US$1.5 billion to gross domestic product annually, with US$85 million going to the federal government. However, based on data that correlate monthly park visits and daily temperature highs, visitation rates to national parks are predicted to increase by an average of 6%-8% by the 2020s, 9%-29% by the 2050s, 10%-41% by the 2080s. As such, a rise in visitation would be of economic benefit to Canada.[435] Nevertheless it has to be considered, that benefits to tourism revenues will not be spread equally because climate change may influence various forms of outdoor recreation differently. Winter activities, such as skiing and snowboarding are vulnerable to climate change because the quality of the experience is highly dependent on climate factors. Studies suggest that increased temperatures will have an overall negative effect on the ski industry, due to a shortened season and reduced number of skiable days.[436]

Another consideration is the opening up of new areas for economic development that were previously unusable due to extreme cold. Known as "climate change boomtowns", these spots refer

[431] Williamson, *et al.*, "Climate Change and Canada's Forests: From Impacts to Adaptation", 13
[432] Lemmen, Donald and Fiona Warren, "Climate Change Impacts and Adaptation: A Canadian Perspective", 79
[433] Lemmen, Donald and Fiona Warren, "Climate Change Impacts and Adaptation: A Canadian Perspective", 53
[434] Bourque, Allain, "From Impacts to Adaptation: Canada in a Changing Climate 2007", 99
[435] National Roundtable on the Environment and the Economy, "Paying the Price: the Economic Impacts of Climate Change for Canada" (2004), 106
[436] Johnston, Mark, *et al.* "Adapting Forest Management to the Impacts of Climate Change in Canada", 37-38

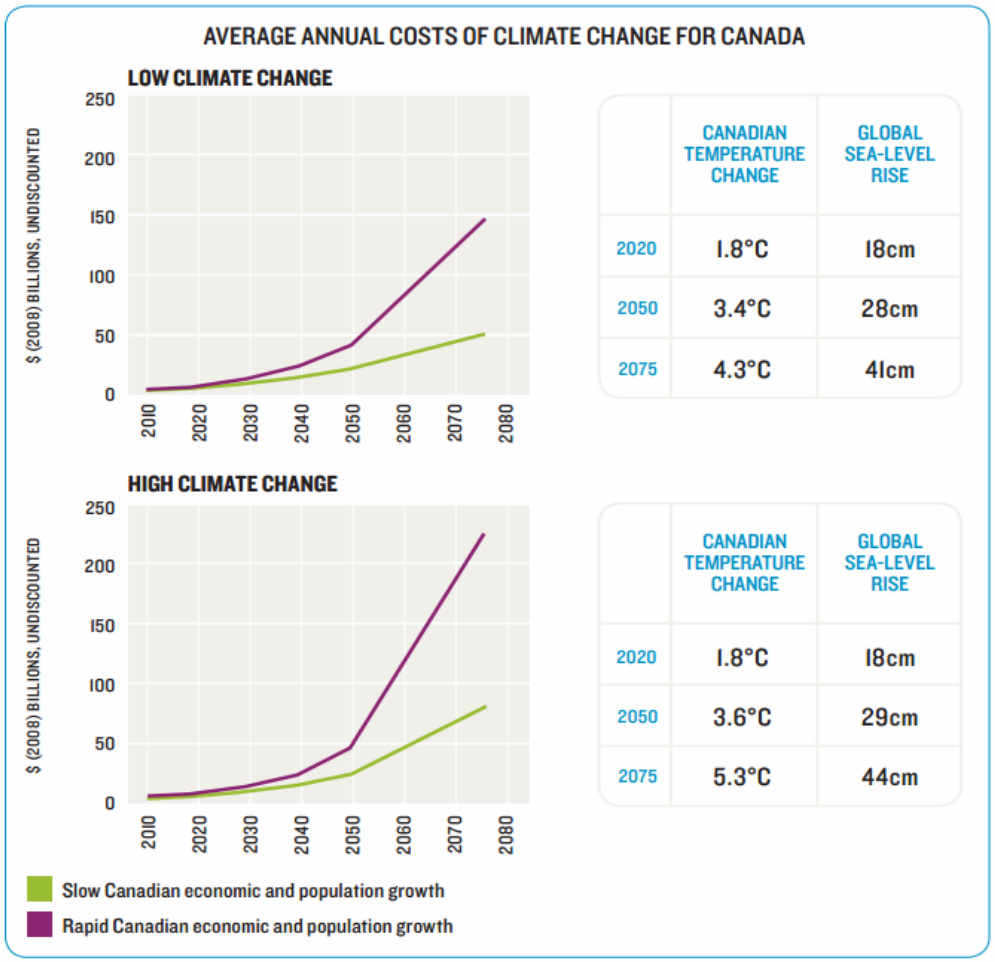
to sites on which investors are betting, that given more warming in the next few years, can be developed into strategic shipping routes through Canada's Northwest Passage.[437]

Despite perceived gains in some sectors of Canada's economy, the current outlook of climate change's effect on the overall picture is unfavorable. The costs and predicted losses associated with climate change are expected to reach US$5 billion per year by 2020 and increase between US$21-43 billion by 2050. The severity will vary based on the level climate change, and the losses depend on the value of the Canadian economy in the future, as higher growth would increase the costs (Figure 5.XXI). [438]

To respond to the impacts of climate change, Canada's government can pursue policies and programs that provide alternative employment to compensate for declining jobs in the conventional forestry sector. It can also invest in expertise in climate change economics to produce data that can inform the decisions of policy makers. It can seek to create better partnerships between government, the private sector, and expert bodies, such as universities, for data and analysis-sharing. At all levels, it can endeavor to generate research and disseminate information regarding the costs and benefits of adaptation. With such information in hand and in the public, government is better situated to act in pursuing policies and programs, as well as allocate scarce resources, in ways that are politically and economically viable to help Canada's economy to adapt.[439]

[437] Fowler, Adam, "Canada's Climate Change Boomtown", BBC News, January 2, 2008, http://news.bbc.co.uk/2/hi/business/7155494.stm (accessed April 02, 2012)
[438] National Roundtable on the Environment and the Economy, "Paying the Price: the Economic Impacts of Climate Change for Canada" (2004), 41
[439] National Roundtable on the Environment and the Economy, "Paying the Price: the Economic Impacts of Climate Change for Canada" (2004), 120

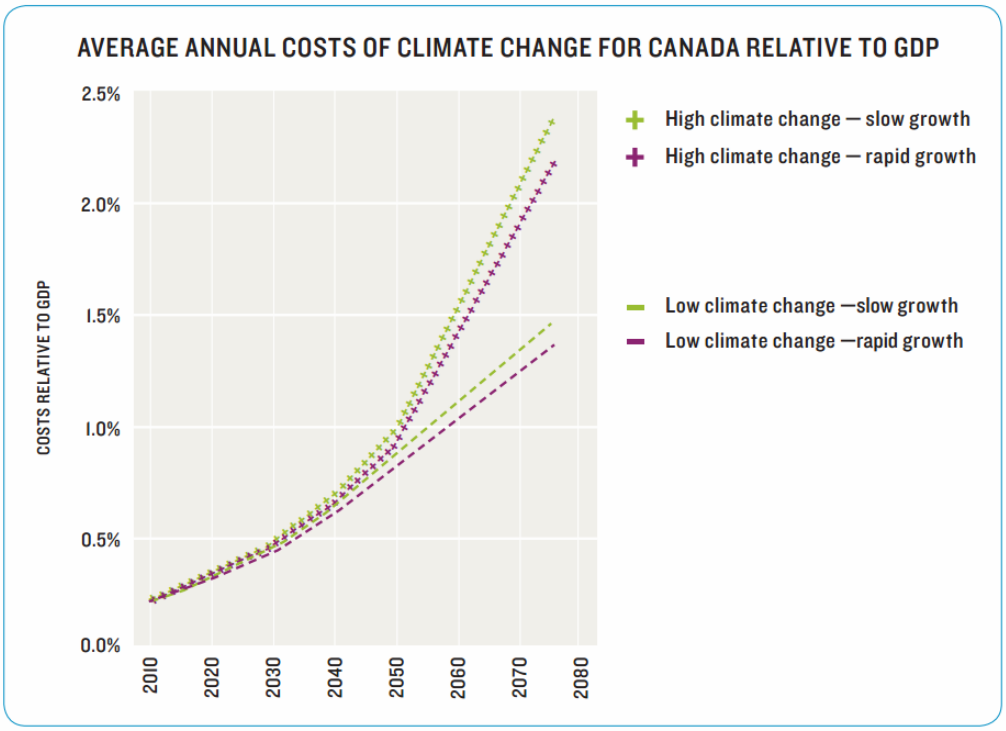
Figure 5.XXII: Average annual costs of climate change for Canada



Source: National Roundtable on the Environment and the Economy, "Paying the Price: the Economic Impacts of Climate Change for Canada" (2004), 41

Figure 5.XXI shows predicted average yearly costs on the Canadian economy over the current century associated with climate change. The figures are based on two scenarios: a slow economic growth model and a rapid economic growth model.

Figure 5.XXIII: Average annual costs of climate change for Canada relative to GDP



Source: National Roundtable on the Environment and the Economy, "Paying the Price: the Economic Impacts of Climate Change for Canada" (2004), 42

Figure 5.XXII shows predicted average yearly costs on the Canadian economy over the current century associated with climate change in relation to gross domestic product. The figures are based on two scenarios: a slow economic growth model and a rapid economic growth model. [440]

The negative health impacts of forest fires, strain on infrastructure, and economic disruption will be widespread, but some communities will be more severely affected by rising temperatures than others, such as rural resource-based communities in the North. Even though the service sector represents 70% of Canada's economy, 1,600 communities are more than 30% reliant on agriculture, forestry, fishing, or hunting.[441] In addition to their reliance on climate-sensitive resources, rural resource-based communities have adaptive ability constraints, such as being small and having

[440] National Roundtable on the Environment and the Economy, "Paying the Price: the Economic Impacts of Climate Change for Canada" (2004), 42
[441] Williamson, *et al.*, "Climate Change and Canada's Forests: From Impacts to Adaptation", 41

undiversified economies with over-specialized labor whose skills are not transferrable to other sectors.[442]

Climate change will especially alter conditions in northern ecosystems, with implications for animal migration routes, meat and fur quality, and availability of edible plants.[443] For example, climate change is predicted to displace caribou habitats and migration routes, which will negatively affect the Inuit communities that rely on this animal as a source of protein.[444] Warmer weather will also shorten the time fish can be netted before spoiling.[445] Already, there has been an observed decline in the amount of country food consumed in Inuit communities during the last 20 years. This is due to decreases in animal health, a deterioration of growing conditions for berries and edible plants, and increased food spoilage. [446]

Access to fresh water is also a concern for inhabitants of northern Canada. Declines in rain and snow, as well as an increase in sedimentation have led to reduced water levels in freshwater bodies. Increased sedimentation and algae growth have also had undesirable effects on the taste and quality, and this will likely raise the cost of water treatment in the future. In Nunavik and Nunatsiavut, government authorities have increased warnings to boil water before consumption. However, the Inuit are not used to doing this and do not like the taste of their other alternative, chlorinated municipal tap water. As such, many continue to drink from natural sources and suffer the negative health effects of not boiling. Another result of this situation is that more Inuit buy bottled drinking water, especially hunters who must travel long distances, adding to their living costs and altering their way of life.[447]

There will be an overall decline in the quality of infrastructure in Inuit-administered regions which are nearly entirely covered with permafrost,[448] putting these communities more at risk of infrastructure deterioration as a result. Additionally, thawing permafrost destabilizes local geographical features, leading to erosion and mudslides.

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[442] Williamson, *et al.*, "Climate Change and Canada's Forests: From Impacts to Adaptation", 48
[443] Ford, James, *et al.* "Climate Change Policy Responses for Canada's Inuit Population: The Importance of and Opportunities for Adaptation" (2009), 184
[444] Williamson, *et al.*, "Climate Change and Canada's Forests: From Impacts to Adaptation", 29
[445] James Ford, *et al.,* "Climate Change Policy Responses for Canada's Inuit Population: The Importance of and Opportunities for Adaptation", 184
[446] Nasivvik Centre for Inuit Health and Changing Environments, "Perspectives from Inuit Canada", Laval University (2005), 78
[447] Centre for Inuit Health and Changing Environments, "Perspectives from Inuit Canada", 81
[448] Ford, James, *et al.* "Climate Change Policy Responses for Canada's Inuit Population: The Importance of and Opportunities for Adaptation", 178

All physical changes brought about by climate change also have an effect on the culture and social order of the indigenous people of Canada's North. As traditional travel routes become unusable and animal migration patterns change, the Inuit are less active on their land. This results in behavioral changes and the cessation of various land-based traditional activities. Also, predicting fluctuations in the environment has long been a critical skill for the Inuit who had traditionally survived solely on the land. But because these fluctuations are increasingly erratic, this knowledge is no longer seen as useful as it once was. As a result, Inuit communities report that elders are more reticent in making predictions and in passing on traditions. Likewise, the youth are less knowledgeable of tradition and ways of survival. [449] This ultimately serves to diminish the revered position that the elders hold in the traditional social order.

As people who live close to nature, Canada's northern Inuit communities are highly adaptable, but much of what is necessary comes at a cost to their culture. For example, hunters can find alternate routes and adapt to changing migration times of local animal populations, as well as alter harvesting behaviors. But to make up for the decline quality and overall quantity of food that can be hunted, grown, or gathered, communities will have to rely on store-bought food or supplies brought in by the government. [450]

In other cases, adaptation for northern communities requires large amounts of resources. Sinking buildings and dangerous mudslides will require resources and capacities that are beyond what the communities can afford. Moving buildings, raising buildings, and installing supporting structures, can be done, but will be costly and require action from the Canadian government.[451] Relocation of whole villages may be required in some instances. The case of the Kivalina community in Alaska having to relocate shows potentially what could become of indigenous communities on Canada's Arctic coastline. Already, the Tuktoyaktuk community, on Canada's northern shore with the Arctic Ocean, is nearing a natural ultimatum to relocate due to rapidly eroding coastline and softening ground beneath them. But even though this hamlet is home to only 870 people, the Canadian government estimates it would cost US$50 million to move it.[452] Such a move would therefore be costly, potentially fraught with political complications, and once more affect the fragile traditions of the northern communities.

[449] Centre for Inuit Health and Changing Environments, "Perspectives from Inuit Canada", 71-73
[450] Centre for Inuit Health and Changing Environments, "Perspectives from Inuit Canada", 78
[451] Ford, James, *et al.* "Climate Change Policy Responses for Canada's Inuit Population: The Importance of and Opportunities for Adaptation", 187
[452] Ford, James, *et al.* "Climate Change Policy Responses for Canada's Inuit Population: The Importance of and Opportunities for Adaptation", 187

5.3.3 Canadian Climate Change Policy

Canada is a signatory to the United Nations Framework Convention on Climate Change (UNFCC) and the Kyoto Protocol. Since the UNFCC went into effect, Canada has submitted five National Communications reporting on its progress in reducing greenhouse gas emissions. However, Canada's participation in the Kyoto protocol is a contentious issue in domestic politics. A stalwart member of Canada's conservatives, Stephen Harper, criticized the treaty as being "a socialist scheme to suck the money out of wealth-producing nations" in 2002. Now, as prime minister of Canada, Mr. Harper is pulling his country out of the Kyoto protocol, becoming the first country to do so.[453] However, even under liberal government, which originally signed onto the UNFCC and the Kyoto Protocol, little was done at the federal level to address climate change. Between 1990 and 2009, Canada's carbon emissions rose 20.4%, making its original pledge under the Kyoto protocol – to cut emissions by 6% from 1990 levels – virtually impossible.[454]

Despite little action from the national government, provincial governments have been more active in addressing climate change. British Columbia, Manitoba, Quebec, and Ontario participate as full partners in the Western Climate Initiative (WCI), an association of western states in the United States and provinces in Canada whose aim is to evaluate and implement ways to reduce their carbon emissions and realize the benefits of doing so. Together, WCI represents 20% of US GDP and 79% of Canadian GDP.[455] Each member has submitted action plans with goals for reduced carbon emissions, achieved mainly through carbon taxes.[456] The most ambitious goal of the organization is to create an integrated cap-and-trade program. In 2011, WCI created Western Climate Initiative Inc., a non-profit corporation to provide administrative and technical services to support implementation of states' and provinces' emission-reducing plans.[457]

Case Study: Toronto's Climate Change Adaptation Strategy

In 2008, Toronto became one of the first Canadian cities to develop a comprehensive climate change adaptation strategy, detailing a number of short and long-term actions aimed at raising awareness, developing strategies, consulting the public, and including adaptive actions in the budgets of relevant

[453] The Economist, "Kyoto and out", December 17, 2011, http://www.economist.com/node/21541849 (accessed April 02, 2012)
[454] The Economist, "Kyoto and out", December 17, 2011, http://www.economist.com/node/21541849 (accessed April 02, 2012)
[455] Western Climate Initiative, "Clean Energy: Creating Jobs, Protecting the Environment" (2010), 3
[456] Western Climate Initiative, "Partner Climate Action Plans" (2012), http://www.westernclimateinitiative.org/climate-action-plans (accessed April 02, 2012)
[457] Western Climate Initiative, "History", http://www.westernclimateinitiative.org/history (accessed April 02, 2012)

departments of city government. This came after a decade of highly erratic weather through extreme heat, drought, flood, new insect pests, and an increase in heat-related deaths. [458] The plan set in motion more than 100 actions designed to adapt or reduce the impact of climate change.[459] The goals of the initiative are to:

- Provide a rationale for incorporating adaption to climate change into city government policies, programs, and activities
- Build on existing partnerships to engage stakeholders in urban areas, such as businesses and residents, in actions aimed at adaptation to climate change
- Describe programs already underway that provide protection from climate change
- Suggest short-term actions to increase protection from climate change and provide other benefits
- Recommend a process to systematically assess risk to the city from climate change, prioritize areas of action, and develop strategies to protect and reduce impact.[460]

In 2009, Toronto's government created the Environmental Protection Reserve Fund to fund the plan's objectives. Short term actions proposed by the strategy included various activities such urban tree planting, redesigning parking lots, and enforcement of tree protection. Actions aimed at the plan's long-term strategy were to be carried out over a two-year period between 2009- 2011. They are outlined as follows:

- Create internal mechanisms and processes for development of comprehensive adaptation strategy by working with city councils to establish mandates and coordinate with city agencies, develop work plans and funding strategies, and mobilize existing expertise.
- Engage the public and other stake holders through public meetings and with a website that gives updates.
- Incorporate climate change adaptation into city policies and high level plans.

[458] Kazmierczak, Aleksandra, and Jeremy Carter, "Adaptation to Climate Change Using Green and Blue Infrastructures", University of Manchester, June 2010, 8-9
[459] Official Website of the City of Toronto, "Climate Change Adaptation", http://www.toronto.ca/teo/adaptation/index.htm (accessed April 02, 2012)
[460] Kazmierczak, Aleksandra, and Jeremy Carter, "Adaptation to Climate Change Using Green and Blue Infrastructures", 9

- Undertake research to analyze how climate is changing locally and what the impacts are for the future.
- Develop a city-wide inventory of climate risks and vulnerabilities.
- Conduct risk assessments to prioritize impact.
- Identify and assessed adaptation options.
- Develop and implement climate change adaptation strategies.
- Develop monitoring and evaluation procedures.[461]

As the schedule of actions has recently come to a close, the overall impact of the strategy is yet to be seen. However, key takeaways from Toronto's experience with developing a comprehensive city-wide climate change adaptation strategy are:

- Interdepartmental cooperation was crucial for success of the project
- Involving staff in seminars, conferences, and related events was successful in gaining acceptance for the project
- The requirement to address mitigation and adaptation in budget plans was essential in mainstreaming adaptation thinking and action.
- Adaptation will require continued engagement, commitment by institutions, creative thinking, and funding.[462]

[461] Kazmierczak, Aleksandra, and Jeremy Carter, "Adaptation to Climate Change Using Green and Blue Infrastructures", 11-13
[462] Kazmierczak, Aleksandra, and Jeremy Carter, "Adaptation to Climate Change Using Green and Blue Infrastructures", 18

5.4. Mexico

"It's a tragedy because there is virtually no harvest," lamented Jorge Herrera, the governor of the northern state of Durango, where the impact of the 2011 Mexican drought has hit especially hard. At the end of 2011, over 70% of Mexico had been affected by its worst drought in 70 years, with reduced forecasts for Mexico's agricultural output and growing worries about diminishing water supplies.[463] [464] Because Mexico is no stranger to droughts, food security has always been a top priority. But the challenge of agricultural self sufficiency is increasingly complicated by extreme weather events and the prospect of rising global temperatures. Thus, the consequences of climate change on Mexico's environment with regard to land use, along with the social and economic consequences, are important considerations.

5.4.1. Climate Change Predictions and Vulnerabilities of Mexico's Environment

Eighty-five percent of Mexico's land is classified as arid or semi-arid with unevenly distributed rainfall. Mexico's southeastern tropical region, which represents 7% of its landmass and a small percentage of its cropland, receives 40% of its annual rainfall. Meanwhile, the Central Mexican Plateau constitutes 79% of the country's landmass, where 60% of the population and 51% of cropland are located; however, it receives only 12% of the nation's rainfall.[465] And throughout most of the country, evaporation exceeds potential precipitation.[466][467]

Future climate scenarios and their projected impacts vary in scale, but there is a general consensus among researchers on the direction of Mexico's climate: it will become hotter and dryer. A 2009 World Bank report on Mexico's agricultural sector and the Mexican government's Third National Communication both predict moderate temperature increases in Mexico by 2020, resulting in greater fluctuations of rainfall.[468] [469] This would have a deleterious effect on the environment and agriculture. Precipitation decreases of up to 15% are predicted in the northern and central regions,

[463] Torres, Noe, "Mexican farmers suffer worst drought in 70 years", *Reuters*, 25 November 2011, http://www.reuters.com/article/2011/11/25/us-mexico-drought-idUSTRE7AO18Q20111125 (accessed April 02, 2012)
[464] "Mexico: Draught hits water supply of 2.5 million", *The Guardian*, November 26, 2011, http://www.guardian.co.uk/world/feedarticle/9965496 (accessed April 02, 2012)
[465] Hershaw, Eve, and Teresa Lozano, "Neoliberal reform, climate change, and rural vulnerability" (2009), Long Institute for Latin American Studies, University of Texas Austin, 1, 3
[466] Appendini, Kirsten, and Diana Liverman, "Agricultural policy, climate change, and food security in Mexico", *Food Policy 19 (1994)*, 156
[467] World Bank, "Climate Change Aspects in Agriculture: Mexico Country Note", January 2009, 2
[468] Appendini and Liverman, "Agriculture Policy", 160
[469] World Bank, "Climate Change Aspects in Agriculture: Mexico Country Note", 2

and overall there would be a 4.2% increase in non-suitable land for agriculture. Moreover, another study by Mexico's International Institute of Agriculture and Livestock Research (INE) found that recent increases in temperature have prolonged the lifespan of forest plagues. A 1°C increase at an elevation of 1,500 – 2,500 meters above sea level (masl) could affect 10-30% of an ecosystem area through economically relevant plagues. At 2,501- 3,000 masl, a 2°C increase would result in an increase of 30-40%.[470]

A drier climate is predicted to affect 67% of temperate forests,[471] which provide the majority of Mexico's wood production.[472]Conditions would favor increased forest fires, replacement of tropical forests by savannas in central and southern regions, replacement of semi-arid by arid vegetation in central and northern regions, and the extinction of some tropical species.[473] Also, with the loss or downgrade of vegetation cover, soil quality would decline.[474]

In the event of rising temperatures, the most notable changes would occur in the northern regions. The northwest region and the Baja California peninsula would see the greatest drop in suitability for supporting vegetation, namely the semi-arid species. Some regions in Mexico's southern plateau, however, would see an increase in semi-arid plant suitability. Though despite these gains, the results of a study by the United States Agency for International Development (USAID) indicated that climate change, based on current models, would lead to decreased overall surface suitability for a common semi-arid plant species, the *Acacia farnesiana*.[475] If the case of *Acacia farnesiana* is be taken as a barometer test of how well most semi-arid species would fare under increased temperatures, then the prognosis would be decreased semi-arid vegetation overall.

Mexico's tropical southern zones would experience a re-balancing of plant species as the temperature rises. Some native exotic woods, such as mahogany, would increase as land suitability improves; while others, like the Red Cedar, would decrease in numbers. Additionally, some tropical species would expand to higher elevations that were previously unsuitable.[476]

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[470] USAID, "Forests, Land Use, and Climate Change Assessment for USAID/Mexico", 18-19.
[471] USAID, "Forests, Land Use, and Climate Change Assessment for USAID/Mexico", 3
[472] Mader, Ron, "Forests of Mexico", *Planeta*, 21 November 2011, http://www.planeta.com/ecotravel/mexico/mxforest.html (accessed April 02, 2012)
[473]World Bank, "Climate Change Aspects in Agriculture", 3
[474] National System of Environmental Information and Natural Resources (SNIARN, in Spanish), "Mexico's 2008 State of the Environment Report", Ch3: Soils, http://app1.semarnat.gob.mx/dgeia/informe_2008_ing/03_suelos/cap3_2.html (accessed April 02, 2012)
[475] USAID, "Forests, Land Use, and Climate Change Assessment for USAID/Mexico", 3
[476] USAID, "Forests, Land Use, and Climate Change Assessment for USAID/Mexico", 18

Agriculture

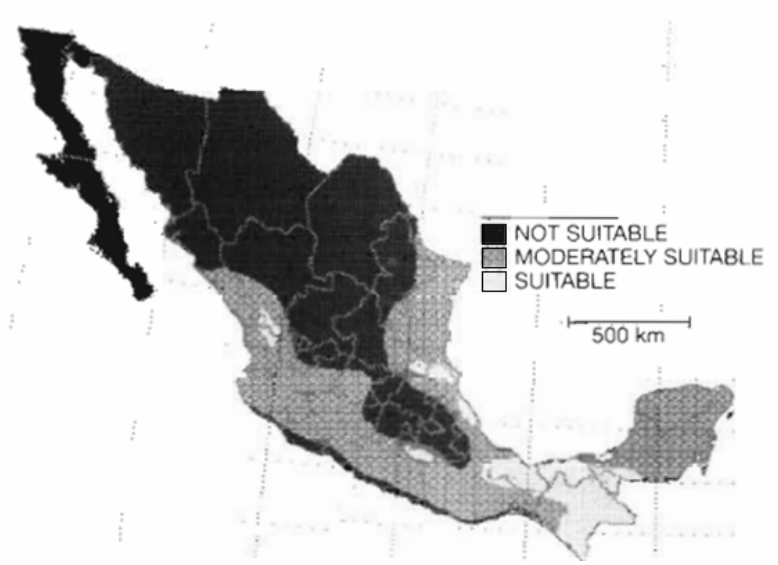
Agriculture accounts for 5% of Mexico's GDP.[477] Forty-percent of Mexico's land surface is used for agriculture,[478] though only a mere 16% of national land area is classified as agriculturally "suitable".[479] Great strides have been made over the past two decades to increase irrigation in Mexico, but as of 2008, only about one-third of Mexico's cultivated land was irrigated.[480] This means the majority of Mexican crop farmers must rely on low seasonal rainfall, which is highly irregular and unevenly distributed.[481]Given Mexico's arid and semi-arid environment, a small decline in rainfall can bring about significant agricultural losses. Indeed, droughts are, on average, the cause of 90% of Mexico's agricultural losses.[482]

Corn is the most important crop in Mexico. Approximately 60% of Mexico's cultivated land is used for growing corn by 3 million producers. [483] After the United States, the People's Republic of China, and Brazil, Mexico is the 4th largest corn-producing country in the world.[484][485] Corn crops are highly sensitive to climate variability, such as delays to the start of rainy season or unusually severe mid-summer draughts.[486][487] This is especially significant for Mexico because 65% of its corn is grown on non-irrigated land.[488] Elevated temperatures are associated with harmful effects on the land used for corn cultivation, such as soil degradation and increased salinity in irrigated areas.[489]

[477] US Department of State, "Background Note: Mexico" (2011), http://www.state.gov/r/pa/ei/bgn/35749.htm: see Economy (accessed April 02, 2012)
[478] Brodziak, Fabricio, and Ana Lucia Garcia, *et al.*, "Climate Change Impacts on Socio-Environmental Conflicts: Vulnerability in Facing Climate Change and Social Conflicts in Mexico", Partners for Democratic Change International (PDCI), June 2011, 15
[479] Appendini and Liverman, "Agriculture Policy", 156
[480] "Country Profile: Mexico", International Commission on Irrigation and Drainage (ICID), http://www.icid.org/cp_mexico.html, 2
[481] Hershaw and Lozano, "Neliberal reform", 3
[482] Appendini and Liverman, "Agriculture Policy", 156
[483] Nadal, Alejandro , "The Environmental and Social Impacts of Economic Liberalization on Corn Production in Mexico", Oxfam BG and WWF International (2000), 4
[484] Juarez, Benjamin, and Mark Ford, "Mexico: Grain and Feed Annual Production Forecast to Rebound", 3
[485] Rodriguez, Carlos Manuel, "Corn Harvest in Mexico Rises to Record 25 Million Tons, May Climb Further", *Bloomberg* (2010), http://www.bloomberg.com/news/2010-10-01/corn-harvest-in-mexico-rises-to-record-25-million-tons-may-climb-further.html (accessed April 02, 2012)
[486] Appendini and Liverman, "Agriculture Policy", 157
[487] World Bank, "Climate Change Aspects in Agriculture", 3
[488] Juarez, Benjamin, and Mark Ford, "Mexico: Grain and Feed Annual Production Forecast to Rebound", 2
[489] USAID, "Forests, Land Use, and Climate Change Assessment for USAID/Mexico", 29

Figure 5.XXIII demonstrates the results of a study published in *Climate Research* that indicate a 2°C increase in temperature would reduce Mexico's moderately suitable agricultural land for corn growing by 8-18%, depending on the accompanying increase or decrease in precipitation. [490] Based on this, the figure shows the suitability of growing zones of rain-fed corn crops in Mexico. This is a baseline scenario.[491]

Figure 5.XXIV: Suitability of growing zones of rain-fed corn crops in Mexico

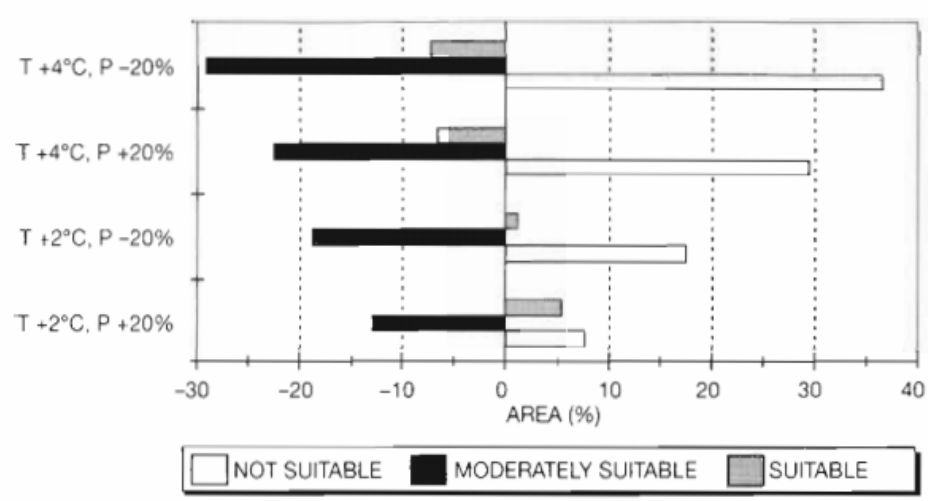


Source: Conde, Cecilia and Diana Liverman, *et al*., "Vulnerability of rainfed maize crops in Mexico to climate change", 22

As further Figure 5.XXIV shows, all predicted cases of temperature increases between 2-4°C, even with consideration of positive and negative fluctuations of precipitation, indicate a decline of moderately suitable zones for growing corn. Further, the predicted gains in suitable zones would not make up for reductions of moderately suitable zones. It furthermore shows percentage differences in the relative area occupied by non-suitable, moderately suitable, and suitable between baseline and climate change scenarios.[492]

[490] Conde, Cecilia, and Diana Liverman, *et al*., ""Vulnerability of rainfed maize crops in Mexico to climate change", *Climate Research 9 (1997)*, 19
[491] Conde, Cecilia and Diana Liverman, *et al*., "Vulnerability of rainfed maize crops in Mexico to climate change", 22
[492] Conde, Cecilia and Diana Liverman, *et al*., "Vulnerability of rainfed maize crops in Mexico to climate change", 22

Figure 5.XXV: Percentage Differences



Source: Conde, Cecilia and Diana Liverman, *et al*., "Vulnerability of rainfed maize crops in Mexico to climate change", 22

However, the authors of the study note the complexity of predicting just how negatively or positively climate change would affect all corn crops. They cite individual cases in which some corn varieties in certain locations in Mexico with unique conditions could benefit from increased temperatures and rainfall.[493] But unless these conditions can be replicated across most of Mexico's relatively unfavorable soils, this is unlikely to reverse an overall negative trend.

After corn, sugarcane growing uses the second largest area of cultivated land. The production of sugarcane is among Mexico's most lucrative, alone accounting for .05% of national GDP. There are 158,000 growers, and the industry employs 2 million people directly and indirectly.[494] It is, thus, an important crop both economically and politically.[495] Droughts and environmental degradation are cited among the greatest and most serious challenges affecting Mexico's sugarcane industry,[496] able

[493] Conde, Cecilia and Diana Liverman, *et al*., "Vulnerability of rainfed maize crops in Mexico to climate change", 22

[494] Geo-Mexico, "The geography of Mexico's sugarcane industry", September 3, 2011, http://geo-mexico.com/?p=4969 (accessed April 02, 2012)

[495] Knapp, Robert, "Mexico and Sugar: Historical Perspective", Horticulture and Tropical Products Division Foreign Agricultural Service USDA, 1

[496] Buzzanell, Peter, "Outline and Structure of Mexico sugar sector", *Sugar Beet Grower*, May 3, 2010, http://www.sugarpub.com/5/post/2010/5/sugar-in-mexico-an-industry-overview-by-peter-buzzanell.html (accessed April 02, 2012)

to cause wide fluctuations in national output.[497] Climate change stands to affect a large number of people linked to the sugarcane industry if conditions become less favorable for growing.

Live-Stock production

In the early 1990s, one-third of Mexico's land was officially designated grazing territory. By the early 2000s, it was over half. Most of this area is located in Mexico's northern regions, where cattle are raised primarily for export to the United States. At around 23 million, cattle are the single largest consumer of forage resources on Mexico's pastureland.[498] [499] As is the case with corn cultivation, climate change could adversely affect soil suitability for the vegetation needed for cattle grazing. Climate scenarios cited by the World Bank which predict moderate temperature increases and reduced rainfall are expected to decrease pastureland up to 6% by 2020.[500]

Additionally, a *United States Department of Agriculture* (USDA) study on climatic influences on livestock found that climatic conditions, namely ambient temperatures, affect voluntary feed intake, which directly affects body weight of livestock and thus overall production. The immediate effect of reduced intake is to prolong the time-to-slaughter period, lowering productivity and leading to revenue losses for producers. Over time, producers can select for breeds that are better adapted to conditions brought on by climate change. However, breeds that are more tolerant of warmer temperatures are generally less productive, which is likely due to the natural mechanisms that allow them to be dominant breeds under such conditions.[501]

Unlike grain farmers, cattle producers have more options to mitigate losses during periods of extreme weather. They can export live animals, sell animals at a loss to feedlots, or slaughter. They are therefore somewhat more adaptable to the vicissitudes of climate change. As was demonstrated during the 2011 drought, considered the worst in seven decades, Mexican cattle exports during the first three months of the year were already 23% higher than at the same time in 2010. [502] However, such practices would, of course be, unsustainable in the long term if weather conditions do not improve.

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[497] Geo Geo-Mexico, "The geography of Mexico's sugarcane industry", September 3, 2011, http://geo-mexico.com/?p=4969 (accessed April 02, 2012)
[498] Peel, Derrell , and Kenneth Matthew Jr., *et al*. "Trade, the Expanding Beef Industry, and Feedlot and Stocker Cattle Production in Mexico", United States Department of Agriculture (USDA) (August 2011), 3
[499] Mongbay.com, "Mexico Index", 1996, http://www.mongabay.com/history/mexico/mexico-livestock_other_crops.html (accessed April 02, 2012)
[500] World Bank, "Climate Change Aspects in Agriculture", 3.
[501] Hatfield, J.L., *et al.*, "The Effects of Climate Change on Agriculture, Land Resources, Water Resources, and Biodiversity", USDA Agricultural Service (ARS), 2008, 66-67
[502] Juan, Zaida San, and Benjamin Juarez, *et al.,* "Mexico: Livestock Producers Manage Drought Conditions", USDA Foreign Agricultural Service, 2011, 1-4

Food Security

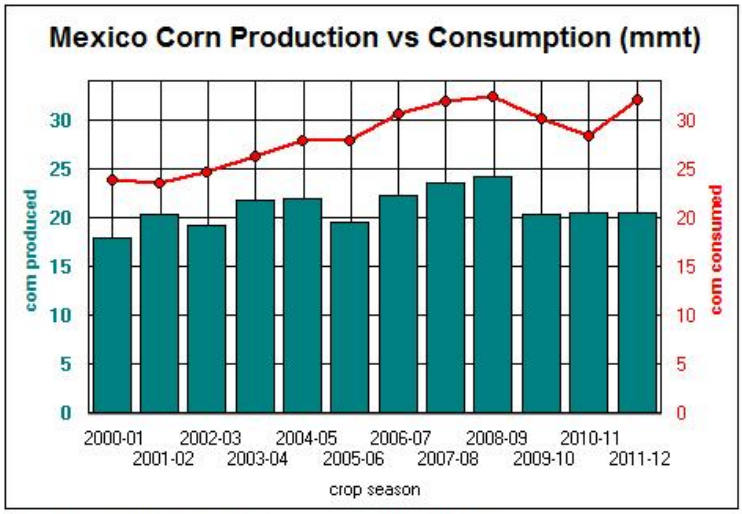
Throughout Mexico's history, access to water supplies and its relationship to food security have been tied to the rise and fall of pre-Hispanic civilizations. When the Spanish arrived in the 16th century, they increased irrigation but also introduced cattle, grain varieties, and agricultural practices that were less water-conservative than those of the indigenous peoples. Control of good land was essential as food supplies continued to wax and wane, leading to migration and social unrest in times of poor harvest.[503]

In the early 20th century, a system of land reform, known as *ejido*, was formally codified to provide collectivized land to poor peasant farmers so that they could grow enough to feed themselves. New techniques and technologies developed during the Green Revolution helped Mexico attain self-sufficiency in corn in 1967. However, thereafter, due to a complex set of factors, such as a growing population, falling food prices, more competition with global food producers, and adverse climate, Mexican corn production has not kept up with demand. In the early 1990s, one fifth of Mexico's population was considered malnourished.[504] Further, many of Mexico's agricultural subsidies were cut, along with a constitutional amendment to end the *eijido* system, as part of pro-market reforms and Mexico's subsequent entry into NAFTA. [505]

Since NAFTA took effect, Mexico has been drawn into an increasingly reliant relationship with the United States to maintain adequate food supplies. In key areas, Mexico's consumption of US agricultural products has not kept up with its exports. It exports much of its cattle to the United States, who has a comparative advantage in feedlot systems, and buys it back as US beef.[506] Though rates of malnourishment have improved,[507] Mexico still imports corn to meet consumption demand (see Figure 5.XXV). Despite selling, on average, 77% of its agricultural exports to the United States,[508] Mexico has run a net agricultural trade deficit with the United States every year, except during the 1995 peso crisis when dollar-denominated products were too expensive for most Mexicans to buy. [509][510]

[503] Appendini and Liverman, "Agriculture Policy", 156
[504] Appendini and Liverman, "Agriculture Policy", 149-152
[505] Schmidt, Ronald, and William Gruben, "Ejido Reform and NAFTA", *FRBSF Weekly Letter* (October 2, 1992), 2
[506] Peel, Derrell, and Kenneth Matthew Jr., *et al*., "Trade, the Expanding Beef Industry", 1
[507] Global Hunger Index 2010, http://www.ifpri.org/sites/default/files/publications/ghi10.pdf
[508] Big Picture Agriculture, "Agricultural trade between the US and Mexico", May 5, 2011, http://bigpictureagriculture.blogspot.com/2011/05/agricultural-trade-between-us-and.html (accessed April 02, 2012)
[509] Martell Crop Projections, "Mexico Strong Corn Consumption Prompts Higher Imports", November 2, 2011, http://www.martellcropprojections.com/SampleCropReports/Mexico-Strong-Corn-Consumption-Prompts-Higher-Imports (accessed April 02, 2012)

Figure 5.XXVI: Mexico corn production vs. consumption



Source: Martell Crop Projections, "Mexico Strong Corn Consumption Prompts Higher Imports"

Figure 5.XXV shows Mexico's corn production vis-à-vis consumption between 2000 and 2012; 2011-12 has been adjusted taking into account effects of severe nationwide drought.[511]

Some commentators argue Mexico's lack of self-sufficiency in food does not matter, since pro-market reforms help more productive sectors thrive. But others argue there is something fundamentally wrong with a situation in which some Mexican small farmers find it cheaper to buy corn from across the border than grow it in their own soil. There is potent symbolism over the issue of needing to import corn because it is Mexico's staple food and at the heart of its traditional agriculture.[512] [513] Figure 5.XXVII shows that the United States has consistently exported more agricultural products to Mexico than it has imported since the early 1990s.[514]

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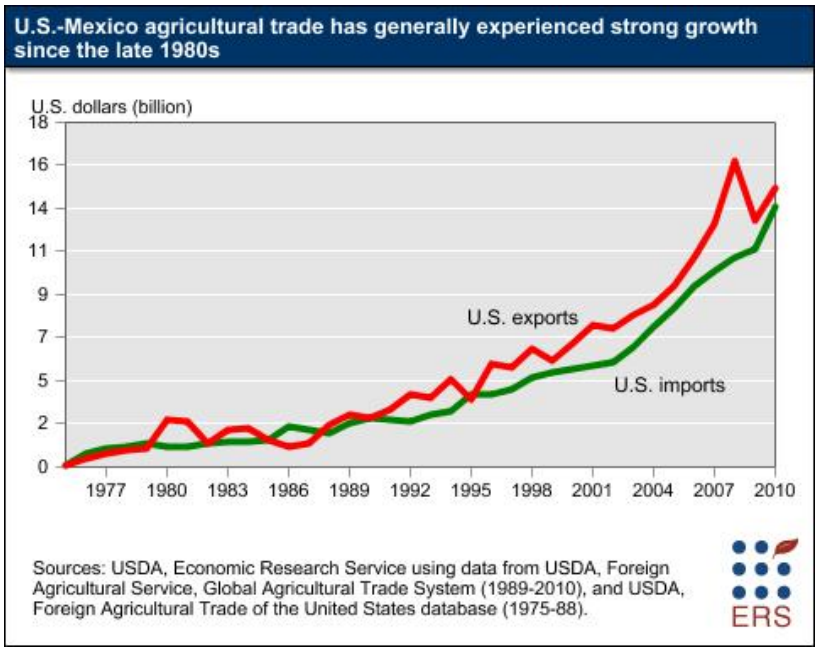
[510] Audley, John J. et al. "NAFTA's Promise and Reality: Lessons from Mexico for the Hemisphere" (Carnegie Endowment for International Peace, 2004), 67
[511] Martell Crop Projections, "Mexico Strong Corn Consumption Prompts Higher Imports"
[512] Wall, Allan , "Must Mexico be Self-Sufficient in Corn?", Mexi-data.info, last modified March 3, 2008, http://mexidata.info/id1739.html (accessed April 02, 2012)
[513] McCarty, Dawn, "NAFTA Key to Immigration Problems in the United States", *Houston Catholic Worker (23)* No.3, May-June 2008, http://www.cjd.org/paper/NAFTA.html (accessed April 02, 2012)
[514] Big Picture Agriculture, "Agricultural trade between the US and Mexico"

Figure 5.XXVII: US imports and exports



Source: Big Picture Agriculture, "Agricultural trade between the US and Mexico"

This discussion is intended to highlight the fragile state of Mexico's food security and economy in light of consequences associated with climate change predictions. The intended corollary is that adverse weather arising from climate change could severely stress an already vulnerable situation. Decreased agricultural output would hurt producers and the many people who make a living from Mexican agriculture. It would also influence higher food prices, increase agricultural imports, and it would cause many to go hungry.

5.4.2. Social and Environmental Consequences of Land Reforms and Climate Change

Citing its contribution to the "low productivity" and "unacceptable living standards" of Mexico's agricultural sector and as an impediment to entry of NAFTA, in 1991 Mexico's president Carlos Salinas De Gortari phased out the *ejido* system. The *ejido* system gave the right to peasant farmers to petition the government to collectively own land for use in subsistence agriculture. Under the new reforms, property rights were redefined and members of a collective could choose to exit their *ejido* and convert a plot of communal land into private property. With this land they could cultivate, rent

out to others, or sell.[515][516] At its peak, *ejido* communities numbered 29,000, with 3 million producers, and comprised of 75% of Mexico's agricultural production. Following the reform, *ejido* laborers tried to continue farming as before, but many were squeezed out as a consequence of the new NAFTA rules. Mexico discontinued subsidies that had supported *ejido* farmers in the past, as well as cut strategic tariffs which had protected them from larger and more efficient producers.[517] Technical assistance programs for farmers dropped from US$2 billion in 1994 to US$500 million by 2000.[518]

NAFTA reforms and long-running shifts in the economics of agriculture left many small rural farmers unable to compete in the modern agricultural sector. Since the 1970s, the declining price of corn moved more Mexican farmers towards higher value cash crops, such as fruits and vegetables, which require more fertilizers and water. Poorer rural farmers could not afford these inputs, and chose to continue growing rain-fed corn (earning it the title "peasant crop"). Many *ejido* farmers who could not survive in the new post-NAFTA era sold their land plots to larger agribusinesses, often at undervalued prices due to poor bargaining abilities.[519][520] In some regions, up to 70% of *ejido* farmers abandoned farming altogether because of the high obstacles in competing with more modern capital-intensive farmers. Employment in Mexico's agricultural sector declined from its pre-NAFTA high of 8.1 million to the current 6.8 million.[521]

These changes have strained poor rural farmers more than any other group. In the early 1990s, corn producers made up 10% of Mexico's labor force. The subsequent loss of subsidies and lack of credit needed to sustain and compete in a more liberalized market threatened their livelihoods and food security. [522] Since NAFTA took effect, income inequality rose,[523] and two million farmers had left their lands by 2002. Many had done so to find work as migrant laborers both internally and internationally.[524] Recent research has found that efforts to provide *ejidos* farmers with land ownership certificates are associated with increased emigration to the United States.[525] It is not

[515] Connell, David William Connell, "Can I buy Ejido land?", Connel & Associates, 1998, http://www.mexicolaw.com.mx/ejido.html (accessed April 02, 2012)
[516] Schmidt, Ronald, and William Gruben, "Ejido Reform and NAFTA", 2
[517] Davis, Benjamin, and Guy Stecklov, *et al.,* "Domestic and international migration from rural Mexico: Disaggregating the effects of network structure and composition", *Population Studies (56*) (2002), 297
[518] Faux, Jeff, "The Global Class War", *Google Books*, 2006, http://books.google.co.th/books?id=ORkb5cWp9NsC&printsec=frontcover#v=onepage&q&f=false, see "Rural Poverty in Mexico: NAFTA's Intended Consequence" (accessed April 02, 2012)
[519] Appendini and Liverman, "Agriculture Policy", 151
[520] McCarty, Dawn, "NAFTA Key to Immigration Problems in the United States"
[521] John Audley and Demetrios Papametriou, *et al.* "NAFTA's Promise and Reality", 74, 17
[522] Appendini and Liverman, "Agriculture Policy", 162
[523] Audley, John, and Demetrios Papametriou, *et al.* "NAFTA's Promise and Reality", 13
[524] Jeff Faux, "The Global Class War": see "Rural Poverty in Mexico: NAFTA's Intended Consequence".
[525] Hunter, Lori, and Sheena Murray, *et al.* "Climatic Variability and US Migration from Rural Mexico", Institute of Behavioral Science (Population Program), University of Colorado Boulder (March 2011), 5

surprising, then, that a 2001 study in the *Latin American Research Review* found 64% of Mexican immigrants to the United States came from areas with a population of less than 15,000 – or in other words, rural regions.[526]

Mexico's moves towards making its agricultural sector more competitive have also had important environmental consequences, such as straining Mexico's already-short water supplies. Mexico is one of the most water-stressed countries in the Western hemisphere. The rise in larger farmland holdings and more industrialized agriculture focused on cash crops for export has only increased the demand for water. As one of Mexico's comparative advantages, the export of fruits and vegetables from Mexico has grown dramatically since NAFTA was enacted. However, a study for the Carnegie Endowment for Peace found that fruits and vegetables for export used 20-30% more water than crops grown for domestic consumption. Thus, the export of these crops represents a transfer of millions of gallons of freshwater. Moreover, larger farms used more water per yield and were less sensitive to how these activities affected the local groundwater table than small *ejido* farms.[527]

In another example, the dominance of US wheat imports has led Mexican wheat farmers to respond with more irrigation-intensive cultivation in Mexico's northwest region. Farmers also switched from bread wheat to durum wheat, which requires more fertilizer. The results of such activities are increases of nitrogen in local groundwater and a 50% decline in the groundwater table in the breadbasket area of the Yaqui Valley.[528]The increased concentrations of nitrogen use as fertilizer pose a threat to sustainable use of soils. Nitrogen use has moved away from small-scale farming and increased in large-scale operations. Such concentrated applications raise the salinity and acidity levels of the soil.[529][530]

These activities exacerbate Mexico's drought vulnerability by escalating the trends towards water shortages and soil degradation, with the possibility of desertification in the most extreme cases. Factors such as these make Mexico more prone to crisis in the event of rising temperatures and increasingly erratic rainfall, like those predicted by climate change scenarios. As such, it can be understood within the current context that more environmental changes of these kinds would spur more migration. In fact, this is already happening.

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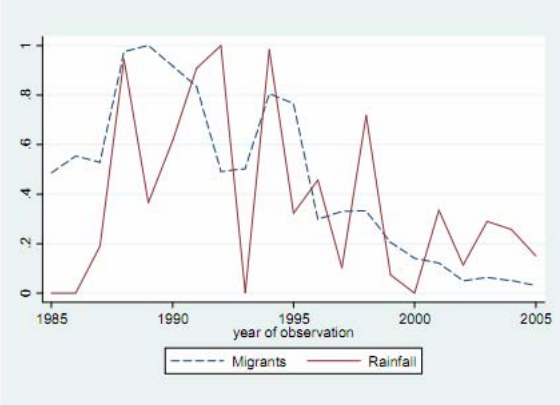
[526] Durand, Jorge, and Douglas Masse, *et al.,* "Mexican Immigration to the United States: Continuities and Changes", *Latin American Research Review (36) No. 1* (2001), 115
[527] John Audley and Demetrios Papametriou, *et al.* "NAFTA's Promise and Reality": 63.75.
[528] John Audley and Demetrios Papametriou, *et al.* "NAFTA's Promise and Reality": 62.
[529] John Audley and Demetrios Papametriou, *et al.* "NAFTA's Promise and Reality": 67.
[530] Phillip Barak, "Long Term Effects of Nitrogen Fertilizers on Soil Acidity", *University of Wisconsin*, http://www.soils.wisc.edu/extension/wcmc/proceedings/2A.barak.pdf

In 2011, researchers at the University of Colorado in the United States released a study on climate change and Mexican migration, using data from over 24,000 households between 1987 to 2005, which found that rural households are more likely to send a migrant during drought conditions than during wet conditions. If the community has a history of migration, the correlation is much higher. This suggests migration is one coping strategy for dealing with environmental disasters.[531] Another study from Princeton University in the United States looked at Mexican crop yields and subsequent emigrations. It concluded that for every 10% reduction in crop yields, there was an extra 2% in Mexican emigration to the United States. Based on climate change models, it estimates that while holding everything else constant, by 2080, 1.4 to 6.7 million adult Mexicans will emigrate as a result of agricultural productivity declines.[532] This has substantial implications – socially, economically, and politically – for Mexicans and Americans.

Increased volume of immigration to the United States strains its federal and local governments' capacities to receive them, as well as affect the local labor markets. At 11.4 million in 2009, Mexican immigrants already account for 30.1% of all immigration to the United States.[533] Of that number, the Pew Hispanic Center estimated roughly 6 million Mexicans were living illegally in the United States. [534]A 2001 study by the Center for Immigration Studies found that in the United States, 33.9% of households headed by a legal Mexican immigrant used at least one major welfare program. The figure was 24.9% for households headed by an illegal Mexican immigrant.[535] And because almost two-thirds of adult Mexican immigrants in the United States have not completed a high school education, their increasing numbers have driven wages for unskilled labor down by approximately 5%.[536]These effects have caused significant social and political backlash against Mexicans living in the United States.

[531] Hunter, Lori, and Sheena Murray, *et al.,* "Climatic Variability and US Migration from Rural Mexico", 2
[532] Feng, Shuaizhang and Alan Krueger, *et al.,* "Linkages among climate change, crop yields and Mexico-US cross-border migration", *Proceedings of the National Academy of Sciences of the United States of America*, June 24, 2010, http://www.pnas.org/content/early/2010/07/16/1002632107.full.pdf+html, 1
[533] Terrazas, Aaron, "Mexican Immigrants in the United States", Migration Policy Institute (MPI), February 2010, http://www.migrationinformation.org/USFocus/display.cfm?ID=767
[534] Passel, Jeffrey, "Estimates of the Size and Characteristics of the Undocumented Population", March 21, 2005, http://pewhispanic.org/files/reports/44.pdf, 1
[535] Camarota, Steven, "Immigration from Mexico: Assessing the Impact on the United States", July 2001, http://www.cis.org/articles/2001/mexico/mexico.pdf, 5-7

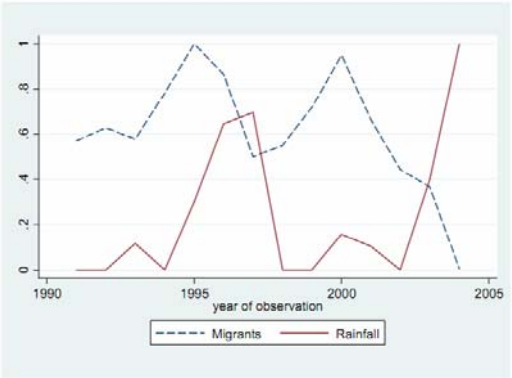
Figure 5.XXVIII: Proportional Migrant and Rainfall Trends in Historical Regions



Source: Hunter, Lori, and Sheena Murray, *et al.* "Climatic Variability and US Migration from Rural Mexico", 44

Figure 5.XXVII shows proportional migrant and rain fall trends in regions with a history of migration. States included in this region are Aguascalientes, Collma, Guanajuato, Jalisco, San Luis Potosi, Zacatecas.[537]

Figure 5.XXIX: Proportional Migrant and Rainfall Trends in Non-Historical Regions



Source: Hunter, Lori, and Sheena Murray, *et al.* "Climatic Variability and US Migration from Rural Mexico", 45

Figure 5.XXVIII shows proportional migrant and rainfall trends in regions not historically known for migration.[538]

[537] Hunter, Lori, and Sheena Murray, *et al.* "Climatic Variability and US Migration from Rural Mexico", 44
[538] Hunter, Lori, and Sheena Murray, *et al.* "Climatic Variability and US Migration from Rural Mexico", 45

5.4.3. Mexico's Climate Change Policy

In 1993 Mexico's legislature ratified the United Nations Convention on Climate Change (UNFCCC) as a non-Annex I country.[539] Cited as its general commitments were (1) to carry out research and build national capacities in understanding the effects of climate change in Mexico; (2) assess Mexico's contribution to green house gasses in the atmosphere; and (3) develop policies and measures aimed at reducing and mitigating the effects of climate change.[540] In accordance with these aims, Mexico has, at present, submitted four National Communications to the UNFCC, the most of among developing countries. The First National Communication, submitted in 1997, established the National Greenhouse Gas Inventory (NGHGI), which estimates the anthropogenic sources of green house gases and natural sinks.[541] The subsequent national communications have updated the NGHGI, presented results of vulnerability assessments, future scenarios, and mitigation options. They also report on the impact of policies already established.[542] Reinforcing its commitments to the UNFCC, Mexico ratified the Kyoto Protocol in 2000, allowing it to collaborate with developed countries through the Clean Development Mechanism (CDM).[543] The CDM allows developing countries to earn salable certified emission reduction (CER) credits through emission cutting projects.[544]

In order to mainstream climate change priorities in development policy, the Inter-Ministerial Commission on Climate Change (CICC, in Spanish) was created in 2005. It is the federal agency responsible for developing policies and strategies that cut emissions, aid adaptation, and initiating programs related to its commitments under the UNFCC. The CICC is also the Designated National Authority on the CDM in Mexico.[545] The CICC is an integration of the heads of the following ministries: Environment and Natural Resources (SEMARNAT); Livestock, Rural Development, Fisheries and Food (SAGARPA); Communications and Transport (SCT); Economy (SE); Social Development

[539] The category of non-Annex I is reserved for developing countries that are especially vulnerable to climate change but have limited capacity to respond and adapt. Developed countries classified as Annex II are required to provide financial resources to help developing countries adapt and undertake emission reductions activities under the Convention (See: "Parties & Observers", United Nations Framework Convention on Climate Change, http://unfccc.int/parties_and_observers/items/2704.php)
[540] USAID, "Forests, Land Use, and Climate Change Assessment for USAID/Mexico", 20
[541] World Bank, "Climate Change Aspects in Agriculture: Mexico Country Note", 3
[542] USAID, "Forests, Land Use, and Climate Change Assessment for USAID/ Mexico", 20
[543] USAID, "Forests, Land Use, and Climate Change Assessment for USAID/ Mexico", 20
[544] "Clean Development Mechanism", United Nations Framework Convention on Climate Change, http://unfccc.int/kyoto_protocol/mechanisms/clean_development_mechanism/items/2718.php (accessed April 02, 2012)
[545] USAID, "Forests, Land Use, and Climate Change Assessment for USAID/ Mexico", 22

(SEDESOL); Energy (SENER); Ministry of the Interior (SEGOB); Foreign Affairs (SRE); Treasury (SHCP); and Health (SS). The ministries for Tourism and the National Institute of Statistics and Geography attend as permanent guests.[546] The CICC is permanently chaired by the head of SERMARNET and alternately chaired by the Underminister of Planning and Environmental Policy of SEMARNET (SPPA, in Spanish). It consists of the following six working groups:

1) The Special Climate Change Program (GT-PECC) is in charge of gathering information for the annual reports on climate change actions submitted to the CICC, coordinated by the SPPA.

2) The Mexican Committee for Emission Reduction and GHG Sequestration Projects (COMEGI) is in charge of promoting and evaluating CDM projects. It is coordinated by the Direction General for Climate Change Policy of the SPPA.[547]

3) The Working Group on International Affairs (GT-INT) promotes collaboration between ministries to define Mexico's position in international climate change fora. It is coordinated by the SRE.

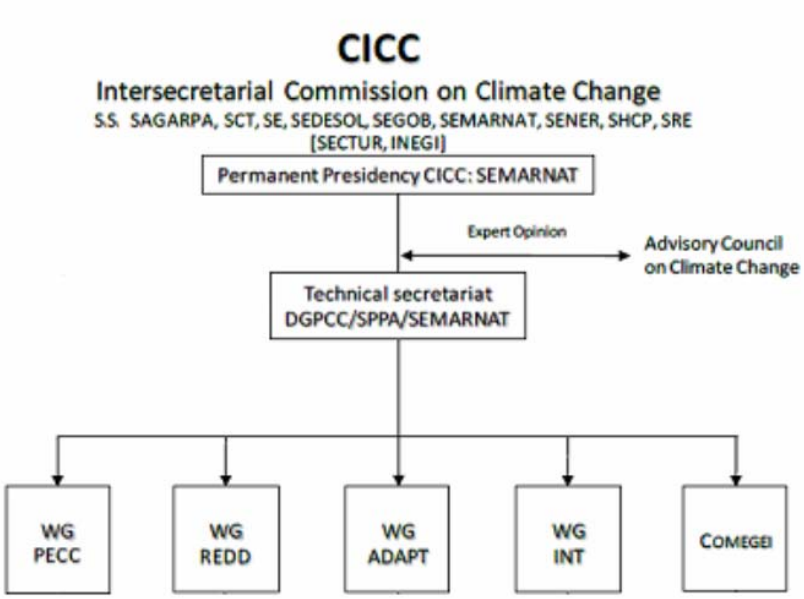
4) The Working Group on Adaptation Policies and Strategies (GT-ADAPT) is a part of the Interior Minstry which collaborates with the nine ministry-members of CICC, along with the Ministry of Tourism, the General Coordination of Civil Protection, and the Prevention of Disasters (CENAPRED).

5) Working Group on Reducing Emissions from Deforestation and Degradation (REDD) is charged with developing a national REDD strategy; a reference emissions scenario; a Monitoring, Report, and Verification (MRV) system; and facilitiate cross-sectoral consultation on REDD issues. REDD is coordinated by the National Forest Commission (CONAFOR, in Spanish). [548]

A permanent consultative body was created for the CICC called the Advisory Council on Climate Change (C4). The C4 monitors the work of the CICC and submits recommendations for improvement. It is made up of 24 experts from academic, social, and private sectors.[549] Figure 5.XXIX shows structure of the Intersectretarial Commission on Climate Change (CICC).[550]

[546] USAID, "Forests, Land Use, and Climate Change Assessment for USAID/ Mexico", 22
[547] USAID, "Forests, Land Use, and Climate Change Assessment for USAID/ Mexico", 22
[548] USAID, "Forests, Land Use, and Climate Change Assessment for USAID/Mexico", 23
[549] USAID, "Forests, Land Use, and Climate Change Assessment for USAID/Mexico", 23
[550] USAID, "Forests, Land Use, and Climate Change Assessment for USAID/ Mexico", 23

Figure 5.XXX: Structure of the Intersecretarial Commission on Climate Change



Source: USAID, "Forests, Land Use, and Climate Change Assessment for USAID/ Mexico", 23

5.4.4. The Market Approach to Conservation: Payment for Environmental Services (PES)

Payment for Environmental Services (PES) is broadly defined as the practice of inducing farmers or landowners to manage their land or provide an environmental service in return for an incentive, such as a monetary payment. An example of an environmental "service" would be regulation of water flows and flood prevention by land with high levels of tree cover. But in this case, landowners usually do not receive any kind of incentive for maintaining this kind of environmental service. Therefore, PES is a way of restoring environmental services and benefits that have been lost due to mismanagement or lack of incentive. The overarching principle of PES is to pay those who provide such public goods, and those who pay are the ones who will benefit. PES is a different kind of response to managing extreme climate events, such as those associated with climate change, in that

it seeks to strengthen the natural defenses against disasters, such as droughts and floods, rather than following a reactive approach, such as increasing water extraction and repairing damages. [551]

Case Study: National Payment for Hydrological Services (PSAH)

Forests and areas with vegetation cover 72% of Mexico's territory. Temperate and tropical forests cover 50% of the country, as seen in Figure 5.XXX. The national rate of deforestation between 1994 and 2000 is 1.2% per year, with a higher rate of 2.4% deforestation for tropical forests. If these rates hold constant, Mexico's forests will be depleted within a hundred years. [552]

The vast majority (around 80%) of forested land is held by *ejido* collectives and indigenous communities,[553] while the primary direct anthropogenic causes of deforestation are clearing trees for agriculture, extraction of wood for sale, and extraction of wood for fuel. [554] These activities, however, are not evenly distributed across all forested communities, as some communities do not have permits to extract wood for sale and others engage in economic activities that do not contribute to deforestation. [555] Also, among *ejido* collectives with permits, the rate of deforestation depended on the extent to which its forestry activities were vertically integrated. Communities that hire outside contractors tend to have a higher rate of deforestation. The logic of this is that communities that carry out their own extractive forestry projects would be more concerned with the sustainability of their supply. [556]

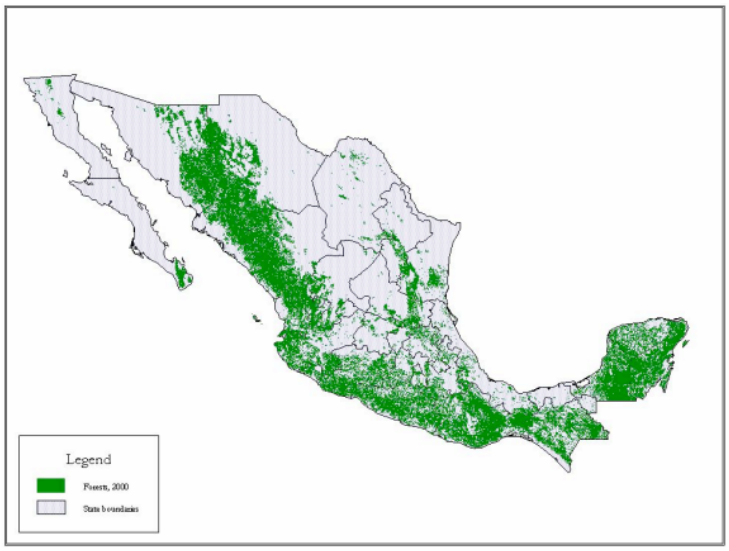
Mexico's forests provide an array of environmental services, such as a being home to one of the most biologically diverse ecosystems in the world and to serve as a source of global carbon sequestration. But they also play a role in maintaining water flows in underground aquifers, as well as improving the

[551] The World Bank, "What is Payment for Environmental Services?", http://web.worldbank.org/WBSITE/EXTERNAL/TOPICS/ENVIRONMENT/EXTEEI/0,,contentMDK:21010580~menuPK:1187844~pagePK:210058~piPK:210062~theSitePK:408050~isCURL:Y,00.html (accessed April 02, 2012)
[552] Alix-Garcia, Jennifer, and Alain de Janvry, *et al*. "An Assessment of Mexico's Payment for Environmental Services Program", Comparative Studies Service Agriculture and Development Division, United Nations Food and Agriculture Organization (FAO), 2004, 3-4
[553] Alix-Garcia, Jennifer, and Alain de Janvry, *et al*. "An Assessment of Mexico's Payment for Environmental Services Program", 5
[554] Alix-Garcia, Jennifer, and Alain de Janvry, *et al*. "An Assessment of Mexico's Payment for Environmental Services Program", 36
[555] Alix-Garcia, Jennifer, and Alain de Janvry, *et al*. "An Assessment of Mexico's Payment for Environmental Services Program", 6, 45
[556] Alix-Garcia, Jennifer, and Alain de Janvry, *et al*. "An Assessment of Mexico's Payment for Environmental Services Program", 8

quality of the water. Mexico's National Water Commission has reported that 66% of the most important aquifers are overexploited, with an average extraction rate of 190%.[557]

The overuse of aquifers has serious implications. Underground aquifers supply 64% of the public's water and one-third of all water used for agriculture. With the number of overused aquifers increasing more than three-fold in the last 40 years, and with growing urban centers extracting more water than is replaced each year,[558] Mexico is tipping a fragile balance and increasing its vulnerability to drought. In 2000 Mexican government decided to pursue a program of conserving forest resources as a way to conserve hydrological services. [559]

Figure 5.XXXI: Mexican Forest Cover in 2000



Source: Alix-Garcia, Jennifer, and Alain de Janvry, *et al*., "An Assessment of Mexico's Payment for Environmental S ervices Program", 3

Early in 2000, President Vincente Fox's administration floated the idea for the first national-level payment plan for environmental services. A mandate was given to the Department of Policy and Environmental Economics (PEA) and academics at the Iberoamerican University to develop a PES program that related forest conversation to hydrological services. In 2002, a 2-year pilot PES program to pay landowners for conserving forests was announced. It had a budget of US$2 million and was to

[557] Alix-Garcia, Jennifer, and Alain de Janvry, *et al*., "An Assessment of Mexico's Payment for Environmental Services Program", 9
[558] Geo-Mexico, "Mexico's freshwater aquifers: undervalued and overexploited" (November 5, 2011), http://geo-mexico.com/?p=5320 (accessed April 02, 2012)
[559] Alix-Garcia, Jennifer, and Alain de Janvry, *et al*., "An Assessment of Mexico's Payment for Environmental Services Program", 9, 17

be managed by the Subsecretariat of the Ministry of Environment and Natural Resources (SEMARNAT). However, due to competition among federal entities and budget cuts to SEMARNAT, the project was moved to the National Forest Commission (CONAFOR). The proposal to fund the program through municipal water fees was then accepted by the National Congress and the Environmental Commission.

But just when the pilot seemed ready to start, it was cancelled. The reason was political: if the pilot began in 2003, it would end in 2005; and this would leave the administration less than two years to implement a nation-wide program. Hence, despite its incomplete budget for the full 5-year program, CONAFOR went forward with the national plan.[560] The program was called *Payment for Hydrological Services* (PSAH, in Spanish) and offered 5-year renewable contracts for both individual and communal landowners to cease deforestation.[561] CONAFOR embarked on a national promotion tour to explain the program. However, the promotion campaign was criticized for failing to adequately convey the concept of environmental services and created lots of false expectations. Many of the vague concepts described by CONAFOR representatives did not even make it into the final program.[562]

To apply for the program, landowners had to fill out a two-page form and present proof of legal ownership.[563] Contracts and payments were given for specified areas of forest with prices per hectare. Cloud forests received US$40 per hectare and US$30 for other types. The original criteria for eligible land stipulated that the land had to have more than 80% tree density per hectare, was in an overexploited aquifer, and was near population centers greater than 5,000 inhabitants. But because of inadequate human resources and time to assess each application's eligibility, CONAFOR changed its criteria to 80% tree cover. Furthermore, due to insufficient satellite images, areas that were not covered under images in CONAFOR's archives were automatically excluded from consideration. These changes led to the selection of larger properties with lower population densities.[564]

Due to time constraints, contracts were re-written in late 2002 to give payments after a full year of conservation. Additionally, because one-fifth of the budget, 4 million pesos, had to be spent before the end of fiscal year 2003, payments were given for forest conservation during 2002. This came

[560] Alix-Garcia, Jennifer, and Alain de Janvry, *et al*. "An Assessment of Mexico's Payment for Environmental Services Program", 18-24
[561] Alix-Garcia, Jennifer, and Elizabeth Shapiro, *et al.,* "Forest Conservation and Slippage: Evidence from Mexico's National Payment for Ecosystem Services Program", Yale University (August 6, 2010), 8
[562] Alix-Garcia, Jennifer, and Alain de Janvry, *et al*. "An Assessment of Mexico's Payment for Environmental Services Program", 23
[563] Alix-Garcia, Jennifer, and Elizabeth Shapiro, *et al.,* "Forest Conservation and Slippage", 8
[564] Alix-Garcia, Jennifer, and Alain de Janvry, *et al*., "An Assessment of Mexico's Payment for Environmental Services Program", 26-27

despite landowners not knowing whether they were participating in the program or not. Payments were given again in 2004 for conservation in 2003, though it's unknown how much the participants understood the terms of their contracts. [565] [566]

In 2004, Mexico received US$100 million in financing from the World Bank to continue funding, promoting, and researching PES programs for the next 20 years.[567] Between 2003 and 2009, approximately 2.27 million hectares of land (about 1% of national territory) have entered Mexico's PES programs.[568]

Case Studies of Communities Receiving Payments 2004-2005

In late 2004, a team of researchers from the University of California at Berkley chose eleven *ejido* communities in six states that were participating in the program, and sought to find out how the payments had affected forest management since the program began. Figure 5.XXXI shows a description of each of the eleven *ejidos* in the study. None had enrolled all of their land in the program, and of the eleven communities chosen, only five had deforested between 1994 and 2000.[569]

Figure 5.XXXII: A Description of the Eleven *Ejido* Communities Selected by Researchers

Ejido	State	% forest lost between 1994-2000	Total Area (ha)	Area enrolled in program	Has a permit to extract wood?
1	Puebla	-2.8	1,232	356	Yes
2	Puebla	-7.6	724	113.5	Yes
3	Veracruz	-7.1	493	73	No
4	Veracruz	16.5	1,026	499.25	No (used to)
5	Veracruz	0	2,268	1,114	No
6	Michoacan	0.04	1.446	1.400.18	No
7	Mexico	n.a.	1.801	572.24	Yes
8	Michoacan	0	1,364	109.90	No
9	Durango	12.1	10,573	415.13	Yes
10	Chihuahua	6.6	9,340	581	Yes
11	Coahuila	12.4	3,580	845	No

[565] Alix-Garcia, Jennifer, and Alain de Janvry, *et al*., "An Assessment of Mexico's Payment for Environmental Services Program", 27
[566] Lipper, Leslie, and Takumi Sakuyama, *et al.* "Payment for Environmental Services in Agricultural Landscapes", Food and Agriculture Organization, United Nations, 2009, 169
[567] Alix-Garcia, Jennifer, and Alain de Janvry, *et al*., "An Assessment of Mexico's Payment for Environmental Services Program", 30
[568] Alix-Garcia, Jennifer, and Elizabeth Shapiro, *et al.,* "Forest Conservation and Slippage", 4
[569] Alix-Garcia, Jennifer, and Alain de Janvry, *et al.* "An Assessment of Mexico's Payment for Environmental Services Program", 43

Source: Alix-Garcia, Jennifer, and Alain de Janvry, *et al*. "An Assessment of Mexico's Payment for Environmental Services Program", 44

The researchers wanted to know how the payments affected behaviors related to deforestation. Firstly, they found that all of the communities were already practicing conservation techniques. Therefore, there was not a true possibility of major behavioral change. Furthermore, *ejidos* 3, 4, 5 are located in a Biosphere Reserve and are forbidden to continue extractive forestry projects. As well, *ejidos* with permits for commercial forestry extraction are still required to have reserve forest areas. Consequently, in this context, payments for conservation can be seen as a sustained incentive for already-mandated conservation. [570]

Ejido members cited outside factors as contributing most to extractive forestry activities, such as neighboring cattle and tree-stealing. Therefore, much of the conservation activities were preventative, like setting up firebreaks, which are barriers or gaps in vegetation to prevent or slow the progress of wildfires. In most cases, communities reported increasing the frequency of their conservation activities as a result of the payments. However, the researchers note that this was not corroborated by outside sources, and some study teams perceived that community members had difficulty finding the firebreaks they claimed to be maintaining.[571]

Figure 5.XXXIII: A summary of results from the eleven case studies

Ejido	Pre-payment extractive activities	Pre-payment conservation activities	Post-payment conservation activities
1	Firewood extraction, felling of wood to get orchids, stealing of wood by outsiders	Firebreaks every 3 years	Firebreaks every year
2	Firewood extraction, stealing of wood by outsiders, neighboring cattle enter forest	Forest surveillance	Increased surveillance
3	Agricultural activities by *ejido* members, neighboring cattle enter forest,	Forest surveillance and firebreak maintenance once a year. Biosphere.	Forest surveillance and firebreak maintenance twice a year
4	Wood extraction for sale and domestic use, firewood extraction	Maintenance of firebreaks. Biosphere.	Increased maintenance and surveillance of forest area
5	On private parcels (where there is forest), agricultural use	Annual maintenance of firebreaks, surveillance of boundaries by all members. Biosphere.	Same activities, but only members receiving payments , increased surveillance
6	Neighboring cattle enter forest, stealing of wood by outsiders	firebreak maintenance and surveillance	Increased surveillance
7	Forestry, stealing of wood by	Thinning of dead trees,	Same activities

[570] Alix-Garcia, Jennifer, and Alain de Janvry, *et al*., "An Assessment of Mexico's Payment for Environmental Services Program", 48

[571] Alix-Garcia, Jennifer, and Alain de Janvry, *et al*., "An Assessment of Mexico's Payment for Environmental Services Program", 47

	outsiders	pest control, surveillance and firebreak maintenance	
8	Neighboring cattle enter forest, stealing of wood by outsiders,	Firebreaks, reforestation, removal of dry wood	Same activities
9	Wood extraction	Trimming, pest control, fire brigades, reforestation (where necessary)	Same, in addition to fencing in PES land
10	Wood extraction	Firebreak maintenance, trimming of trees, thinning	Same, in addition to digging canal to aid flow of water from PES parcel
11	Neighboring cattle enter forest, forest fire in 1998, cattle grazing by some *ejido* members	Surveillance of fire prone areas	Removal of cattle from PES area, otherwise same activities

Source: Alix-Garcia, Jennifer, and Alain de Janvry, *et al*., "An Assessment of Mexico's Payment for Environmental Services Program", 47

Among *ejidos,* the researchers also found a general lack of clear understanding about the program's objectives and rules. Most *ejido* members were able to identify the population centers that benefited from the hydrological services that are supported by conservation of their forests; however, none of them realized that the payments were compensation for these services. Many *ejido* members told researchers they thought the payments were part of a poverty-alleviation program linked with forests. Therefore, researchers surmised the misunderstanding of the program contributes to the lack of behavioral change. This was the result of rushed promotion by CONAFOR leading up to the program's launch. [572]

Another factor limiting improvement in forestry management is the absence of technical assistance. Without experience in forestry administration and technical assistance, the researchers argued that it's unreasonable to expect communities to design and implement highly effective conservation schemes for a PES program.[573] They also found corruption – in the form of some intermediaries charging a fee equivalent to a percentage of the payment for filling out paperwork – which made people hesitant to participate in a government payment program. [574]

Payment had not been withheld from any of the participants in the survey, meaning that compliance is very good or monitoring is not very effective. The cost of the operation and monitoring in the first

[572] Alix-Garcia, Jennifer, and Alain de Janvry, *et al*., "An Assessment of Mexico's Payment for Environmental Services Program", 53
[573] Alix-Garcia, Jennifer, and Alain de Janvry, *et al*., "An Assessment of Mexico's Payment for Environmental Services Program", 8, 49, 53
[574] Alix-Garcia, Jennifer, and Alain de Janvry, *et al*., "An Assessment of Mexico's Payment for Environmental Services Program", 53

year is estimated at US$714,285, which yields an average cost of US$5.6 per hectare. Monitoring in the second year had been conducted randomly on 28 *ejidos* (22%) and all were found to have met contract requirements.[575]

Overall Effectiveness in the First Two years

From available research, it appears that the PSAH program in its first full two years was not effective in achieving its stated goal of protecting forests for the sake of conserving overexploited aquifers. This is evident in Figure 5.XXXIII which shows that almost none of the payments were going to landowners in watersheds categorized as extremely or strongly overexploited. Indeed, the majority of payments (65.1%) went to landholders in areas with aquifers classified as not overexploited. [576] Moreover, researchers found there was little pressure to deforest in communities receiving payment because they were already practicing conservation techniques and appeared to accept the payments without clearly understanding what they were for. Technical assistance was not provided. And as a result of these circumstances, there was little behavioral change.[577]

Figure 5.XXXIV: Distribution of Payment Recipients by Aquifer Type, 2003 and 2004[578]

Aquifer type	Total area (%)	Population living in area (%)	Hectares in PES, 2003 (%)	Hectares in PES, 2004 (%)
Extremely overexploited (+100% to +800%)	0.05	9.2	0.02	0.00
Strongly overexploited (+50% to +100%)	0.04	19.5	0.00	0.00
Moderately overexploited (+5% to +50%)	18.6	14.5	13.3	9.6
In equilibrium (−5% to +5%)	2.9	11.3	0.01	0.00
Not overexploited (<−5%)	65.1	45.4	78.7	85.0
No data	13.4	0.1	8.0	5.3
TOTAL	100	100	100	100

Source: Lipper, Leslie, and Takumi Sakuyama, *et al.,* "Payment for Environmental Services", 173

Lessons learned from the PES

The main take-away points based on the experiences with the PES could be formulated as followed:

[575] Alix-Garcia, Jennifer, and Alain de Janvry, *et al*., "An Assessment of Mexico's Payment for Environmental Services Program", 41
[576] Lipper, Leslie, and Takumi Sakuyama, *et al.,* "Payment for Environmental Services", 173
[577] Alix-Garcia, Jennifer, and Alain de Janvry, *et al*., "An Assessment of Mexico's Payment for Environmental Services Program", 75
[578] Lipper, Leslie, and Takumi Sakuyama, *et al.,* "Payment for Environmental Services", 173

(1) design a program with clearly established objectives and criteria;

(2) provide technical assistance for land owners to achieve the program's objectives; and

(3) focus the program on communities whose behavior needs to change, using payment scales sufficient to affect this change.

A PES program needs clear articulation of its objectives, criteria, and expectations. Poor articulation of the program's objectives led to much misunderstanding of Mexico's PSAH plan among participating landowners. This is due in part to the rush to implement the scheme before all the parts of the program were ready. However, even after payments began, researchers found that participating landowners did not well understand the concept of payment for environmental services, and, thus, did not recognize the exact reason they were receiving payments. Hence, payments should not begin until participants indicate that they understand what they are agreeing to. Seeing as how no new conservation activities were introduced as a result of the program, it can be inferred that change did not occur because participants did not understand what actions the payments were intended to produce.

Also, the PSAH program allowed landowners to enroll only part of their land. This means landowners could merely shift extractive forestry activities to other parts not covered under the contract. To remedy this situation, contracts should be made to cover all land under ownership. Without technical assistance, it is unlikely that landowners will know how to enact highly effective forestry conservation plans. Relevant government agencies need to be prepared to work with the communities and participating landowners on how they can carry out conservation that fulfills the objectives of the program.

Programs intended to create a behavioral change should be focused on communities or areas where state resources can be spent most effectively in achieving the program goals. Target communities or areas ought to be those in which the owner's behavior is known to be contributing to the negative trend, or whose behavioral change has the most potential to fulfill the program's objectives. In Mexico's case, all communities in the Berkeley study were already practicing conservation, thus payments did not have much influence on their behavior, which in turn had little impact on the program's effect on the environment. Payments still provide incentive to conserve, however, in keeping with the idea of payment for service, the amounts should reflect the amount of behavior change desired or necessary to fulfill the program's objective. To establish prices, planners can use quotations on forestry projects forgone, comparisons with average GDP per capita, or use an auction

system to find the minimum amounts at which potential participants are willing to accept in order to conserve forests.

5.5. Summary

Throughout the chapter it became evident that NAFTA, as a regional organization with a rather loose environmental structure, is facing challenges referring to climate change effects and mitigation measures. This is even more obvious in the land sector, which lacks clear regional policies and subsequently institutional structures. Ideally, NAFTA policy should be providing tenure security, improved land and natural resource information and strengthening land administration. In this context experts agree that considering and implementing untraditional practices such as prohibitions on development or the elimination of counterproductive subsidies is paramount. Even more importantly, the roots of incentives need to be identified, examining domestic economic, financial and legal mechanisms to support conservation and sustainable use, despite setbacks in non tariff trading.

As a regional structure, NAFTA has the responsibility to set the precedent in environmental regulation to avoid negative implications of its policies, such as the Mexico's Popular Revolutionary Army case study. Additionally, climate change initiatives should prepare to offset the implications trade blocs may have on land use and societies. This includes resettlement planning for populations at risk of displacement and loss of livelihoods, further integrated land and water resource management, special programs for land and natural resource tenure in areas subject to climate change. Additionally, there should be more effective regulatory frameworks, standards and liberalization schemes which threaten to undermine land access and use rights of poor and vulnerable groups. However, as the NAAEC / CEC have little political and legal power to require the parties implement more effective laws, only to encourage facilitation, domestic reform may be the key to environmental reform in North America. As a result, the national policies and institutional frameworks need to carry some of the regional (almost denied) responsibilities.

In the United States, there needs to be more of a balance of the major feedbacks and interactions between climatic, socioeconomic, and ecological influences considering the current emphasis on economic repercussions and industrial success. In light of the implications of climate change on land use, the United States should judge how development affects the nation’s ability to produce sufficient resources, support citizens and encourage economic feasibility in the long term. There also needs to be more secure partnerships with state and regional action, to ensure comparability between national/global and state/regional models. Reform will require the development of new models linking the geophysics of climate with spatial and temporal dynamics of land-use change and the socioeconomic drivers of land use. Evolving public and private land management questions call

for new data and information. There is an overall need for the scientific understanding of the process of land-use change, the impacts of different land-use decisions, and the ways that decisions are affected by a changing climate and increasing climate variability are priority areas. A lesson that can be learned from Canada's experience is that even in the absence of robust federal policies aimed at climate change mitigation or adaptation, communities and provincial governments are actively responding to the advent of climate change. This is perhaps born of the urgencies of local conditions that compel people to act, such as in the case of Toronto designing and implementing a city-wide climate change adaptation plan after experiencing many negative effects of climate change. However, much more needs to be done, and, as the Toronto experience shows, continual engagement on the issue is necessary in order to protect communities from climate change and reduce impacts.

In Mexico, it has to be stated, that the pro-market reforms and the entry into the North American Free Trade Agreement (NAFTA) led to increasing reliance on the United States to supply its food and worsening poverty for small rural farmers. Adding to this, academic studies and news reports suggest that Mexican migration and emigration patterns are correlated with environmental factors. Researchers at Yale University estimate that 1 to 6 million adults will emigrate from Mexico by 2080 because of climate change's deleterious effect on agriculture. It can thus be argued that increased temperatures as a result of climate change's effect on an already-fragile environment would be destabilizing for Mexico's economy and society. Decreased agricultural output as a result of climate change would widen Mexico's dependency on American agricultural imports and worsen its trade balance. The resulting higher unemployment would likely encourage more migration and exacerbate inequality. This, along with higher food prices, and possible water shortages, would cause many to suffer and could spark conflict.

As one of the most water-stressed countries in the western hemisphere and faced with the prospect of rising temperatures, a program such as the Payment for Environmental Services (PES) has the potential to positively affect many climate change-related issues pertinent to Mexico, such as deforestation, desertification, and water scarcity. Available research on the program, however, showed that payments were not well-targeted to supporting land on overexploited aquifers, and due to the absence of technical assistance and an unclear understanding of the terms of the program among landowners, there was little behavioral change in forestry management observed as a result of the payments. A re-design of its selection methods, clearer articulation of the program's goals and its expectations of landowners, and provisions for technical assistance, could vastly improve the program's results. Yet despite its early shortcomings, there has been considerable interest in

Mexico's pioneering efforts with PES programs, which led the World Bank to finance Mexico's PES-related activities for another 20 years.

Chapter 6

Conclusions and Policy Recommendations

6.1. Conclusions

By assessing the vulnerability of the three examined regions (in terms of regional organizations and there member states), it has been shown that climate change impacts related to land use are extremely varied and potentially severe. In conclusion, it can be stated that all examined regions have to deal with three major issues (varying in their intensity):

- Climate change impacts on agriculture
- Impacts of natural disasters and extreme weather events (floods, storms, droughts, heat spells, changes in precipitation)
- Threats to coastal areas due to sea Level rise

Nevertheless, the conditions and also the political response are very different among the three regions. Europe's vulnerability has to be considered relatively low, while its adaptation capacity is quite high. Furthermore, the EU shows a strong commitment to combat climate change and has started to implement respective legislation and concrete measures. North America might partly even be able to profit from temperature rises (e.g. in the agricultural sector), though the weakest economy of NAFTA, Mexico, is particularly hard-hit by the negative impacts. In addition, since on the supranational level, climate change is barely addressed in the agreement, environmental standards are in risk to be undermined. Following economic rationality in a free target area, producers will choose productions sites were additional social and environmental costs are low. If common standards are not in place, this strongly favors an undercutting competition regarding social and environmental standards. Through this, among NAFTA, the already weakest member, Mexico, became a net loser in terms of social and environmental costs.

Southeast Asia has to be considered as one of the most vulnerable regions in the world, combining a relatively low adaptation capacity with potentially severe impacts, especially from disasters and weather events. Although climate change is addressed in the ASEAN framework, legislation is not effective yet and even reverse trends (deforestation) could not be effectively stopped yet. The most important reason behind this is that the institutional and legal framework is insufficient and it cannot be enforced properly due to weak capacities. Important legislation, especially regarding land ownership, but also regarding environmental protection is not even in place in many countries in the

region. This makes it very hard, if not impossible, to implement effective measures that really target relevant groups and stakeholders.

In spite of these shortcomings, which are primarily related to a lack of governance, another lesson learned is that successful policies and measures do not only – and even not entirely – depend on supranational or national actions. The example of NAFTA and particularly the USA demonstrate that in contrast to low action on these levels, state or community initiatives also have to be considered as important and effective. Furthermore, the case studies from ASEAN show, that participation of the affected local communities and individuals play a key role for the impact and the effectiveness of adaptation and mitigation measures. A good political program might fail or at least be heavily constrained if it is not supported by the affected groups; while on the other hand, bottom-up approaches can be effective if local support is given. Therefore, effective policy planning should be done at all levels and include the participation of affected stakeholders of whom support is needed for effectiveness and success. As a conclusion of the main findings of the study, the following table also provides a short overview on the main findings and issues for the three regions that were examined:

Table 6.I. Overview of the finding for the three regions

Climate Change Impacts	EU	ASEAN	NAFTA
General Vulnerability	low	high	medium
Main impacts	River flooding Droughts (Mediterranean area) Sea level rise/Land loss (North Sea area)	- More and intensified natural Disasters (storms, droughts, extreme weather events) Sea level rise, flooding in megadeltas	Natural disasters (flooding, wildfires) Droughts (Mexico)
Main social implications	Rising costs for insurances and protection land loss Impacts on Tourism	threats to urban poor and inhabitants of LECZs High costs through disaster damages (regional) water availability Impacts on agricultural production land loss	Stressed food and water availability (Mexico) Worse conditions for agricultural production (Mexico) land loss

Adaption and Mitigation			
General (technical and economic) Adaptation Capacity	high	medium to low (depending on the region)	High in the US and Canada, low in Mexico
A&M inclusion in supranational framework	Integrated and comprehensive EU policies	Addressed in ASEAN, but not effectively enforced Space for improvement Establishment of common basic standards	Not addressed in the NAFTA framework
Levels dealing mainly with A&M	EU, member states, regional, local	ASEAN (partly), Member states	Regional, local
Biggest constrains	Social acceptance of A&M measures	Costs of effective measures Lack of data and information	Political resistance on national level (US, CAN)
Most important issues	Define common policies in relevant fields (energy)	Stopping Deforestation Protection of coastal areas and mega deltas Gathering of data Intensifying local participation Reinforce existing treaties and laws	Balance social outcomes within NAFTA (currently Mexico Net loser) Define common policies
Land rights and land ownership			
Land rights situation	Land tenure rights defined and administered	Regionally lack of clearly defined land ownership and land rights	Problems with land rights and social and economic standards in Mexico
Data on land use, production etc.	Detailed data available	General lack of data concerning land ownership, forms of land use etc.	Gap between US/Canada and Mexico
Social implications related to land	Income of farmers only secured by subsidies, setting wrong incentives	Threats to livelihood of local and rural communities Economic unsecurity for farmers Food security	Mexico net-looser of NAFTA integration – ecologic and social standards Food price increases hit vulnerable Mexican market

A&M Actions related to land	Subsidies through CAP and rural development policy, incentives for eco-friendly investments,	Introduction of new seeds and technologies, local projects regarding disaster prevention and production improvement	Payment schemes (PES), local initiatives in US and Canada

Source: HDFF, 2012

As also described throughout the chapters, this table demonstrates that the European Union and its member states seem to be prepared best in comparison. While in NAFTA, the main obstacle to effective policy are the resistance of two member states and therefore the lack of common policies, ASEAN has to deal with the huge economic challenges related to climate change impacts and to strengthen its enforcement capacities.

Nevertheless, based on the issues outlined in Chapter 2 of this study, it can be seen that some of them were only barely or not even at all addressed in the EU, NAFTA or ASEAN. This especially concerns adaptation measures with real severe impacts. One example is the question of the possible resettlements in Low Elevation Coastal Zones (LECZ). In Europe this might not be a broad issue, but it also concerns selected regions (such as islands in the North Sea or loss of coastal edges in Great Britain). Protecting hotspots like Venice incur enormous costs, but so far it seems that society is still willing and able to absorb them. It has to be seen how this will develop in the future and if governments would be able to implement more drastic measures if necessary. One constraint for consequent adaptation planning in Western Europe is also that societies – as in Germany – might see adaptation as an act of surrender towards climate change. In North-America however, more extensive measures might be necessary, for example in Louisiana. In the ASEAN region however, resettlements in LCZA and delta areas might be inevitable in the future. Beyond the environmental dimension, this will be also a social issue in order to recognize and to improve the situation of the urban poor. Living in wild settlements and slum areas, often they also have no legal status or rights, including their land rights. Overall, the social and environmental challenges related to ongoing urbanization has to been addressed properly so far and – as shown through the vulnerability analysis – will be likely to intensify due to climate change impacts.

A comprehensive approach to tackle economic, social, and environmental problems, and of these marginalized groups to empower them to adapt to and cope with climate change and particular disaster impacts, has not been developed so far in the region. Of course this will raise difficult and sensitive political issues, including the recognition of wild land taking or forced retention from threatened areas. Nevertheless this will be necessary to avoid even more severe social implications

in terms of costs of not acting. This is underlined by the calculations presented in this study and in the quoted research done concerning this issue.

This leads to the question what factors can be identified that led or at least favored the implementation of climate change adaptation and mitigation. It might not sound very promising, but it has to be stated that the main drivers for concrete actions and policy changes were reactions to crisis and disasters. The German change in energy policy was a direct consequence of the disaster in Fukushima, and the U.S. was forced to critically review their flood protection system after Hurricane Katrina. Also in Thailand, the 2011 flood has led to a more intensive debate. Therefore, the biggest issue in actual policy making besides the pure content is the strong political will and commitment to push forward preventive policies against upcoming obstacles and resistance. This demands political leadership and also a high competency in political management. What difference the political aspect makes can be seen by comparing the EU and North America. Nevertheless, political commitment alone won't be enough to achieve sustainable results. Therefore it needs other driving forces as well. Based on the experiences in climate change policy, it can be seen that policies are more accepted and from point even driven by the private sector if they can create a "business" case. During the last ten to fifteen years for example, German industry took over a leading position on the world market for green technologies and has thus developed an own interest in establishing eco friendly and sustainable technologies. For the same reason, giving carbon credits to local people and creating alternative sources of income will be more likely to be successful than regulatory measures alone.

But how can – generally speaking - such a "business case" be created? This is the point where policy making plays a crucial role. Through a mix based on subsidies, incentives and regulatory measures, the government can somehow enforce the development of certain technologies that are not ready for the market yet. Examples from Europe/Germany are the obligation to add a certain percentage of biofuels to normal gasoline or the German subsidies for solar power cells that led to massive investments and larger production scales at German producers.

However such measures have to be examined very carefully. In economic theory, the general case of industry development under protected circumstances is highly disputed and there is a very thin line between supportive measures in order to achieve marketability and the artificial cultivation of subsidized and inefficient state-dependant industry. The aforementioned example of German solar cell producers demonstrates the related risks, since it has to be considered as a worrying sign that the partial cutback of solar subsidies could not be achieved due to resistance from the producers and the political sphere as well.

Taking this into account as well as the detailed findings and data of chapters 3-5 of this study, the following policy recommendations for climate change adaptation and mitigation on the Thai and ASEAN level:

6.2. General policy recommendations

Recommendation one:

Establish common environmental standards on supranational level

As shown for NAFTA and already discussed above, liberalization within a free trade area or further going economic integration scheme bears the danger, that member states try to attract foreign investment through undercutting standards of the other countries within the integration area since tariffs and other trade barriers are not longer in place. This competition potentially does not only affect environmental standards, but also social standards, wages, labor laws, workers rights, tax regimes, etc. Even in the European Union disputes occur regularly if single member states try to gain economic advantages by undercutting the Unions average. Slovakia was criticized a few years ago for establishing a flat tax much below the tax level of other member states and in the current economic crisis in Germany, neighbors argue that Germanys gained its strong position in the EURO zone only because of strict wage policies and an export policy that harmed partners.

Therefore, in order to profit from economic liberalization within integration schemes while mitigating negative effects at the same time, rules need to be established in which the states agree on common standards. For the environmental dimension this means that economic liberalization agreements should be flanked by common agreements on minimum environmental protection standards that cannot be undercut by any member state without some kind of sanction mechanism from the others. Such a framework could, for example, address forest protection as one major issue for climate change mitigation in Southeast Asia.

It is obvious, that such a commitment can only be achieved in cooperation with all member states. Nevertheless, since Thailand is one of the founding and key members of ASEAN and in a comparably strong economic position, the Royal Thai Government (RTG) does have the potential to play a key role in establishing a reliable framework and giving a direction.

Beyond the social and environmental dimension, for Thailand, this is also a matter of economic interests. Undermining standards in weaker countries could lead to a loss of industrial production.

Therefore it is in the interest of the RTG to maintain high standards that at least match the existing national protection laws in order to compensate non existing ASEAN and AFAT regulations.

Recommendation two:

Empower supranational institutions to be capable to act

One of the biggest challenges for all kinds of international and supranational agreements are that they might fill papers and reports, but that it is not primarily ensured that they are effectively implemented on the national level. One has just to think about all the UN human rights documents that have been signed from Stalin's Soviet Union in 1945 up to Assad's Syria today. Therefore, international agreements need a mechanism to be enforced effectively. To achieve real environmental protection, ASEAN would have to install institutions that ensure that environmental standards are kept in the member states. This would have to include the capacity to monitor the national law enforcement, to identify violations, and to put mechanisms into service to sanction misbehavior. Such institutional capacity will not only bring a benefit in environmental issues, it is also useful in ensuring that all member states stick to their commitments regarding tariff regimes, the abolishment of trade barriers, etc.

Although the huge debts of some members of the EURO zone demonstrate that even the respective European agreements on economic and financial discipline were undermined by many member states, the EU generally shows how an effective supranational framework can work. In many fields, EU legislation has a huge impact on national laws and the Union has the capacity and the tools to enforce its legislation. Especially from the commission, but also the European court and other bodies like the cartel, authorities provide the necessary tools. While taking the EU as a positive example, however, it should be added that one does not have to agree on the intensity of integration that is equivalent to the EU. The import point here is only that a supranational authority needs to be capable to enforce the given standards – no matter if they are few or many.

Therefore, the RTG, as well as the other ASEAN governments need to demonstrate a strong commitment to ASEAN institutions and treaty obligations. It has to be ensured that misbehavior and violations of common standards can be effectively panelized within the ASEAN bodies. One weakness of the European framework for the common currency was, however, that the monitoring system was designed dysfunctional. Because the states were left to monitor themselves and there is no single, unified monitoring entity observing themselves among each other, the question of sanction mechanism, although clearly defined on paper, became a matter of bargain among the states. Therefore, safeguards and sanction mechanisms should be designed as independent institutions.

From the perspective of the government this might look inconvenient but it will strengthen the framework in the long run.

Of course it has to be considered (and respected), that ASEAN integration has not a level comparable to the EU yet and this might also not be in accordance with the political will of its members. Nevertheless it has to be kept in mind that the political will to establish a common market (which is obviously expressed through AFTA), somehow automatically raise the demand for certain common structures and regulations. Otherwise either the common market will not function or the economic and social outcomes cannot be properly addressed within a common framework.

Recommendation three:

Establish land tenure legislation and ensure land ownership rights

As stated, on major challenge in many regions is the lack of defined land ownership. This is true for farmers in rural areas but also for urban poor in slum areas. If land ownership is not defined however, climate change impacts on the respective communities cannot be tackled effectively. Who should receive compensation or state support for destroyed property or harvest lost? How should adaptation and mitigation measures to be addressed effectively? And how could any kind of carbon trade system work, if the sellers of trade certificates cannot be identified?

Therefore, states should improve their land legislation and strengthen the responsible authorities, especially in rural areas where registries of deeds might not be even exist at present. The objective should be to provide reliable land titles that are also enforceable towards courts and communities. Sometimes it is argued that some local communities do not know or even understand the concept of individual land ownership and that their economic model bases on collaborative assets. In this cases land ownership could also be granted to a certain community as a whole. This would at least also define one specific group as owner and a target group. As mentioned in Chapter 2, land ownership might support local communities beyond environmental issues, advancing self responsibility, and facilitate access to loans for investments. Defining land ownership in rural areas is furthermore a mandatory precondition to have a chance at all to include forest protection into emission trading schemes. In urban areas, granting land ownership titles to marginalized groups would not only secure their legal status or entitle them to receive access to support measures in cases of natural disasters, but also force local authorities to deal with urbanization generally and also think of broader adaptation which might include the retention from some areas (as described in 6.1.).

Beyond that, land ownership has also a supranational dimension. In the study “Research project about AFTA and its social implications for the Kingdom of Thailand”, conducted by HDFF 2010-2011 for the Thai Research Fund, the issue of land liberalization in economic integration schemes was examined. It was discussed how far interim agreements could help to adjust to social and economic inequalities among the members. Since the free flow of goods and capital allow it to invest and buy land where it is cheap, a lack of defined land ownership in rural areas favors the exploration of natural resources by foreign investors at cost of local communities. Along with a stronger maintenance of economic standards as outlined in recommendation one, land ownership rights would help the affected communities and individuals to represent their interests and profit from economic gains in their region. On the supranational level however, the question of land ownership rights and the possibility of investments should be dealt with care and sensitivity as outlined in HDFFs last research study.

For the Thai government this involves analyzing in detail the status of land ownership, especially in rural areas and among marginalized communities. A database should be built to whom parcels are belonging. In the cities, particularly in Bangkok, the urban poor and their properties have to be registered and properly ensured. Towards the international level (ASEAN but also beyond), the RTG has to make sure that land rights and social standards apply also for foreign land buyers. As long as AFTA does not an effective framework for land related issues, the national legalization needs to find a suitable compromise to attract FDIs but also maintain national standards.

Such standards might seem as a disadvantage towards competitors within the free trade area, but this can be outbalanced either by other incentives (e.g. tax facilitations) and also through the advantage, that e.g. clear defined land ownership titles, defendable land rights and overall a functioning legal and regulatory framework is even more favoring investment, than additional cost for such provisions might hinder.

Recommendation four:

Seek supranational cooperation for supranational problems

It is impossible to generally define which issue should be addressed on what level (supranational, national, regional, local or individual). As the coastal protection example in Europe show, the states differ in how they distribute responsibility for dealing with environmental protection. In the Netherlands, it is completely a national task, in Great Britain it is completely regional and in Germany

it is regional with national financial support. It is possible that different systems work efficiently in the same way. Furthermore it depends on factors like the organization and political system of the state (federalized or centralized), the distribution of the budget, etc. It can be said, however, as a basic directive, that an issue should be addressed on the level that is affected. That means, for example, that supranational action, cooperation, and legislation are needed where environmental challenges affect more than one member state. For ASEAN that would mean, for example, that disaster prevention (tsunami warning e.g.) or coping with floods in transnational river basins are suitable cases for transborder cooperation, such as it is done in Europe concerning the Rhine, whose floods affect potentially affect five countries. To go deeper, this would also mean that flood prevention in Thailand in the Chao Praya River goes beyond the responsibility and capacity of one province.

On the national level, the Royal Thai Government should not only address the national issues but could also function as a focal point for the exchange of lessons learned. Concerning the recurring river floodings in the Chao Praya area and its economic impacts, the issue of flood protection should be a nationally coordinated issue, not limited to the provinces. In the bigger picture, despite the question of responsibility, the RTG should establish channels were stakeholders can exchange best practices and lessons learned. The ICZM approach has demonstrated how such a system can help not only to bring together relevant stakeholders but also to share experiences for local projects and implementations.

Recommendation five:

Gather more data and intensify research

Looking at ASEAN, it was mentioned that research on climate change's effects and the vulnerability of certain regions has not been examined in detail so far. As seen for Thailand, the potential impacts of sea level rise are only rarely investigated. Therefore research has to be intensified to get a clearer image what to expect and what effects might lead to which impacts. Even if the result can only be projections they will allow a more precise planning of adaptation and mitigation measures (e.g. defining flood prone areas and to develop long term strategies).

Furthermore, ASEAN states need much more and extremely more accurate data on population, population distribution, inhabitants of rural areas and LCZA, economic assets in threatened areas and land use related data on agricultural production, crops, the exact distribution of forests and their

development, etc. One strength of the often-criticized European bureaucracy is that these kinds of data are gathered know for decades through authorities, registration offices and statistical offices. In Europe for example, the Common agricultural policy that was designed under complete different circumstances for completely different purposes other than land use and climate chage allows one to draw a very detailed picture of the European agricultural sector. This made it possible to implement adaptation measures and link them to support policies (particularly subsidies), because the bureaucracy have clear data, what is planted where, how many livestock exist, how fertilizers are used and how high the estimated agricultural emission are. Furthermore (see recommendation one), the EU schemes are effective to enforce mechanisms of control and sanctions.

That does not mean that ASEAN should copy the Common Agricultural Policy (CAP), as it has caused a lot of problems in other fields as described in the EU chapter. CAP is only an example on how knowledge based on reliable data is facilitating the design of suitable policies, instead of just guessing or believing that just doing "something" might be good enough. In combination with more detailed climate change research, defining vulnerabilities, and potential impacts more clearly, such a database will allow the design and implementation of more effective adaptation and mitigation programs. Such data gathering is also interlinked with other recommendations here, for example, with the issue of land ownership. (Data on the status quo has to be gathered to define land ownership, while later clearly defined land ownership will help to gather further data on production, emissions.)

The proposed building of a database referring to land ownership could also form the basis to examine the concrete land usage in different areas. Although over bureaucratization should be avoided, this database could be used to register agricultural and economic land use activities, GHG emissions, etc. In order to examine possible climate change impacts and to develop long term adaptation strategies, the Royal Thai Government has to intensify its research activities, especially in coastal areas as a preparation for an integrated coastal zone/shoreline management system. Since ASEAN seems not to be in a leading role here, particularly since a common agricultural policy seems not reasonable, such kind a agricultural data collection should be done on the national and the regional levels. ASEANs role could be however to invest in and coordinate specific research activities on climate change and climate change outcomes.

Recommendation six:

Intensify local participation and include relevant stakeholders in planning processes

The case studies have shown that the support and the involvement of the affected people play an important role for the success of the concrete implementation of measures. This is true for a climate change adaptation project in the case of Vietnam, but could also be seen in Germany. Somehow in Western Europe it might be even harder to manage the political process, because the demand for participation and involvement is strongly addressed by the affected people themselves who already have forums that are missing on the coast of Vietnam. Anyway, in both cases, gaining the acceptance and support of the target group will have benefits beyond just the facilitation of the adaptation process. The target groups have to understand who they can benefit from a certain measure (e.g. a new crop sort). On the other hand, local communities are a valuable source of information (e.g. on seeding practices, rainfall patterns etc.). Therefore, the inclusion might even improve the outcome of a policy.

But inclusion is also an issue of political management. Especially against the backdrop that climate change adaptation and mitigation also always is in the area of conflict between environmental needs and social impacts, it makes sense to include all relevant stakeholders in the planning and implementation process to achieve an optimized balance between the different needs. In addition to the local people, stakeholders also include economic interests (that can never be completely denied). The establishment of a natural reserve in order to protect forests, for example, might affect the local communities in terms of their livelihood but also the tourism sector. Bringing these stakeholders together would allow them to find a solution where the natural reserve establishment is flanked by a concept of eco-tourism. This also opens the possibility of new income sources for the local community that in turn might ensure their economic security and lead to acceptance of the natural reserve and forest protection. Thus, it is a part of their own interests to ensure their new economic perspective.

Projects like this already exist in development cooperation but they are often limited in time and resources. Therefore, stakeholder involvement should become an integrated part of national policy planning methods. How this can work in an institutionalized setting can be seen with the ICZM projects and implementations that were presented in the EU chapter. From the examples given it can also be concluded that bringing stakeholders together can lead to suitable compromises where additional harmful costs are inevitable. The agreement between the UK government and the British insurers association demonstrate how shared responsibility (guaranteeing maximum coastal protection efforts in exchange to ongoing insurance coverage), can help to mitigate social impacts on the affected people and communities.

Therefore, the Royal Thai Government should – where possible – institutionalize local participation. A good example were this has already being recognized is the mitigation plan of the ministry of agriculture as well as the Bangkok Metropolitan Administration plan that explicitly included the private sector. On the legal and institutional level, formalized participation measures might include mechanisms like the formal right to submit petitions and amendments to running planning processes or public hearings regarding the project implementations. Although potentially inconvenient, this would also include an effective right to appeal to local and national courts effectively. The baseline of this approach should be the model of action that insures that decisions are taken as "close to the citizen" as possible. This would also mean to strengthen the provinces and local communities, granting them a certain local autonomy and strengthen their administrative and financial responsibility in environmental issues.

Recommendation seven:

Address adaptation and mitigation through a comprehensive approach

To ensure, that climate change adaptation and mitigation is properly addressed it is not only sufficient to actualize environmental legislation or to put particular climate change related laws into force. Climate change adaptation and mitigation are crosscutting issues that affect a broad range of policy areas, especially energy policy, rural planning, industry and building laws, etc. Therefore it is also important for policy making to interpret climate change policy as a crosscutting issue and to include climate change related issues in the respective legislation. The legislation in Europe gives a good example by already demanding the inclusion of climate change issues in other policy areas in its basic treaties.

The advantage of this comprehensive approach is that it is at least ensured that awareness of climate change issues is institutionalized in policy debates and that relevant and potential fields can be identified. In order to do so, the Royal Thai Government should include a "climate change clause" in new land related laws. Furthermore existing laws related to environmental issues, rural and urban planning, energy, and buildings should be amended by such a clause.

Recommendation eight:

Ensure capability of institutions and law enforcement

This recommendation can be generalized for many problems beyond the issue of this study and is in accordance to general research on development. It is known and it has also been mentioned in this study, that in many cases, even if suitable legislation is in place and rights and regulations are clearly defined, the practical worth of them depends on the capacity of the authorities to enforce them. This has already been discussed for the supranational level, but it is also true for the national level. Also national legislation and policy can only be successful if national institutions are capable of carrying them out, if rights and titles (land ownership) can be enforced towards police and court, and if decisions of authorities are accepted and enforced. Therefore it is an ongoing task for the Royal Thai Government to work at the provincial level to improve the capacity of their institutions, fight corruption, educate state officials and stick to the principles of good governance. The positive are of this affect the success of all policies, not only regarding climate change and land. Since ASEAN enfolds states with very different political systems, it is unclear if it can be always the right institution to foster this process. Therefore the RTG should take these actions independently from ASEAN and function as an engine within the supranational structures.

6.3. Formulation of a management model

Following these policy recommendations, the next step is to consider how an effective adaptation and mitigation policy can be implemented concretely. Despite the fact that this study cannot provide a solution that claims general suitability (as argued, it depends on many factors), the following model should present a scenario of an idealized planning and implementation process. As an example, the fictive case of forest protection (see recommendation six) should be continued here. Based on the recommendations, that stakeholder should be involved and issues should be addressed on the responsible and capable level, this management model proposes a subsidiary approach.

Step	Action	Fictional example of forest protection in a certain area
1	Identify the problem *(-> Intensify research and gather data)*	In the considered province, during the last 50 years, 30% of natural forests were destroyed due to slash and-burn agriculture which is still ongoing.
2	Identify impacts relevant for climate change adaptation and mitigation *(-> Intensify research and gather data)*	• Deforestation raises emissions. • The carbon storage capacity decreases. • Land use change (forest to agricultural land) increase vulnerability to soil erosion and disaster damages (it is assumed that the region is threatened by storms).
3	Define the overall objective of the measure	• The remaining forest area in the region should be maintained.
3a	Define the specific objective of the measure	• Establishment of a natural reserve
4	Identify the relevant stakeholders	• National government -> Wants to protect the forest area but also to mitigate social impacts • Local communities who burn forests for agriculture -> Natural reserve threaten their economic livelihood • Regional government -> Represents the social and economic interests of the region. Fears social problems, if livelihood is threatened; Agricultural production is important for the food security of the region. • Private sector -> Is interested in the exploration of the area and use its economic potential

5	Bringing the stakeholders together to examine and to find a solution	• A natural reserve will be established. • The region will however be accessible for eco-tourism, financed by private investments or PPP. • The local communities will be included in the implementation and jobs will be created. Economic gains stay in the region • To ensure food security and maintain/increase agricultural production, the existing farms are supported via introduction of new technologies, consultancy etc.
6	Identify responsibility and capabilities	• Parks will be administered by the regional/local authorities. • Where necessary, support from a higher level is granted (e.g. promotion via the national tourism board, investments in eco friendly infrastructure, financing of flanking agricultural measures, etc.)
7	Implement legislation and ensure enforcement	• Define land titles in the region and the shares of the local communities • Release national and regional laws to establish the reserve • Empower local authorities to control and enforce the non-violation of the park borders

Though very generalized, this is an example of how an adaptation and mitigation measure could be planned and implemented through a participatory approach. To implement the described steps, one can use further management tools to identify the problem and the objectives (Project-Management Tools like Problem trees; SWOT analysis, Project Cycle Management etc.). Further, it will be of course a matter of discussion and negotiation. It also has to be kept in mind that potentially not all stakeholders will be satisfied (e.g. another potential stakeholder could be the timber industry). But at least the given example would provide a solution that has potentially balanced the need of environmental protection and social implications through mitigation of negative effects on the local communities while at the same time offering new development opportunities.

6.4. Concrete issues for Thailand

Despite the general conclusions and recommendations, the examination of Thailand has shown specific tasks for future climate change adaptation and measures on the national level. Conclusively, the following issues are relevant for Thailand:

Greenhouse Gas Inventory (GHG)

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 appropriate activity data to support the estimation of greenhouse gas inventory The sectors that should be given special attention are agriculture and forestry.
- Train relevant officials and agencies to carry out the estimation regularly
- Develop techniques in greenhouse gas emission forecasting

Impact, Vulnerability, and Adaptation

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

- Climate Change

- Development of more climate change scenarios at the sub-regional level address uncertainties
- Development of advanced techniques to analyze impacts on major sectors, especially annual and perennial crops
- 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.

- Climate variability and extreme events

In Thailand, research on vulnerability and adaptation to climate variability and extreme events is in its early stage. The need of support is seen in the following areas:

- Studies and research on the sea-level rise are vital for the future of Thailand
- Technologies to cope with coastal erosions and are appropriate for local conditions
- Technologies and policies to cope with massive flooding
- 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

Greenhouse Gas Mitigation

Thailand has adopted strategies to conserve energy and to use renewable energy, with a view of achieving ambitious targets. To meet such targets, advanced and economically sound technologies are vital. Under the existing market system, many 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. Techniques, know-how and technologies to mitigate GHGs are needed as follows:

- Technologies to mitigate GHG from rice paddy fields
- Advanced technologies for energy conservation for electricity production and consumption
- Development of knowledge and infrastructure for innovation of clean technologies
- Technologies for biomass and biogas energy production appropriate for local conditions

Mitigation in the agricultural sector

The mitigation plan of the Ministry of agriculture has already outlined the strategies that needs to be followed in order to mitigate climate change effects in the Thai agricultural sector related to the five

areas of Plants, Soil, Water, Livestock and fishery and the overall effect from climate change to agriculture:

- Strategy on knowledge management
- Strategy on prevention and solution of the climate change problems
- Strategy on campaign, information dissemination, public relation and personnel capacity development

The tools defined by the plan are: education, training, distribution of information. Furthermore it recognizes the necessity of participation of farmers as well as measures to monitor and evaluate the strategies and offers advice to the involved stakeholders (government units, staff and farmers). This plan should be implemented under the authority of the Ministry of Agriculture.

Others

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

- Development of regional information exchange and communication
- Capacity enhancement of meteorologists
- Capacity building for negotiators of the UNFCCC and the Kyoto Protocol
- Capacity building for short- and medium-term weather forecasts

Implementation of the Bangkok Metropolitan Action Plan

- Expand the Mass Transit Rail System within Bangkok Metropolitan Area
- Promote the Use of Renewable Energy
- Improve Building Electricity Consumption Efficiency
- Improve Solid Waste Management and Wastewater Treatment Efficiency
- Expand Park Area

After the last year of the action plan period, it has to be evaluated if the targets could be reached, which obstacles occurred and a on strategy for the next period needs to be defined

6.5. Forecast

The given recommendations provide a basis for a more effective and target orientated land policy planning. Nevertheless, one crucial issue for the ASEAN states cannot be solved through the given recommendations. As discussed in Chapter 2, proper adaptation and mitigation measures are cost extensive. While Western Europe and North America can or at least could finance appropriate policies, it has to be doubted that all ASEAN members have the economic capacity to do so. Especially technical protection, such as coastal protection, is very expensive, and even if one can project that the costs of inaction are even higher, it does not mean, that states can take on the adaptation costs in the first place. In contrast, it has to be feared that costs of later impacts have to be carried by the affected social vulnerable groups, even worsening the negative social impacts of climate change in the future.

But how can developing or even least developed countries cope with the costs of proper policies? It seems evident that this will not function without external support. Therefore, climate change projects are already addressed in development cooperation. One solution that is already on the table is provided by the CDM KP mechanism. So far however, ASEAN states are only rarely using these opportunities. At the moment, the most projects are carried out in China, Brazil, and India, while ASEAN's share is only marginal. Therefore, an additional policy recommendation would be, to intensify the use of the CDM mechanism to implement appropriate measures. In order to support the efforts of the economically weakest ASEAN member states, an appropriate path could also be the idea of trilateral cooperation, bringing together e.g. the EU, Thailand, and an LDC for a common project.

In order to tackle the particular problem of deforestation in Southeast Asia, the discussion has to be continued on how existing forests and reforestation projects can be effectively included into the CDM schemes and a potential carbon trade mechanism. Still, many sensitive questions regarding this are unsolved. The ASEAN states, however, could fulfill the preconditions by following the recommendations given above, especially through defining land ownership and strengthening capacities.

This is also important to strengthen the right of Thai- and South East Asian Land Owners towards international competitors. In the previous HDFF study "Research project about AFTA and its social implications for the Kingdom of Thailand" it was discussed how to balance the economic interests and the social implications of liberalized land markets. Especially massive land grabbing by foreign

investors (not necessarily from ASEAN but also from e.g. China and the Gulf states), is considered to cause further negative social outcomes, like rising prices, less space for local farmers and the expulsion of rural communities. As an example it was reported recently, that For example, Kuwait is plans to invest 20 million US dollars to irrigate 4,500 hectares in Laos to produce rice for export.[579] On the other hand, there is a need to attract foreign investment also and especially for the development of green technologies and the sustainable protection of the environment. A recent article published in the Bangkok Post outlined the critical point of social interest vs. environmental and climate change needs by stating the example that *"forest dwellers are kicked off their ancestral land for forest officials' carbon credit money."* To mitigate the social implications and – this might be even more important – the impression that climate change mitigation measures might be profitable for certain stakeholders, it is even more important that the outcomes and also the potential profits are socially balanced by specific regulations. In terms of foreign investments that could mean that legislation make sure that foreign investment need to fulfill certain economic and ecologic standards. If such Standards do not exist on the ASEAN level and/or if they do not seem to be politically achievable, a national solution has to be found.

Meanwhile, ASEAN can play another important role beyond its internal policy making. Behind the backdrop that international climate negotiations are still ongoing, the role of supranational organizations is important for gathering and representing national (regional) interests more effectively in climate negotiations in a way no single country could do, especially towards the key players such as the USA, China, and the EU. Therefore, a strong regional mandate would be potentially helpful to address Southeast Asia's position on the international level in order to achieve a post-Kyoto agreement.

Concerning this international negotiation framework, a last remark should be made on the political debate on the general necessity of climate change adaptation. This debate worldwide often circles around the question if governments "believe" in climate change and its effects or if they do not. Therefore, also the necessity of adaptation and mitigation measures is judged based on the political environment. This can be criticized from a scientific point of view saying that climate change is not a question of "believing" but of reliable scientific data, but somehow this whole discussion misses one key point. The utility of adaptation measures is not exclusively linked to potential climate change impacts. Coastal protections against storms or river flood prevention programs, for examples, are independent issues that have to be addressed anyway. Germany, Britain, the Netherlands, and others, have dealt with these issues in a professional manner for decades since before anthropologic

[579] Bangkok Post, "Foreign Land Grab threat not just and ill?, http://www.bangkokpost.com/blogs/index.php/2012/05/25/foreign-land-grab-threat-not-just-an-ill?blog=64

climate change was even acknowledged. Climate change might influence the intensity and the frequency of such events, but they will occur in the future as they did in the past, independently from the question over whether temperatures will rise by one or five degrees. Therefore climate change adaptation regarding disasters is also and maybe the most important adaptation to protect against extreme weather events and climate volatility.

This means, that disaster prevention, in terms of research, warning systems, protection etc. will pay off in any case for the ASEAN states were the issue has not been addressed sufficiently so far. This is also true for addressing the situation of the urban poor in LCZA. Far beyond physical protection, improving their social situation, legally ensuring their rights, investing in basic infrastructure, etc. are likely to produce enormous positive social effects and contribute to the achievement of the Millennium Development goals. Also, measures like improving technology in the agricultural sector, reducing fertilizers, using improved seeds, and adapting planting and crops sorts optimal to the given environmental conditions, have positive impacts far beyond the pure climate change related targets, contributing to food security and the protection of natural resources such as ground water. Therefore, the improvement of land related policies and planning as well as rural development are important and ongoing tasks that will have to be addressed more intensively on the different levels of society.

Therefore, the Royal Thai Government should in any case continue and intensify its environmental protection efforts and take an active role in supranational negotiations. Then, Thailand will be, despite its vulnerability, in a very good position to deal with future disaster and climate impacts and mitigate its economic and social consequences.

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V. Annexes

Annex 2.I: Overview of selected technical and management mitigation options in agriculture[1]

Category	Measure	GHG 2 concerned	Technical mitigation potential (per ha/unit product)	Potential implementation cost	Technical feasibility	Comments
Management and processing of manure	Increase removal frequency (from housing buildings to covered storage)	NH3, CH4	High for pigs, (no/low potential for cattle)	High	High	High electricity needs
	Improved outdoor storage techniques (e.g., natural crusting, straw, plastic or rigid covers	NH3, N2O,CH4	Low	High	High	Slightly decreased costs for pig farms
	Improved application techniques (e.g., trailing hose, trailing shoe, injection)	NH3, N2O	Medium/High	Medium/high	High	Need specific equipment for some application techniques, such as direct injection
	Optimized manure storage	CH4	Medium/High	High	Medium	New storage facilities can have large capital cost. Reducing emissions from manure storage is a complex process and attention needs to be paid to the emissions of other gases such as N2O and ammonia
	Anaerobic digestion for biogas production	CH4, N2O	Very high	High costs needing investment support but cost-effective depending on the use of heat produced	Medium/High	Significant variability in potential. Remunerative feed-in tariffs for electricity generated are required. The process reduces GHG from the input material, while delivering renewable energy

Mineral nitrogen fertilizers	Use of controlled-release nitrogen fertilisers	N2O	Medium	Low	Medium	Fertilizers in which N is slowly released, so there might be less losses of fertilizer. They can potentially increase the efficiency of N use, bus still substantial gaps in research and are more expensive.
	Application of nitrification inhibitors	N2O	Medium	Low	Medium	Compounds added to fertiliser that prevent the turnover of ammonia into nitrate and lead to a decrease of fertilizer use or a higher N uptake. Substantial research gaps
	Improved management (appropriate timing avoiding leaching risk periods, split of application)	N2O	Medium	Low (if there no opportunity cost from output loss)	Medium	To split applications needs increased labour and machinery use.
Infrastructure (animal housing)	Livestock housing straw to slurry–based	N2O,CH4	Low/Medium	Increased costs	High	Not recommended as negative effects for animal welfare
	Natural ventilation of animal housing	NH3, CO2 CH4,	Medium	Decreased energy costs, low investment costs	Medium	
	Cages and aviaries instead of floor system for layer hens	NH3, N2O	Medium	Decreased	High	Unenriched cages not recommended because unacceptable for animal welfare reasons and to be phased out by 2012 according to Council Directive 1999/74/EC on the protection of laying hens.
	Use of bedding material in livestock housing	NH3, N2O	Medium	Decreased	High	

	Increased grazing periods, summer half day grazing system in comparison with year-round animal housing	NH3, N2O,CH4	Medium	Medium	Medium/High	High variability of feasibility, according to regional and farm land resources
	Phase feeding systems for pigs (according to their age class)	CH4	Medium/High	Decreased costs as greater efficiency of feed use	High	
Animal, breeding	Genetic improvement to improve feed efficiency	CH4	High	High research and farm costs	Medium	This is only a long-term measure with potential negative implications for animal welfare
Land and soil management	Conservation agriculture-No tillage (minimal soil disturbance)	CO2 (carbon fixation and energy savings), (N2O)	Medium/high	High (at least during the conversion period)	Medium/High (but variable)	These cultivation methods are often associated with the use of permanent soil cover (cover/catch crops, mulches), and diversified crop rotations/ crop combinations to control weeds and pests.
	Conservation agriculture-Reduced tillage	CO2 (carbon fixation), (N2O)	Medium/high	Medium (at least during the conversion period)	High	Capital cost of buying or hiring new equipment. Potential for opportunity cost of lost production in areas less suited to reduced tillage. Significant GHG reductions due to energy savings and increased accumulation of carbon. Farmers need extensive training and access to specific advisory services
	Cover crops (temporary vegetative cover between two main crops)	CO2 (carbon fixation), (N2O)	Low	No / low	High	Positive environmental effects: improvement soil structure and nitrate absorption, reducing leaching
	Residue management (no removal)	N2O	Medium/high	No / low	High	Benefits water conservation, soil quality, biodiversity. It may conflict with efforts to use residues as biomass for energy production

Adding nitrogen-fixing leguminous crops (e.g., lucerne, beans, peas, clover) to rotations	CO2 (carbon fixation), N2O	High	No / low	High	The measure is a low cost practice (legume seed and opportunity cost if this lead to a reduction of a more profitable crop). Generally, it increases productivity as reduces fertilizer needs
Management of organic soils (peatland)	CH4, CO2	Medium/high	High	Medium	Opportunity cost of abandoning cropping, small cost of drain blocking
Permanent set-aside	CO2, N2O	Medium/high	Medium/high (opportunity cost from output loss)	Low	The overall implications for the large GHG balance need to be considered as set aside may lead to intensification on other parts of the land and in some cases may cause currently non-agricultural systems to be brought in to production. Field strips or extended field margins, can have some benefits for mitigation and also biodiversity while having less impact in terms of lost production.
Agro-Forestry systems (combining annual and permanent crops or trees)	CO2	Medium/high	Medium	Medium	Costs involve: opportunity cost of lost production and cost of trees. It can improve biodiversity (depending on the permanent crop)

[1] This table shows some possible technical and management solutions for reducing farming GHG emissions and maintain and enhancing carbon stocks. The mitigation potential, costs, technical feasibility of these options are only indicative as there are significant spatial disparities according to the types of soils, climate, farm characteristics and other factors.
[2] NH3 (ammonia) is not a GHG but an important polluting gas closely linked to livestock activities and a source of additional GHG emissions.
Source: EU-funded projects MEACAP-Impact of Environmental Agreements on the CAP and PICMAT- Policy Incentives for Climate Change

Source: European Commission *The role of European agriculture in climate change mitigation* European Commission Working Document (Brussels 2009) 47-49

Annex 4.I: Eight Principles of Good ICZM[1]

Principle 1:
A broad overall perspective (thematic and geographic) which will take into account the interdependence and disparity of natural systems and human activities with an impact on coastal areas.

Principle 2:
A long-term perspective which will take into account the precautionary principle and the needs of present and future generations.

Principle 3:
Adaptive management during a gradual process which will facilitate adjustment as problems and knowledge develop. This implies the need for a sound scientific basis concerning the evolution of the coastal zone.

Principle 4:
Local specificity and the great diversity of European coastal zones, which will make it possible to respond to their practical needs with specific solutions and flexible measures.

Principle 5:
Working with natural processes and respecting the carrying capacity of ecosystems, which will make human activities more environmentally friendly, socially responsible and economically sound in the long run.

Principle 6:
Involving all the parties concerned (economic and social partners, the organisations representing coastal zone residents, non-governmental organisations and the business sector) in the management process, for example by means of agreements and based on shared responsibility.

Principle 7:
Support and involvement of relevant administrative bodies at national, regional and local level between which appropriate links should be established or maintained with the aim of improved coordination of the various existing policies. Partnership with and between regional and local authorities should apply when appropriate.

Principle 8:
Use of a combination of instruments designed to facilitate coherence between sectoral policy objectives and coherence between planning and management.

[1] Evaluation of Integrated Coastal Zone Management (ICZM) in Europe 7

Annex 4.II Indicative list of the main rural development measures that can be used to support mitigation in agriculture and rural areas (on the basis of the rural development regulation as modified by the Health Check)

Mitigation domain	Examples of actions	Possible supporting measures of Rural development Regulation	Potential effects
Reduction of farm-level emissions of CH4 and N2O	• Investments in on-farm biogas plants (using animal manure) • Investments in manure storage facilities • Investments in equipment for better application of fertiliser (e.g., spreader, precision farming	Article 26: modernisation of agricultural holdings	Support for investments in costly equipment is essential to motivate farmers economically to improve agricultural performance in term of GHG emissions
	• Reduction of fertilisers use (reduced use, timing of application, diversified crop rotations) • Extensification of livestock (e.g., reduction stocking density) • Organic farming	Article 39: agri-environment payments	Agri-environmental measures hold an important potential to stimulate adoption of targeted or climate-relevant measures to reduce methane (CH4) and nitrous oxide (N2O) emissions
Reduction of farming emissions of CO2	• Investments in energy-efficient equipment and buildings (e.g., insulation) • Investments for on-farm use of renewable energies (e.g., biogas, use of renewable fuels, solar heating and power)	Article 26: modernisation of agricultural holdings	Energy efficiency and diversification if energy supply in farms is becoming increasingly important. Insulation of buildings, increased use of solar energy, vegetal oils, biofuels, and biomass heat and power offer the greatest potential for reducing energy-related CO2 emissions
Soil sequestration in agricultural	• zero or reduced tillage systems which avoid or reduce soil disturbance;	Article 39: agri-environment Article 41: Non-productive investments	By increasing the ability of agricultural soils to store carbon, CO2 can be removed from the atmosphere,

soils	• diversified crop rotations (to reduce fertilizer use) • use of catch crops (green manure crops), protein crops, reduce the removal of residues (stubble), incorporation to soil of organic material; • Conversion of arable land to permanent pastures • Maintenance of permanent fallows areas • maintenance of green cover of soil rows in permanent crops plantations; • establishment of permanent set-aside areas with green cover;		while also playing an important role in improving the long-term quality and fertility of soils
	• maintenance of permanent pastures, as they hold important stocks of carbon, and conversion of arable land to grassland;		
Forest measures	• Improving the wood production (e.g., thinning, changes in the tree species composition)	Article 27 : Improvement in the economic value of forests	Substitution of fossil fuels or high energy content material as steal or concrete by bioenergy from forest biomass
	• First afforestation of agricultural land or of non agricultural land • Forest-environment	Articles 43 and 45: first afforestation of agricultural and non-agricultural land Article : Forest-environment	Enhance carbon sequestration in forests areas
Development of renewable energies	• Support to investments in biogas plants (using animal manure), on farm and local production • Plantation of multi-annual energy crops (e.g., herbaceous grasses, short rotation coppice) • Processing of agricultural/forest biomass for renewable energy • Installations/infrastructure for renewable energy using biomass and other renewable energy sources (solar and wind power, geothermal)	Article 26: modernisation of agricultural holdings Article 28: adding value to agricultural and forestry products Article 29: cooperation for development of new products, processes and technologies in the agriculture and food sector and in the forestry sector Article 53: diversification into non agricultural activities (for local production) Article 54: support for business creation and development (for local production)	Agriculture, and forests, also provides an indirect contribution to emission reductions in other sectors, through the supply of biomass for the production of bioenergy and substitution of fossil fuels.
Diffusion of knowledge, capacity building	• Training and use of farm advisory services in relation to climate change	Article 21: vocational training and information actions Article 24: use of advisory services Article 58: training and information	Information and dissemination of knowledge and advice to farmers (and local communities) in relation to climate change mitigation and possibilities for using and producing renewable energies

Innovation	Development of new technologies, products and processes in the agriculture and forest sectors	Article 29: Co-operation for development of new products, technologies, and processes in the agriculture and food sector and in the forestry sector Article 28: Adding value of forestry products	Innovation can underpin efforts to tackle climate change. As regards forests, increasing of the use of low-value timber, small-sized wood and wood residues for energy production.

Source: Commission of the European Communities (CEC), "The role of European agriculture in climate change mitigation", (European Staff Working Document, Brussels: 2009), 41-42

Annex 4.III: Summary of programming of mitigation actions within Rural development Programmes 2007-2013 [1]

Domain	Types of operations	Code of main RD measures used [2]	Number of national/regional RDPs with		
			No measures	Non-targeted	Targeted
Manure management	Investments on manure storage facilities, and on installations for better manure treatment and processing (including anaerobic digesters)	121	49 [45 %]	34 [31 %]	26 [24 %]
Manure management	Improved manure management (e.g., manure management plans, frequent removal of manure from animal housing to covered storage)	214	41 [38 %]	44 [40 %]	24 [22 %]
Fertilisation efficiency	Investments in equipment for better application of mineral fertilisers, mineral and manure (e.g. spreader, equipment for precision farming)	121	64 [59 %]	34 [31 %]	11 [10 %]
Fertilisation efficiency	Actions to improve efficiency of fertiliser use (e.g., reduction of use, changing practices, improved spreading techniques, calculation N balance)	214	24 [22 %]	52 [48 %]	33 [30 %]
Energy efficiency	Energy-savings investments (e.g., energy efficient buildings, installations, greenhouses, use new materials)	121, 123, 124	30 [28 %]	47 [43 %]	32 [29 %]
Farm management	Organic farming	214	3 [3 %]	46 [42 %]	60 [55 %]
Farm management	Integrated production (including fertiliser reduction, extended crop rotations)	214	41 [37 %]	29 [27 %]	39 [36 %]

Soil, land management	Soil conservation techniques (e.g., reduced tillage methods, permanent green cover, catch crops, management stubble)	214	20 [18 %]	48 [44 %]	41 [38 %]
Soil, land management	Reduced use / restoration of organic soils (peat land)	214	67 [61 %]	26 [24 %]	16 [15 %]
Livestock management	Extensification of livestock (e.g., reduction stocking density, increase grazing)	214	52 [48 %]	42 [39 %]	15 [14 %]
Pastures management	Extensification of pastures management (e.g., reduced/no fertilisation, practices to maintain/increase soil organic levels such as diversification of grass species)	214	35 [32 %]	44 [40 %]	30 [28 %]
Land use change	Permanent set-aside (long-term fallow)	214, 216	85 [78 %]	15 [14 %]	9 [8 %]
Land use change	Conversion of arable land to permanent pastures	214, 216	79 [72 %]	14 [13 %]	16 [15 %]
Land use change	Conversion of agricultural land into forest (afforestation)	221	46 [42 %]	11 [10 %]	52 [48 %]
Building capacity	Training, demonstration projects, information actions (in relation to climate change, mitigation actions)	111	37 [34 %]	52 [48 %]	20 [18 %]
Building capacity	Setting up and use of advisory services (in relation to climate change, mitigation actions)	114, 115	70 [64 %]	23 [21 %]	16 [15 %]
Innovation	Development of new technologies and processes	124	80 [73 %]	16 [15 %]	13 [12 %]
Average			**48 [44%]**	**34 [31%]**	**27 [25%]**

[1] A total of **109 RDPs** have been analysed: 18 national programmes (all except the National programme of France Hexagone), 90 regional programmes (including the 21 "Documents Régionaux de Développement rural"

of France), and 1 the national framework (Germany).
[2] Codes used are: 111-Training, 114-Use of advisory services, 115-Setting-up farm advisory services, 121-Modernisation, 123-Adding value to agricultural and forest products, 124-Cooperation for development of new products, processes and technologies, 214- Agri-environment, 216-Non-productive investments
Source: Synthesis report of the results of a survey

Source: Commission of the European Communities (CEC), "The role of European agriculture in climate change mitigation", (European Staff Working Document, Brussels: 2009), 44-45

Summary of programming to support renewable energies within Rural development Programmes 2007-2013

Domain	Types of operations	Code of main RD measures used [1]	Number of national/regional RDPs with		
			No measures	Non-targeted	Targeted
Biomass-based energy	Investments for on-farm production and use of biogas	121	71 [65 %]	12 [11 %]	26 [24 %]
Renewable energies	Investments support for on-farm use of other renewable energies for electricity and heating (e.g., glasshouses, buildings)	121, 125	49 [45 %]	20 [18 %]	40 [37 %]
Biomass	Plantation perennial energy crops (e.g., short rotation coppice and herbaceous grasses)	121	73 [67 %]	20 [18 %]	16 [15 %]
Biomass based energy	Processing of agricultural/forest biomass for renewable energy (e.g., biofuels) (on farm and local actions)	121, 123, 124, 311, 312	17 [16 %]	39 [36 %]	53 [49 %]

Renewable energies	Investment support for local energy supply: installations/infrastructure for renewable energy using biomass and other renewable energy sources (solar, wind power)	311, 312, 321	45 [41 %]	29 [27 %]	35 [32 %]
Building capacity	Training, demonstration projects, information actions in relation with production and use of bio-energies	111, 331	50 [46 %]	45 [41 %]	14 [13 %]
Average			**50 [51 %]**	**27 [24 %]**	**30 [25 %]**

[1] 121-Modernisation, 123-Adding value to agricultural and forest products, 124-Cooperation for development of new products, processes and technologies, 125-Improving and developing infrastructure, 311-Diversification into non-agricultural activities, 312-Suppot for business creation and development, 321- Basic services for the economy and rural population, 331-Training and information for rural actors

Source: European Commission *The role of European agriculture in climate change mitigation* European Commission Working Document (Brussels 2009) 41-42

VI. List of attachments

Chapter 2

Adaptation to climate change in agriculture, forestry and fisheries: Perspective, framework and priorities

CLIMATE CHANGE AND LAND TENURE - THE IMPLICATIONS OF CLIMATE CHANGE FOR LAND TENURE AND LAND POLICY

IPCC: Agriculture

IPCC: Climate Change 2007: Synthesis Report

IPCC: Climate Change 2007: Synthesis Report - Summary for Policymakers

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IPCC: Forestry

IPCC: IPCC SPECIAL REPORT - EMISSIONS SCENARIOS

Land use and climate change

Tropical Deforestation and Climate Change

Verantwortung ernst nehmen – Industriestaaten müssen Klimaschulden tilgen

WWF: Deforestation and Climate Change

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Adaptation to Climate Change - ASEAN

ASEAN Climate Change

Brunei Constitution

Cambodia Law on Land Management, Urban Planning and Construction

Case Study Cambodia - 30 Tenure Rights and Benefit Sharing Arrangements for REDD

Case Study Indonesia

Case Study Malaysia

Climate change and agriculture and forestry 2011

Climate Change and Urban Planning

Climate change impact on agriculture 2005

Climate change -Thailand

Climate Change Vulnerability

Consultancy report on climate change policy mapping in Cambodia
Indonesia Case Study
Indonesia Energy Law 2007-1
Indonesian Constitution
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Laos Law on Environmental Protection
Malaysia Environmental Quality Act 1974
Myanmar constitution
Philippine Disaster Risk Act
Singapore's National Climate Change Strategy 2. - Vulnerability and Adaptation
Thailand Investment Promotion Act
Thailand Karen Community Carbon Footprint
The Economics of Climate Change in Southeast Asia
Vietnam Constitution

Chapter 4

13th amendment to the German Atomic Energy Law
AEA: Adaption to climate change in the agricultural sector
Aktionsplan Anpassung
Bundesregierung - German adaption strategy
CEC: EU Whitepaper
CEC: Green Paper
CEC: Role of European agriculture
Critical currents - Carbon trading
Cummins - Review of ICZM
DKKV: Final
DMG: Klimastatement 2007
DWD: Klimastatusbericht
EC: Action against climate change
EC: DG ARD Agriculture
EC: DG CAP discussion paper
EC: TFEU

EC: The EU emission trading scheme

EFMA: Annual report

ESP: Rural development

EUROSTAT_E27 GHG

Fischer: EU Energie und Klimapolitik

Friesecke: Precautionary and Sustainable Flood Protection in German

GDV: Climate Change Challenge

German Federal Planning Act

Germanwatch: Klimawandel in Deutschland

Hochwasserschutzgesetz (flood prevention act)

IEEP: ILUC

IEEP: Land use implications

IPPC: Europe

JRC: Climate Change impacts in Europe

Olesen: Agriculture

PEER: Europe adapts to climate change

PESTA: Impacts on agriculture

PRC: Economics of climate change adaption

RC: Evaluation of ICZM

UBA: 40 Prozent Senkung

UBA: Forstwirtschaft

Zebisch: Climate Change in Germany

Chapter 5

Ackermann: The Cost of Climate Change

Alix- Garcia: An Assessment of Mexico's Payment for Environmental Service Program

Alix- Garcia: Forest Conservation and Slippage

American Planning Association: Policy Guide on Planning & Climate Change

Appel: Water Wars

Appendini: Agricultural policy

Applied Research Center: Check the Colorline - Poverty Fact Sheet

Audley: NAFTA's Promise and Reality

BIOCAP: Adapting Forest Management

Bourque: From Impacts to Adaption

Campbell: Land Degradation in Mexico

Canadian Council of Forest Ministers: Vulnerability of Canada's Tree Species to Climate Change

CCCC: Estimating the Mortality Effect of the July 2006 California Heat Wave

CEC: Analytic Framework

CEC: Environmental Assessment of NAFTA

CEC: Landuse

CEC: NAFTA's Institutions

CEC: North American Environmental Law and Policy

Davis: Domestic and international migration from rural Mexico

EPA: Climate Change Indicators

EPA: Climate Change Science Facts

Ford: Climate Change policy responses

Gehring: Eco-Health in the Americas Legal Working Paper Series

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Hatfield: Agriculture

Hueth: Standards and the Regulation of Environmental Risk

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Jacott: The Generation and Management of Hazardous Wastes

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Schott: Revisiting the NAFTA Agenda on Climate Change

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USDA: Agricultural Research Service

USDA: CONSERVATION RESERVE PROGRAM

USDA: Economic Modeling of Effects of Climate Change

USDA: Farm Service Agency and Climate Change

USDA: Forest Service: Forest Legacy Program

USDA: The Effects of Climate Change on Land Resources in the US

Watson: US Climate Change Policy

WCI: Brochure

Williamson: Climate Change and Canada's Forests

World Bank: Mexico Country Note