

Policy Department
Economic and Scientific Policy

Climate change impacts on Developing Countries – EU Accountability

This study was requested by the European Parliament's Committee on the Environment, Public Health and Food Safety.

Only published in English.

Authors: Fulco Ludwig, Catharien Terwisscha van Scheltinga, Jan Verhagen, Bart Kruijt, Ekko van Ierland, Rob Dellink, Karianne de Bruin, Kelly de Bruin and Pavel Kabat.

Wageningen University and Research Centre
Droevendaalsesteeg 4, 6708 PB Wageningen,
The Netherlands
www.wur.nl

Co-operative Programme on Water and Climate (CPWC)
Westvest 7, 2611 AX Delft, The Netherlands
www.waterandclimate.org

Fulco.Ludwig@wur.nl
Pavel.Kabat@wur.nl

Administrator: **Yanne Goossens**
Policy Department A: Economic and Scientific Policy
DG Internal Policies
European Parliament
Rue Wiertz 60
B-1047 Brussels
Tel: +32 (0)2 283 22 85
Fax: +32(0)2 284 90 02
E-mail: yanne.goossens@europarl.europa.eu

Manuscript completed in November 2007.

The opinions expressed in this document do not necessarily represent the official position of the European Parliament.

Reproduction and translation for non-commercial purposes are authorised provided the source is acknowledged and the publisher is given prior notice and receives a copy. E-mail: poldep-science@europarl.europa.eu.

Table of contents

Executive summary.....	iii
1. Introduction.....	1
2. Impacts of climate change on developing countries.....	2
2.1. Observations of recent impacts of climate change	2
2.1.1. Observed changes in climate	2
2.1.2. Observed impacts of climate change on the natural and human environment.	3
2.2. Future impacts of climate change on developing countries.....	3
2.3. Impacts of climate change on poverty and development.....	7
2.3.1. Vulnerability to climate change	7
2.3.2. Climate change impact on poverty– why the poor will suffer most	8
2.3.3. Climate change and development	9
2.3.4. Climate change and the Millennium Development Goals	10
2.4. Costs and benefits of climate change.....	11
2.4.1. Costs and benefits of climate change mitigation	12
2.4.2. Costs and benefits of climate change adaptation	12
2.5. Impacts of climate change and climate policies on local economies in developing countries	14
2.5.1. Impacts of mitigation efforts on local economies.....	15
2.5.2. Impacts of adaptation options for local economies.....	16
3. Mitigation of greenhouse gas emissions in developing countries	18
3.1. Assessment of current climate change mitigation efforts.....	18
3.2. Clean technologies transfer to developing countries	19
3.3. EU development policies regarding deforestation.....	21
3.3.1. Policies in the area of climate change mitigation	21
3.3.2. Policies related to soy bean trade.....	22
3.3.3. Policies related to the timber trade.....	23
3.3.4. Infrastructural aid.....	23
3.3.5. Policies related to biofuels	23
3.4. Options for climate change mitigation in developing countries	24
3.4.1. Reducing greenhouse gas emission from land use and agriculture	25
3.4.2. Supporting sustainable and low emission development pathways	26
3.5. Food miles: An inadequate indicator	28

4. Climate change adaptation in developing countries	29
4.1. EU assistance to developing countries to cope with the effects of climate change	29
4.1.1. Review of current funding mechanisms for adaptation in developing countries	29
4.1.2. The link between adaptation and development.....	30
4.1.3. Funding for adaptation and poverty reduction in developing countries	31
4.1.4. Capacity building, data availability and research..	32
4.2. Available EU instruments for development policy in relation to climate change adaptation.....	33
5. Challenges for EU policy coherence	35
5.1. Policy Coherence for Development	35
5.2. Green Paper on Adaptation.....	35
5.3. The Global Climate Change Alliance (GCCA) initiative	37
6. Conclusions and recommendations	39
6.1. Conclusions.....	39
6.2. Recommendations for new EU policies to support climate change adaptation and mitigation in developing countries	40
6.2.1. Recommendations related to Mitigation.....	40
6.2.2. Recommendations related to adaptation	41
7. References	42
List of Figures.....	44
List of Abbreviations.....	45

Executive summary

This report presents a summary of the impacts of climate change on developing countries and what the European Union can do to minimise the effects of climate change on the developing world through both mitigation and adaptation.

A. Climate change impact on developing countries

Climate change will increase global temperatures, change rainfall patterns and will result in more frequent and severe floods and droughts

Depending on future emissions of greenhouse gases, global temperatures are likely to rise between 2 and 4 °C within the next century. The main impacts of climate change will however not be felt through higher temperatures but through a change in the hydrological cycle. Rainfall is likely to increase around the poles and the tropics while in the sub-tropics average precipitation is likely to decrease. Not only the average annual or seasonal rainfall will change; there will also be an increase in the number of extreme events resulting in more frequent and severe floods and droughts.

Developing countries are most vulnerable to climate change

Climate change will have an impact on all countries around the globe. Developing countries are much more vulnerable to climate change than the developed world. Climate change aggravates the effects of population growth, poverty, and rapid urbanisation.

The poor are likely to suffer most from climate change

Without serious adaptation, climate change is likely to push millions further into poverty and limit the opportunities for sustainable development and for people to escape from poverty.

Climate change is likely to reduce economic growth in developing countries; significant investments in climate change adaptation are necessary

Climate change is likely to have a significant impact on the economies of developing countries. Without adaptation and mitigation the losses are estimated to be up to 20% of GDP. To minimise the impacts of climate change, adaptation in developing countries is urgently needed. Reliable estimates of adaptation costs are still unavailable, but they are likely to run into the billions of dollar per year. Climate change is also likely to affect the attainment of several of the Millennium Development Goals (MDGs). Through its impacts on agriculture, climate change is likely to have a significant impact on reducing severe poverty and hunger.

The developed world should reduce their emissions to minimise future climate change

In order to minimize impacts of future climate change, efforts to reduce the emissions of greenhouse gasses in the developed world should be increased. The EU should continue its efforts to stimulate the US to join the Kyoto agreement and to commit itself to future targets. If the developed countries would increase their efforts to reduce their emissions, rapidly developing countries, such as China and India, might be much more likely to join mitigation efforts.

Climate change policies for the rapidly developing countries should focus on mitigation; policies for the least developed countries should focus on adaptation

The EU should stimulate and support adaptation and mitigation in developing countries. New climate change policies developed by the EU should have different focuses for different countries. Separate climate change strategies should be developed for rapidly developing countries - such as China, India, Mexico and Brazil - compared to the Least Developed Countries (LDCs). For the LDCs the EU should focus on assisting in adaptation.

These countries are the most vulnerable to climate change and urgently need support. Furthermore LDCs, generally, have very low emissions so there is not much too gain from mitigation projects. However, greenhouse gas emissions from rapidly developing countries have sharply increased over the last years and the EU should focus on helping these countries to mitigate their emissions.

B. Climate Change Mitigation in developing countries

Mainstream and integrate climate change mitigation into development project programmes and trade negotiations

Reducing emission levels from the developing world is extremely important. If current developments are continuing, emissions from China and India will soon be much higher than the total emissions from all EU countries. Currently the EU is stimulating mitigation and transfer of clean technologies through the Clean Development Mechanism (CDM). Although it is still unclear what the mitigation potential of the CDM is, especially in India the investment in CDM projects is significant. However, the EU should take a much wider approach. In developing countries a lot can be done in terms of increasing energy efficiency, land use change and agriculture. It is also important that developing countries are stimulated to choose a sustainable, low emission development pathway. Choices for more sustainable, low emission technologies should be made early in the process.

Focus mitigation efforts in least developed countries on land use change, agriculture and sustainable development

In the least developed countries mitigation efforts should not focus on the energy or transport sector but on agriculture and forestry. Agriculture is responsible for a relatively large percentage of the emissions in many developing countries. In this sector there are many win-win options both reducing poverty and reducing greenhouse gas emissions. For example improved water and nutrient management can sharply increase production efficiency and reduces at least the amount of emissions per kg food produced. Agro-forestry reduces greenhouse gas emission through increased carbon storage and reduces poverty through diversifying the incomes of local communities.

New soy bean varieties which can grow in rainforest areas pose a great threat to rainforests, especially in South America. Currently, there is a movement to call for a moratorium in soy bean expansion and/or make soy bean production more sustainable. The EU could contribute to these developments by appropriate support to developing alternative planning and by imposing regulations on the international trade in soy beans. This is not an easy task, as soy beans are produced in many other regions than moist tropical climates only, and trade volumes are hard to separate. Nevertheless, the feasibility of some kind of subsidized 'sustainable quality label' should be investigated. EU can also help reduce deforestation by developing policies focussing on supporting the development of sustainable timber extraction methods, and by helping to provide alternatives for the poor.

Actively support post-Kyoto mitigation options in reduced deforestation and/or forest conservation

Deforestation is currently responsible for between 15-25% of global carbon emissions¹. By designing appropriate development policies and by actively supporting incentives for forest conservation through the Kyoto protocol or its successor, a lot could be achieved to reduce deforestation. So far, in the first commitment period of the Kyoto protocol, counting carbon losses and gains through deforestation or avoiding it, were not allowed. Only limited amounts of re/afforestation activities can be funded through the Clean Development Mechanism.

¹IPCC (2007), Stern Review 2007

Present negotiations for the next commitment period of the Kyoto protocol indicate that the parties are agreeing that forest conservation should be allowed in a next 'CDM'. The EU should actively support these post-Kyoto mitigation options in reduced deforestation and/or forest conservation

Stimulate sustainable and low emission development pathways

One of the best ways to minimise future global emission is to stimulate sustainable development. The development pathway countries, regions or communities choose have large impacts on future emissions, and it is important to acknowledge that lower emission development pathways are *not per se* associated with lower economic growth. Currently, one of the main limitations of developing sustainable pathways of growth is institutional capacity both in the planning and implementing phase. EU should stimulate and make funds available for sustainable and low emission development plans in developing countries and help building the capacity needed for the design and implementation of these plans.

C. Climate change adaptation in developing countries

Development reduces climate change vulnerability and improves adaptive capacity

There are important links between adaptation and development and one of the best adaptation strategies is probably development. Stimulating development and reducing poverty will increase the adaptive capacity of people and is likely to make them less vulnerable to climate change. In general, adaptation should be an extension of sustainable development and as such it should focus on: the growth and diversification of the economy, improving education and health, and improving disaster preparedness. Besides adaptation to climate *change* there are also many immediate benefits in improving the management of current climate *variability* in developing countries. Many poor countries are confronted with highly variable rainfall but very few systems are in place to manage this variability and prepare for the next drought and/or flood.

Incorporate impacts of and adaptation to climate change into projects and programmes aimed at achieving the Millennium Development Goals

Climate change will make it harder to achieve the MDGs. However, strategies for achieving the MDGs do not account for climate variability and change. To meet MDG targets substantial investments are necessary. Many of these investments, especially those related to water and agriculture, are sensitive to climate change. To ensure that climate change will not undermine achievement of the MDGs, climate change impacts and adaptation should be incorporated into development projects and programmes.

Investing in disaster preparedness is much more efficient and saves considerable spending on emergency aid

There are important links between development and adaptation in terms of disaster preparedness. Natural disasters from floods, droughts and cyclones have major impacts on developing countries, not only in terms of human loss, but also on long term development. Disasters can easily remove the progress of years of development and significantly increase poverty. To help developing countries in the aftermath of disasters large amounts of Official Development Assistance (ODA) are spent on emergency aid. It is however much more efficient to invest in disaster preparedness and management.

Official Development Assistance (ODA) funds should be made available for adaptation projects

There is a general consensus that the currently available funding for adaptation is insufficient. The total costs of adaptation are still unclear but will run into the billions of dollars per year.

In addition to insufficient funds for adaptation also the structures which are currently in place to finance adaptation are limiting effective action. To get funds for adaptation it is often necessary to prove that the proposed adaptation is needed because of explicitly identified climate change. Currently, most funds are made available through the UNFCCC process and there are many complaints from developing countries that it is too difficult to get funding for adaptation projects through the Global Environment Facility (GEF). So it is necessary to find more and better functioning funding mechanisms for adaptation in developing countries.

Due to the mutual benefits of sustainable development and adaptation it would make sense to integrate funding for adaptation and development. However, large hesitations exist among donors to integrate funding for adaptation into mainstream development because it goes against the stipulation of the UNFCCC that adaptation funding should be in addition to Official Development Assistance. Some governments would like to see adaptation paid through a polluter pays principle and although this is morally superior there are a lot of practical objections. First of all, except for the funds available through the UNFCCC no effective polluter pays principle is in place yet. Secondly, due to the mutual benefits of adaptation and development, funds should be integrated and thirdly the cost and benefits of adaptation are often hard to estimate. If adaptation is to be funded separately, it is necessary to estimate the costs and benefits. However, in a variable and changing climate it is impossible to estimate which part of the costs is due to "normal" climate variability and which is due to climate change. So in order to fund adaptation, the EU countries should, as a practical and effective solution, increase their Official Development Assistance to 0.7% of GDP (as internationally agreed and re-affirmed by the Council of the EU in June 2005) and mainstream adaptation into developing projects and programmes.

Capacity building related to climate change within developing countries should first and foremost focus on adaptation with particular attention to reducing vulnerability of the poor

In most developing countries the main limitation in coping with the impacts of climate change is a lack of capacity. Climate change often has complicated impacts with large uncertainties. Very few people and institutions have the capacity to do impact studies and identify climate change adaptation options. To interpret climate change information, for designing adaptation strategies and to implement adaptation projects highly educated people are needed. Adaptation needs differ locally; therefore strategies should be tailor-made. Local knowledge and experience is thus important to plan and implement adaptation. Until now most climate change capacity building in developing countries has focused on mitigation, for example in relation to the Clean Development Mechanism (CDM). However, the least developed countries do not need CDM projects. Climate change capacity building in the least developed countries should focus on adaptation instead of mitigation.

Support research collaboration in order to enable knowledge based adaptation and facilitate knowledge exchange

Besides a lack of capacity, in many developing countries there is also a significant lack of data and knowledge on climate change impacts. Developing countries should be stimulated to improve data gathering and make existing data more easily available. The EU should also support research collaboration between partners in the EU and developing countries. Such collaborative projects will facilitate knowledge transfers between European and developing countries and will ensure that climate change research becomes more relevant for developing countries.

1. Introduction

Impacts of climate change will have a **disproportional negative impact on developing countries** (Stern 2007, IPCC 2007). Climate change will exacerbate problems related rapid population growth, existing poverty and a heavy reliance on agriculture and the environment. Developing countries have a much more limited capacity to cope with the problems caused by climate change.

This report presents climate change impacts on developing countries and what the European Union can do to minimise those impacts. Chapter two gives an overview on how climate change affects the different sectors, what the impacts are on poverty and development and what the most vulnerable regions are.

Chapter three focuses on **mitigation of greenhouse emissions** in developing countries and what the EU can do to support mitigation. In 2006, greenhouse gas emissions in China were for the first time higher than in the United States. In India and other rapidly developing countries emissions are rising quickly. Although these countries still have lower *per capita* emissions than the EU, the development of their emission levels will largely determine how fast the climate will change. In addition to domestic mitigation, the EU should support them and export technologies to reduce (the growth of) greenhouse gas emissions. This study gives several recommendations and options for mitigation without jeopardising development.

No mitigation effort however will stop the need for adaptation. Especially the least developed countries, who have contributed little to the problem, will suffer the most. Chapter four focuses on **climate change adaptation** and what needs to be done to **reduce climate change vulnerability in developing countries** and how the EU can help the poorest to cope with climate change. Adaptation to climate change should not be seen independently of development. Development will help and facilitate adaptation which could be integrated into other/existing development policies and projects.

Chapter five describes challenges for EU policy coherence. Chapter six gives general **conclusions** and a list of **recommendations for EU policies**.

2. Impacts of climate change on developing countries

2.1. Observations of recent impacts of climate change

2.1.1. Observed changes in climate

Climate change is not only something of the future, but the climate has already changed significantly over the last 30 years. The average temperature around the globe has increased by 0.75 °C over the last 100 years. Eleven of the 12 hottest years on the instrumental record occurred during the last 12 years. The 1990's were probably the hottest decade of the last millennium (IPCC 2007). The IPCC (2007) concluded earlier this year that at least part of the increase in temperature is caused by human emissions of greenhouse gases (Figure 1). However, global warming has not been uniform. Since 1979, warming has been most intense in North America, Europe and Northern Asia while developing countries have generally seen less of a warming trend than the developed world.

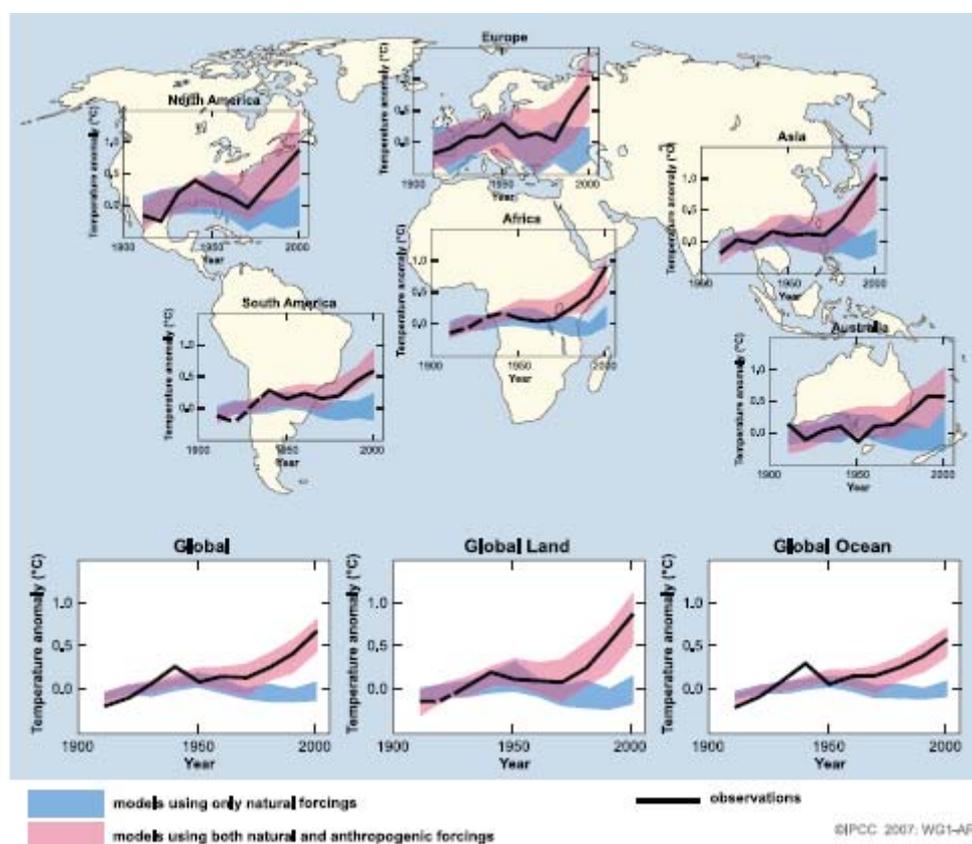


Figure 1: Comparison of observed changes in temperature (black lines) with results simulated by climate models using only natural forcing and using both natural and anthropogenic forcing (including greenhouse gases)

Source: IPCC 2007.

Not only temperatures have changed but also rainfall patterns. Due to a higher variability in rainfall compared to temperatures, trends are often harder to detect and it is more difficult to link them to human greenhouse gas emission. However it is still likely that human activity has contributed to the increase in the number of droughts, heat waves, extreme rainfall events and more intense cyclone activity. These kinds of extreme events particularly affect developing countries.

2.1.2. Observed impacts of climate change on the natural and human environment.

The IPCC (2007) report stated that: “observational evidence from all continents shows that **many natural systems are affected by regional climate changes**”. Most of the observed changes are linked to temperature changes. Unfortunately, most of the studies and observations are from the developed world and there is an important lack of data from developing countries.

Those studies available focussing on the developing world show that Sahel ecological zones have shifted due to a dry and warmer climate which has also caused reduction in run-off (Van Duivenbooden et al. 2002; Gonzalez 2001). In Southern Africa a longer dry season and more uncertain rainfall has reduced agricultural production and has forced people to adapt through switching crops, diversifying livelihoods and planting trees (IPCC 2007). In Africa, lower lake levels have been observed in Zimbabwe, Zambia and Malawi.

In Latin America and Asia, important observed changes are linked to changing glaciers. Due to higher temperatures glaciers and mountain snow packs are disappearing and both in the Andes and the Himalaya, the risks of Glacial Lake Outburst Floods (GLOF) are increasing. Changes in melting patterns of glaciers due to global warming also have an impact on streamflows. River streamflows tend to increase during the spring with a peak earlier in the season. Where glaciers are starting to disappear streamflows are reduced especially during dry seasons. Especially, in the Andes smaller glaciers have already disappeared or will do so in the near future. These glaciers are often important sources of freshwater (IPCC 2007).

2.2. Future impacts of climate change on developing countries

Depending on emission scenarios and models used, temperature rise is estimated to be between 1 and 6 °C in the next century (likely to be between 2 and 4 °C; see Figure 2). **The amount of warming during the next century mainly depends on the rate of increase in greenhouse gas emissions.** To keep temperature rise within 2°C – a major EU target - significant action to reduce emissions are needed. Global temperature increase will not be uniform (Figure 2). Regions around the poles will see more warming than tropical regions.

However, the **main impacts of climate change** will not be felt through higher temperatures but through a **change in the hydrological cycle**. Global warming will intensify the hydrological cycle which will increase global precipitation. Changes in rainfall patterns will not be evenly spread around the globe. Around the tropics and in the northern part of the Northern Hemisphere (Canada, Russia, and Northern Europe) rainfall is likely to increase but in most of the sub-tropical regions – where many developing countries are located - rainfall is likely to reduce.

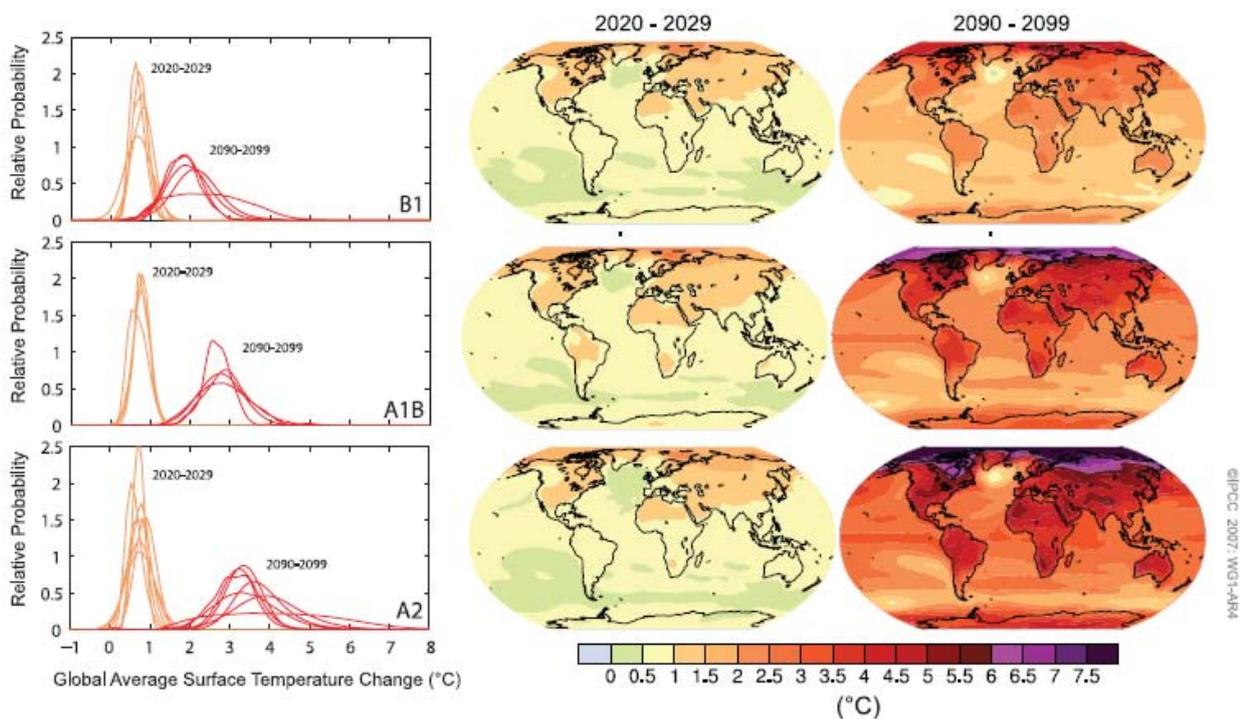


Figure 2: Projected surface temperatures changes for the 2020-2029 and the 2090-2099 period for three different emission scenarios. The left panel shows uncertainties of temperatures rises as the relative probabilities of estimated global average warming from different models
Source: IPCC 2007

Figure 3 shows in more detail how rainfall is projected to change around the globe. Briefly, the following changes are predicted for developing countries: Southern Africa is likely to get drier; East Africa and the Horn of Africa will probably receive more rainfall. For the Sahel the changes are still unclear. In Latin America, the Caribbean, the Amazon and Chile are likely to see a reduction of rainfall. For the South-Eastern part of South America an increase in summer rainfall is predicted. In Asia, the Indian subcontinent could see an increase of precipitation during the monsoon season but lower rainfall is predicted outside the rainy season. This indicates that the differences between the seasons will increase, with more drought stress during the dry season, due to higher temperatures and less rainfall, and more floods during the monsoon. Also for South-East Asia the projected changes in rainfall depend on the season. During the Northern Hemisphere winter (December-February) rainfall might reduce while rainfall is likely to increase in the June - August period.

However, not only the average annual or seasonal rainfall will change, there will be an **increase in the number of heavy rainfall events resulting in more floods**. Furthermore, the number of days with rainfall is likely to decrease which consequently increases chances of prolonged periods without precipitation resulting in **more frequent and more severe droughts**.

Table 1 summarizes the most important impacts of climate change on water, agriculture, health, biodiversity and coastal zones in the various regions¹.

¹ See IPCC 2007 report for more detailed information on the impacts of climate change

Table 1 Summary of the most important projected impacts of climate change on the different sectors in developing countries.

	Africa	Asia	Latin America
Water	<ul style="list-style-type: none"> ○ More frequent droughts, especially in Southern Africa ○ More frequent low water storage in reservoirs and lakes ○ Reduced run-off in Northern and Southern Africa; increased run-off in East Africa ○ More frequent floods, especially in East Africa ○ Increased water stress due to both climate change and increased demand ○ Increased water scarcity could trigger more conflicts 	<ul style="list-style-type: none"> ○ Disappearing glaciers reduce summer streamflow of most large rivers affecting more than one billion people ○ Snowmelt earlier in the season will increase risk of spring floods ○ Increased water shortages during the dry season in South and East Asia ○ higher flood risks during the monsoon season in South East Asia and the Indian subcontinent ○ Likely increase of water stress due to a combination of increased population growth, higher per capita water demands and climate change. 	<ul style="list-style-type: none"> ○ Rapid increase of number of people affected by water stress due to a combination of climate change and increased demand. By 2050, between 60 and 150 million people will experience water stress. ○ re-treat of glaciers and reduction in mountain ice and snow cover will severely reduce water availability in some countries. ○ By 2030, 60% of the people in Peru will experience reduced water availability due to disappearing glaciers ○ In Chile the delivery of water to several coastal cities could be comprised in the near future due to melting snow packs and disappearing glaciers. ○ Reduced hydropower generation capacity ○ The combined effect of land clearing and more intense rainfall events is likely to increase the number of landslides. ○ More frequent and intense cyclones will increase the number and severity of floods in Central America
Agriculture	<ul style="list-style-type: none"> ○ Severe impact on food production and security ○ Agriculture in several marginal semi-arid regions will become unsustainable ○ Increased poverty of small scale farmers ○ Small increases in productivity in regions with mild climate change where rainfall is increasing ○ Changing season will make agriculture more difficult, e.g. changed sowing dates due to later or earlier start of wet season ○ Less predictable water availability will make nomadic agriculture more difficult 	<ul style="list-style-type: none"> ○ Increased climate variability will generally increase the number of crop failures due to either floods or droughts. ○ In areas where rainfall is predicted to increase agricultural production is likely to improve. ○ Irrigated agriculture which depends on run-off from snowmelt and/or glaciers is likely to be affected; snow will melt earlier in the season which will reduce water availability during the (late) summer when irrigation is most needed. ○ Agricultural production in low lying coastal areas such as large parts of Bangladesh will be affected by increased flooding and salt water intrusion. ○ Likely increase of diseases and pests affecting both plant and animal production systems. 	<ul style="list-style-type: none"> ○ Reduced yield of annual crops such as wheat, maize, rice and soybean in several regions due to higher temperatures and shorter growing seasons. ○ In some regions such as central Argentina wheat yields could increase due to more precipitation. ○ Regions most suitable for coffee production will move to a different location; coffee yields and quality are likely to change already with small temperature increases (1-2°C). ○ Specifically coffee but also other crops are likely to be affected by more diseases and pests. ○ Disappearing glaciers and reduced snow melt is likely to reduce water availability for irrigation. ○ Likely increased land degradation and salinisation in the drier part of the continent

Ecosystems and biodiversity	<ul style="list-style-type: none"> ○ Most natural ecosystems will be affected; detailed impacts remain unclear due to a lack of data and well documented studies ○ Biodiversity in the highlands of East Africa is severely threatened ○ 25-40% of large mammal species in National Parks will become endangered ○ Wildlife Tourism at risk in East and Southern Africa due to lower density of large mammals ○ Desertification likely to increase due to combined threats of climate change and unsustainable land use ○ Coral reefs are particularly vulnerable to warmer temperatures. 	<ul style="list-style-type: none"> ○ Large parts of the biodiversity at risk, although detailed analyses are lacking for most countries. ○ Forest fires have been observed to increase over the last 20 years due to higher temperatures; this trend could increase into the future. ○ Grasslands are likely to see a reduction in productivity due to higher temperatures and increased evaporation; desertification will increase if land use remains unchanged. ○ In Mountainous regions such as the Himalaya different vegetation zones will move higher into the mountains. ○ Species with low migration rates could become (locally) extinct and vegetation zones could disappear 	<ul style="list-style-type: none"> ○ Particularly the combination of land use change/deforestation and climate change can have devastating impacts on biodiversity. ○ More savanna like vegetation will replace tropical forest in the Eastern Amazonia and parts of Mexico. ○ Arid vegetation is likely to expand and replace semi-arid vegetation in particular in North East Brazil and Mexico. ○ Higher temperatures and more frequent droughts are likely to increase the number of fires. ○ Reduced run-off from glaciers and snow melt in summer threatens many ecosystems which depend on these kind of water resources. ○ Increased competition for water is likely to result in much lower water availability for ecosystems which could result in the disappearance of wetlands.
Health	<ul style="list-style-type: none"> ○ Increased malaria risks due to warmer temperatures ○ Increase of water borne diseases due to more frequent floods and droughts ○ Higher temperatures and reduced water availability increase risks of cholera and other diseases related to bad sanitation ○ More frequent floods increase the risk of drinking water contamination 	<ul style="list-style-type: none"> ○ Higher temperatures in combination with increased forest fires and urbanisation will reduce air quality and increase respiratory diseases. ○ Likely increased risks of malnutrition and diarrhoea in the poorer countries such as Bangladesh, Nepal and Myanmar. ○ Increased risk of vector borne diseases; several diseases like Malaria will expand into new areas which were previously not affected. 	<ul style="list-style-type: none"> ○ Increased malaria infection risk around the southern limit of the disease due to higher temperatures; changes in rainfall patterns will also affect the impact of Malaria. ○ Air pollution is likely to increase due to more frequent wildfires. ○ Higher temperatures will increase heat stress especially in urban “heat islands”; extra impact in areas with a lot of air pollution. ○ Migration and increased poverty as a result of climate change could cause unexpected increases in several diseases.
Coastal Zones	<ul style="list-style-type: none"> ○ 40 % of West-African people live in coastal cities; increased flooding risks due to sea level rise ○ Sea level rise and changed precipitation patterns in combination with environmental pressure will result in the disappearance of many coastal ecosystems such as deltas, mangroves and coral reefs ○ Livelihoods of millions at risk due to disappearing coastal ecosystems 	<ul style="list-style-type: none"> ○ Several mega-cities are located along the coast and are likely to be affected by sea level rise; ten to hundreds of millions of residences are directly at risk of flooding. ○ Coastal erosion is likely to rapidly increase with rising sea levels. In some Asian regions a 30 cm sea level rise could result in 45 meter of landward erosion. This erosion is likely to destroy many human made structures built for flood protection. ○ Higher sea levels will destroy large areas of mangrove forest which will increase flood risks of coastal regions. ○ Large areas of coral reefs will disappear due to a combination of warmer sea surface temperatures and sea level rise. 	<ul style="list-style-type: none"> ○ Higher sea surface temperatures have a large impact on coral reefs; loss of coral reefs could have an impact on tourism in the Caribbean. ○ Sea level rise will affect low lying coastal regions through increased flood risk and salt water intrusion. ○ Flood risks will especially increase if they are combined with increased storm and hurricane occurrences. ○ Most of the tourism industry is concentrated along the coasts and is vulnerable to sea level rise and increases in the number of storms and hurricanes. ○ Changes in the frequency of El Niño and higher sea surface temperatures are likely to affect fisheries, especially along the Peruvian coast.

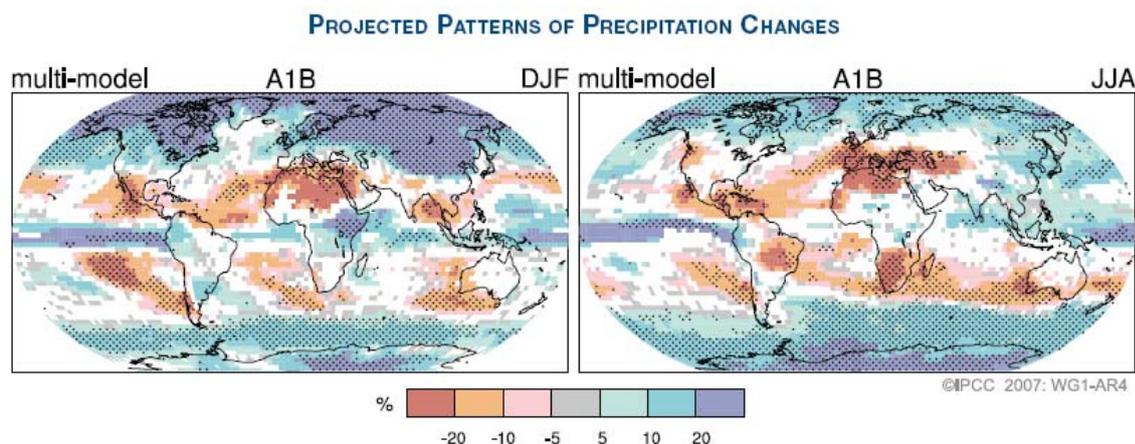


Figure 3: Relative changes in precipitation (in percent) for the period 2090-2099 relative to 1980-1999. Values are based on multi-model comparisons for December to February (left) and June to August (right). White areas are where models disagree on the sign (increase or decrease) of the change and stippled areas where more than 90% of the models agree on the sign of change

Source: IPCC 2007

2.3. Impacts of climate change on poverty and development

The previous paragraph summarised what impact climate change will have on the different sectors. This chapter focuses on the combined impacts of climate change on poverty and development, and which communities/regions will be most vulnerable to climate change. **There is a general consensus that poor people in developing countries will suffer the most from climate change** (Sperling 2003). Developing countries are affected more because of the economic importance of climate sensitive sectors such as agriculture in combination with their low adaptive capacity. Many developing countries lack human and financial capacity to respond to the threads of climate change.

2.3.1. Vulnerability to climate change

Climate change vulnerability analyses are important for defining priorities for policies. Regions or sectors with the highest vulnerability need the most attention. In the IPCC (2007) report vulnerability is defined as: “The degree to which a system is susceptible to, and unable to cope with the adverse effects of climate change”. Vulnerability is a function of the character and rate of climate change and variation to which the system is exposed, its sensitivity, and its adaptive capacity (Figure 4). So **vulnerability can be high because of high exposure** (severe hurricanes), **high sensitivity** (small islands), **or low adaptive capacity** (least developed countries). Of course, vulnerability can also be reduced as a result of high adaptive capacity.

Developing countries are particularly vulnerable to climate change because of the sensitivity of their fragile environments; small changes in climate can cause large environmental changes through, for example, rapid desertification. National economies of many developing countries are very sensitive to climate change because of their dependence on agriculture and forestry. Major floods can also destroy major parts of the infrastructure.

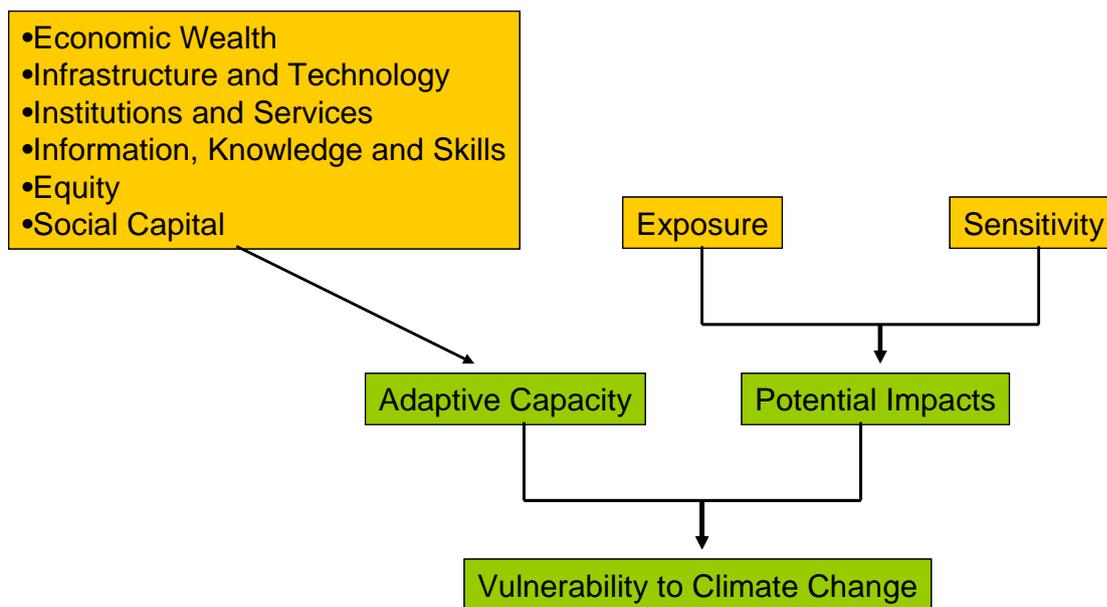


Figure 4: Vulnerability to climate change: the IPCC Third Assessment Report

Source Ionesco et al. 2005

Already now most developing countries are often exposed to climate extremes. In fact, most developing countries are in the (sub)-tropics where natural climate variability is high. Both long term droughts and periods with excessive rainfall often occur in many African and Asia countries. Also in many tropical countries, almost all the annual rain falls within a period of a few months. If the monsoon fails people have to wait at least another year before the next rains come, with devastating effects on agriculture and water resources. El Niño and La Niña cycles have large impacts on rainfall in Asia and Latin America. **Most countries cannot manage this current climate variability.** For example, due to floods and droughts in Kenya during the 1997-2000 El Niño and La Niña, the economies lost up to 22% of the total GDP (Biemans et al. 2006). The failed monsoon in 2002 in India significantly slowed down economic growth (Stern 2007). Another important aspect is that temperatures are already very high in many developing countries and several agricultural systems will not tolerate much warmer weather. The high exposure and sensitivity to climate change in developing countries is often combined with low adaptive capacity. There is a lack of both human and financial capital for effective adaptation.

2.3.2. Climate change impact on poverty– why the poor will suffer most

There are several reasons why climate change has the most severe impact on poor people. Firstly, people **live in areas which will be particularly affected by climate change.** Many poor people live in semi-arid regions in Africa and Asia. These regions already have an erratic climate with unpredictable rainfall causing both floods and droughts. It is especially in these regions where increased climate variability caused by global warming will push them further into poverty. More floods and droughts will reduce their income and destroy their properties. In addition, poor people often live in places which are most vulnerable to climate change. In urban regions, slums are often in flood prone areas where “official” development is not allowed or they are built at steep mountain slopes vulnerable to mud slides.

Another reason why the poor suffer more from climate change is their **dependence on vulnerable economic sectors:** 65% of the workforce in Sub-Saharan Africa and 60% in South Asia work in agriculture. Agriculture in these regions is very vulnerable to changes in rainfall and temperature.

In marginal semi-arid areas, agriculture is likely to become unsustainable. In several regions, future rainfall will be too low or too unpredictable for people to continue to base their livelihood on agriculture. People depending on irrigation are at great risk. For many large Asian rivers, flows are likely to reduce due to disappearing glaciers, reduced snow fall and changing seasons. This will reduce the amount of water which is available for irrigation which is likely to impact many small scale farmers.

The impacts on **health** due to climate change will be felt most by the poor who often have **reduced resistance** to those diseases which are likely to increase due to climate change. For example, diseases like cholera, diarrhoea and malaria often hit the poor the hardest. In addition to reduced resistance, the poor also have much more limited access to healthcare. Due to climate change new diseases will be introduced into areas which were previously not affected. Many rural communities depend on traditional medicines which are mostly not suitable for these new diseases.

Many poor people **lack the adaptive capacity** to cope with changes in climate due to lack of education and access to information. They usually have no access to insurance and or credit markets. There is little or no institutional framework which can be used to help poor people adapt to climate change. Several adaptation options involve the use of (new) technologies like for example flood control systems, new agricultural techniques and the use of climate predictions and early warning systems. Finally, poor people lack the knowledge and education to use these new technologies.

2.3.3. Climate change and development

There is an increasing awareness and a number of studies show that **climate change is likely to reduce economic growth** and development especially in Asia and Africa (Stern 2007; Biemans et al. 2006). Climate change could reduce GDP by 10% in India by 2100 compared to a situation without climate change (Stern 2007). The Stern review also identifies that especially the combination of a slowly declining environment and the shock of extreme events will affect development. The extreme events will knock back years of development while the declining environment will slow down development between extreme events and decrease the resilience to cope with the impacts of extreme events.

Historic events show that **droughts and large scale floods had a significant impact on the economy** of developing countries. During these droughts or floods government incomes are often reduced due to a lower productivity while government spending needs to increase to supply food aid and repair damaged infrastructure. Future climate change is likely to increase the number of floods and droughts which will reduce government incomes and increase spending with a negative impact on budgets.

The impacts on development are likely to differ between countries. Some countries are currently undergoing rapid development. These countries are likely to be more prepared than countries with slow or no growth. These so called "least developed countries" could see their vulnerabilities increase. For a more detailed discussion of impacts on the local economy see paragraph 2.6. In conclusion, without proper adaptation climate change is likely to have a significant negative impact on development.

2.3.4. Climate change and the Millennium Development Goals

In the Millennium Declaration of 2000, 189 nations agreed aiming at a 50% reduction in poverty by 2015, by establishing eight Millennium Development Goals (MDGs). Several recent reports have indicated that climate change and variability will make it harder to achieve the MDGs. The relation between each MDG and climate is discussed below.

1. Eradicate extreme poverty and hunger

As explained above, climate change and variability is reducing economic growth which limits the opportunities to reduce poverty. In addition, climate change is likely to affect the poor the most, putting more people back into poverty and reducing the number of people getting out of poverty.

Food production and security will be seriously affected by climate change. Many of those living in hunger are from the rural areas of developing countries. Most of those people depend on small scale and often marginal agriculture. The income and food production of these people is highly vulnerable to changes in climate.

2. Achieve universal primary education

Climate change impacts will be indirect. For example climate change can reduce development and increase resources spent on disasters. As a result, fewer funds will be available for education and if rural food production is reduced people are less likely to send their children to school.

3. Promote gender equality and empower women

There is little specific knowledge about whether climate change will affect women and men differently. However about 70% of the poor are women (UNDP, 1995) and as the poor are affected the most by climate change women are likely to be affected more by climate change than men. Climate change is thus likely to slowdown efforts to work on gender equality and the empowerment of women

4. Reduce child mortality

Modelling work² showed that reduced economic growth is likely to increase child mortality because of the link between income and child mortality. Also proper nutrition greatly reduces child mortality but with reduced food security children's diets are likely to be negatively affected. Also waterborne diseases are likely to increase due to climate change; these diseases especially affect young children.

5. Improve maternal health

Impacts of climate change will be indirect. Climate change can reduce food availability and increase the efforts needed to fetch water. This can aggravate the conditions of pregnant woman and changed occurrence of diseases will negatively affect maternal health.

6. Combat HIV/AIDS, malaria, and other diseases

The occurrence and distribution range of malaria is likely to increase as a result of climate change. For example, without proper control measures malaria is likely to expand in parts of central Asia and the East African highlands. People suffering from HIV/AIDS are more vulnerable to a range of diseases caused by lack of clean water and sanitation problems such as diarrhoea, cholera and other water borne diseases.

² Stern (2007).

7. Ensure environmental sustainability

The target of halving the proportion of people without sustainable access to safe drinking water and basic sanitation will be harder to achieve due to climate change. The risk of a reduced quality and quantity of drinking water will increase due to more extreme weather events. Also gradual changes due to reduced supplies and increasing demand due to growing (urban) populations will increase the risks of supply shortages.

8. Develop a global partnership for development

Developing a global partnership for development should become a world priority. To reduce vulnerability and minimise the number of people severely impacted by climate change a well functioning global partnership is urgently a must.

2.4. Costs and benefits of climate change

The costs (and benefits) of mitigation and adaptation strategies can be assessed through cost-benefit analysis and Integrated Assessment Models. These methods are, however, very data intensive, and the current state-of-the-art does not allow a full quantitative analysis of the costs and benefits involved. Mitigation and adaptation have different impacts on the economy. **Adaptation has an immediate but local effect while mitigation is an investment in limiting future global climate change.** It is by now generally accepted that both measures are needed to combat climate change. Adaptation, however, can only reduce impacts of climate change to a limited extent and mitigation is necessary to keep climate change damages manageable.

Climate change costs can be divided into three different categories. Firstly, there are damages caused by climate change which are referred to as the **residual damages**. These damages are the actual harm that climate change causes through *e.g.* floods and droughts. The second cost category is the **cost of mitigation**. Through mitigation climate change can be limited. Mitigation, however, can consume resources and these costs are referred to as mitigation costs. Thirdly there are the costs of **adaptation**.

Several cost estimates are available for the damages of climate change and for mitigation options. **Reliable estimates of the cost of adaptation are largely unavailable.** A study by de Bruin et al. (2007), however, showed that **adaptation and mitigation costs are in the same order of magnitude. For developing countries there are very few estimates of the costs of climate change.** There are some studies that focus on different regions but these are limited and still do not focus at developing nations as a group. However, it is likely that the damages of climate change will be greater in developing countries than in developed regions.

Mitigation and adaptation affect each other and in economical terms they can be traded off. However due to the different time from the extent to which this can be done is limited. Furthermore due to the exponential costs of adaptation and mitigation it is never beneficial to concentrate on one control.

The next paragraphs shortly review the costs and benefits of mitigation and adaptation. Mitigation is a global issue that is being considered in many contexts. Adaptation, however, has had relatively little attention but is of crucial concern to developing nations. This study focuses on the cost of adaptation.

2.4.1. Costs and benefits of climate change mitigation

Mitigation refers to an anthropogenic intervention to reduce the sources or enhance the sinks of greenhouse gases (GHG). Mitigation can take many forms on various scales: GHG emissions can be reduced for instance by limiting the volume of production and consumption, by restructuring the economy to switch towards less energy-intensive sectors (or more generally by energy savings), and by carbon capture and storage.

As the energy sector is the cause of most of the GHG emissions in developed countries, most mitigation options studied until now focus on the energy sector. For example, through the introduction of sustainable energy sources such as wind turbines and solar panels, GHG emissions can be reduced. The use of biomass fuel can also be a promising form of mitigation. Furthermore through the development of more efficient energy use, emissions can be reduced. Examples of this are more efficient hybrid engine cars. Another important field of mitigation is end use mitigation, where through filters emissions are reduced to a minimum. Finally also carbon removal and storage are a promising form of mitigation, where for example carbon can be stored underground in old oil fields. Until now the cost of carbon storage is too high to use it at a large scale.

Mitigation can also have development advantages for developing countries. It can be beneficial for the European Union to finance mitigation in developing nations. This mitigation cooperation has been encouraged through the Kyoto Protocol where emissions reduction targets could also be met through projects in developing regions. This is referred to as the Clean Development Mechanism (CDM). Most economists praise the efficiency improvements that are realised by the flexible mechanisms such as CDM, but others claim that it prevents “real action” in the developed countries and may “pick the low-hanging fruit”, implying that when developing countries join an international climate agreement in the future, they will be faced with high reduction costs.

2.4.2. Costs and benefits of climate change adaptation

Several reports provide estimates of the costs and benefits of adaptation measures³.

IPCC report (2007) distinguishes the following sectors:

- agriculture, forestry and ecosystems;
- water resources;
- human health; and
- industry, settlements and society.

Also UNFCCC report (2007) focuses on the same sectors as identified by the IPCC when providing an overview of investments needed for adaptation. This report considers the potential impacts of climate change and the possibilities for adaptation. Furthermore, it provides an overview of current and needed investment and financial flows and identifies the necessary changes of these flows regarding investment, financial and policy arrangements. A World Bank (2006) report states that “the impact of climate change and the need for developing countries to adequately adapt to changes in climate and weather variability” is important to the World Bank’s core mission of poverty reduction. According to the World Bank “urgent action is needed to climate-proof development because, as with energy investments, decisions taken today about infrastructure, production systems and institutions determine the vulnerability of those systems for many decades to come”.

³ (Stern, 2006; World Bank, 2006; Raworth, 2007; UNFCCC, 2007).

In the Oxfam International report ‘Adapting to climate change, what’s needed in poor countries, and who should pay’, Raworth (2007) argues that there is an unacceptable inequality in global response to climate change: “rich countries plan multi-billion dollar adaptation measures at home, but provide very little to international funds for least-developed country adaptation”. The report presents an Adaptation Financing Index, which indicates how much rich countries should support adaptation, in proportion to their responsibility for contributing to climate change, and their ability to assist.

The Stern Review (2007) pays considerable attention to the implications of climate change for development and states that “climate change poses a real threat to the developing world”. In addition it comments that more quantitative information on the costs and benefits of economy-wide adaptation is required. According to Stern (2007) integrated assessment models are “currently of limited use in quantifying the costs and benefits of adaptation, because the assumptions made about adaptation are largely implicit”.

Table 2 World Bank preliminary estimate of the cost of additional impacts of climate adaptation (Source: World Bank (2006)/Stern (2007) and updated after discussions with the World Bank)

Item	Amount year	per	Estimated portion climate sensitive	Estimated costs of adaptation	Total per year (US \$ 2000)
ODA and concessional finance	\$ 100 bn		20%	5 – 20 %	\$ 1 – 4 bn
Foreign direct investment	\$ 160 bn		10%	5 – 20 %	\$ 1 – 3 bn
Gross domestic investment	\$ 1500 bn		2 – 10%	5 – 20 %	\$ 2 – 30 bn
Total international investment					\$ 2 – 7 bn
Total adaptation finance					\$ 4 – 37 bn
Costs of additional impacts					\$ 40 bn (range \$ 10 – 100 bn)

bn = Billion

An overview of preliminary estimated costs of additional climate change impacts and adaptation is presented in the World Bank report “Clean energy and development: towards an investment framework”. Table 1 shows estimated core flows of development finance and the proportion of the investment that is sensitive to climate change risks. Table 1 also shows an estimation of the additional cost to reduce that risk to account for climate change. Stern (2007) states that the indicated 5 to 20% ‘estimated costs of adaptation’ is by no means certain. In most activities only certain components will need to be modified, often with relatively low costs and sometimes no additional cost. In other cases, new activities may have to be added.

The World Bank (2006)/Stern (2007) estimated the added costs necessary to adapt investments to climate change risks at \$40 billion per year, with a range of \$ 10 -100 billion.

Raworth (2007) and UNFCCC (2007) present overviews of estimations of the cost of urgent and immediate adaptation needed based on the National Adaptation Plans of Action (NAPAs) submitted to the UNFCCC by Least Developed Countries (LDCs). NAPAs provide a process for LDCs to identify priority activities that respond to their urgent and immediate needs with regard to adaptation to climate change (UNFCCC, 2007). Of the 16 NAPAs submitted by June 2007, the cost of priority activities identified amount to a total of USD 292 million. With the most important sectors: agriculture, forestry and fishers (USD 129.16 million); water supplies (USD 50.38 million), extreme events (USD 35.45 million) and capacity building including research (USD 35.02 million) (UNFCCC, 2007).

Stern (2007) made a very rough estimate by extrapolating the total estimated cost presented by the first five countries that completed a NAPA (total estimates costs of five countries: USD 133 million, averaging to USD 25 million per country) to the 50 Least Developed Countries suggesting adaptation costs of USD 1.3 billion.

The IPCC report considers Africa to be one of the most vulnerable continents to climate variability and change because of multiple stresses and low adaptive capacity. The IPCC report provides an outline of the literature on costs and benefits of adaptation measures related to sea-level rise, agriculture, energy demand for heating and cooling, water resource management, and infrastructure. The report concludes that “the literature on adaptation costs and benefits is limited regarding sectoral and regional coverage; adaptation costs are mostly expressed in monetary terms, while benefits are quantified in terms of avoided climate impacts, and expressed in monetary as well as non-monetary terms” (IPCC, 2007).

In conclusion costs of climate change will be very high and run into billions of dollars, however, especially for developing countries there are large uncertainties in estimated costs.

2.5. Impacts of climate change and climate policies on local economies in developing countries

The expected **impacts of climate change on local economies** in developing countries **will be very diverse**, depending on the specific characteristics of these economies, and the specific climate impacts in the various regions of the world. In addition to the *direct* impacts related to specific local changes in temperature and precipitation, the local economies will experience *indirect* impacts, through changes in international trade and international commodity prices. This section will discuss the impacts related to (i) climate damages, (ii) mitigation efforts and (iii) adaptation efforts.

Box 1 gives some examples of potential impacts but it is not yet possible to provide detailed estimates of the impacts for the various local economies in the different regions of the world. There is uncertainty in the distribution and the impacts of changes in temperature and precipitation. Also due to natural climate variability it is difficult to indicate whether extreme weather events are part of the natural cycle or if they are caused by human-induced climate change. This makes it also very complex to decide about the practical allocation of funds for reducing the damages of climate change.

Box 1 Examples of possible impacts on the local economy

Example 1: A local economy suffering from prolonged drought

If the economy is dependent on locally grown crops, the impacts of crop failure will be very severe and may result in food shortages and hunger. Depending on how relief programmes are organized, the impacts may have a devastating impact on the health of children and their opportunities for education. Drought does not only have short term impacts but also affects future growth potential.

Example 2: A local economy suffering from flooding

Serious flooding damages the infrastructure and the stock of capital goods in the area, including roads, houses, bridges and telecom. This will require large investments in new infrastructure and depending on the resilience and support given to the communities, the impacts may last for several years or even longer, seriously reducing the growth potential of the region.

Example 3: A local economy that might benefit from the potential of growing biomass

If additional demand for biomass occurs, local economy may benefit from growing biomass and selling it at relatively high prices on the world market. This will generate income and jobs and, as compared to Business As Usual (BAU), economy will benefit from "new opportunities" offered by climate change.

Example 4: A local economy suffering from indirect impacts through food markets

If a local economy is dependent on imported staple food like maize, the economy may suffer when the relative price of these commodities start increase as a result of more demand for land for bio-fuel production. Local consumers will be facing higher food prices and their real income will decline as a result of these increased prices.

Example 5: A local economy suffering from water shortages during a prolonged period of drought

People living in arid or semi arid areas are already very vulnerable to shortages of clean drinking water. If less water is available in specific areas this will directly affect the local population because of an acute shortage of drinking water or because of higher costs for obtaining drinking water from larger distances or from deeper wells.

2.5.1. Impacts of mitigation efforts on local economies

As developing countries do not yet have mitigation targets, the impact of mitigation on the local economies is indirect or through the clean development mechanism. For example if **more biofuels will be used for mitigation prices of land and agricultural products are likely to increase.** At the same time it might reduce the price of fossil fuels and these counteracting forces will finally determine the impacts on the various prices of commodities and products in the world market. An increase in the price of agricultural products may offer opportunities for some developing countries, but it provides problems for countries which depend on food imports.

In general it is expected that increased demand for biofuels and biomass will offer new opportunities for developing countries, but it is essential that sustainable ways of production are guaranteed. A risk exists that increased demand for biomass and biofuels will result in large-scale deforestation, in *e.g.* Brazil or Indonesia. **Only if clear conditions and a system of certification of biomass and biofuels can be established, will sustainable production of biomass and biofuels be possible on a large scale.**

If mitigation will be achieved by means of modern sustainable energy technologies in industrialized countries, the impacts on the local economies in developing countries may be much more modest. The world demand for fossil fuels would be reduced and developing countries might actually benefit from relatively low prices of fossil fuels. If mitigation will involve a large portfolio of clean development activities, there can be short term benefits for developing countries by offering CDM projects and by upgrading the energy infrastructure, funded by industrialized countries. However, in the long term, if developing countries will also have emission reduction targets, it may become more difficult to reach these targets, if the low hanging fruit has already been used for CDM projects. Positive impacts on local economies may be related to the establishments of wind parks, improved management of solid waste (in order to reduce methane emissions from landfills), or sustainable energy projects and the related employment in establishing new energy infrastructure under CDM projects.

2.5.2. Impacts of adaptation options for local economies

Adaptation options for developing countries include a wide variety of actions, ranging from improved water management (both for protection against floods and droughts) to changes in agriculture making it more resilient to changes in climate and extreme events. These adaptation costs are in principle a burden to the local economy, and may require investments that otherwise could have been made with the purpose of enhancing economic growth in the region. The **most important adaptation options** in developing countries will concern the following economic sectors or categories:

- agriculture;
- water management;
- infrastructure;
- housing;
- industry;
- public utilities;
- recreation and tourism; and
- natural ecosystems.

Main challenges in **agriculture** are to make the sector more resilient to increased climate variability. New crops and varieties need to be adjusted to changed climatic conditions. Adjustments to livestock systems are needed in order to secure that these systems will be sustainable both economically and environmentally in a future climate (FAO, 2006). Immediate adaptation can in most cases be modest; however, towards the middle of the century adaptation might be very substantial in some regions. In some regions growing crops will become impossible due to water scarcity.

For **water management**, adaptation involves both investing in more water storage and protection against flooding. Important issues for adaptation with regard to **infrastructure** are improving roads, bridges and buildings and reinforcements of dikes. Also protection against landslides often requires infrastructural changes.

For **housing** it is essential to locate houses in areas that will be affected less by climate change through for example developing further away from the coast. This requires careful spatial planning and a good choice of location for residential areas. In some extreme cases complete neighbourhoods need to be relocated due to coastal erosion or expanding river systems.

For **Industry**, industrial installations need to be secured to be able to stand weather extremes, and located in safe areas, in order to avoid disturbances and damages during extreme weather events. **Public utilities** need to be prepared for climate change and for instance management and design of hydro-installations need to be adjusted to be able to cope with a changing climate in terms of precipitation, evaporation and water storage.

The **recreational sector** needs adaptation in terms of safety measures against fires, and in terms of selecting locations that are safe for tourists and the local population under all weather circumstances. This may require relocation of facilities if they are currently under risk.

For all these adaptation options the **costs will be location specific** and therefore difficult to assess in monetary terms. Of course, the costs of adaptation options need to be balanced with the benefits obtained in order to be efficient. In general, **the adaptation costs will strongly reduce the damage costs that would occur without adaptation.**

If large amounts of funds will be generated by the international community to support developing countries in adapting to climate change, these funds may provide new opportunities for local economies to strengthen the agricultural sector and to improve water management and infrastructure.

3. Mitigation of greenhouse gas emissions in developing countries

In order to minimize future climate change, emissions of GHGs should be kept as low as possible. The developed world has by far the highest per capita emission and should take the lead in reducing emissions. However, **GHG emissions from developing countries are increasing rapidly** and mitigation in these countries should be stimulated.

However, independent of future mitigation some climate change will be inevitable due to historic emissions. To minimize the impacts of climate change in developing countries and reduce vulnerability adaptation to climate change is needed and the earlier adaptation starts the better countries will be prepared.

This chapter focuses on what the EU can do in terms of stimulating mitigation; chapter 4 will focus on adaptation.

3.1. Assessment of current climate change mitigation efforts

The Kyoto Protocol outlines **three types of market-based mechanisms**: emissions trading, Joint Implementation (JI) and the Clean Development Mechanism (CDM). Emissions trading allows the 39 governments committed to collective reductions under the Protocol to trade the right to pollute among themselves. Under this scheme, a country may choose to buy emission credits from another country that has managed to reduce its emissions below its Kyoto targets.

Joint Implementation is a mechanism under the Kyoto Protocol through which a developed country can receive "emissions reduction units" when it helps to finance projects that reduce net greenhouse-gas emissions in other developed countries (in most cases the recipient state is a country with an "economy in transition").

The **Clean Development Mechanism (CDM)** allows industrialized countries with a greenhouse gas reduction commitment to invest in projects that reduce GHG emissions in developing countries, providing an alternative to more expensive emission reductions in their own countries. The CDM has two main objectives:

1. To assist developing countries hosting CDM projects to achieve sustainable development.
2. To provide developed countries with flexibility for achieving their emission reduction targets by taking credits from emission reducing projects undertaken in developing countries.

The CDM mechanism provides developing countries with an additional source of income through an environmental service: carbon management. The market as it is now emerging is still in its infancy. As for any market, prices will depend largely on supply and demand relations and the risks involved. The possibility of getting paid for carbon management is expected to stimulate environmental protection and conservation and is expected to be beneficial for social circumstances as well. The implementation of the trade mechanisms and how this will benefit the local poor will differ per region.

Besides the financial initiatives linked to carbon, the UNFCCC agreed in 2001 to establish new funds to support technology transfer, capacity building, and adaptation planning in developing countries. More specifically these are the Special Climate Change Fund, the Least Developed Countries Fund and the Adaptation Fund. The Adaptation fund receives part of the money via a 2% charge of the CERs from CDM projects. All funds are ready to receive money from industrialized countries but so far these money flows have not materialized.

It seems that carbon related money flows are more attractive for both the public and private sector in developing countries. Heller and Suhkla (2003) argue that **there is only marginal potential for development related work through CDM projects**. There remain uncertainties about the rules and practices governing the certification of projects other than small-scale end-use efficiency and renewables. And perhaps more significantly, the removal of U.S. demand for mitigation has depressed prices for all emissions trading programs, including CDM. Projections of the annual mitigation market in 2008-2012 have dropped from 300-700 million tons of carbon equivalent (Mtce) to 0-300 Mtce. Carbon price estimates for 2010 have dropped from a range of \$60 to \$160 per tce with U.S. participation in the Kyoto regime to \$3 to \$87 per tce without U.S. participation. (IEA 2001, Heller & Shukla, 2003)

Private markets have become the primary mode for technology and resource flows from developed to developing countries. While Official Development Assistance (ODA) stagnated over the past decade, private flows increased roughly five-fold. The share of flows represented by private capital peaked in 1996 at 90 % and has declined only slightly since, despite the East Asian crisis, the resultant volatility in capital markets, and a global economic slowdown (Heller & Shukla, 2003). The official benchmark, as set in 1970, for developed countries to increase their level of assistance to 0.7 % of their Gross National Incomes (GNI) is only reached by a few countries⁴.

Africa is a critical case to test the potential for CDM in the development process: Lecocq and Capoor (2003) show that volumes are low and only few projects include development priorities. For example a review of Moroccan CDM projects by Karani and Gantsho (2006) shows that 7 projects on energy efficiency can only generate 85,000 CER's per year (Senhaji, 2004). Also most South African projects tend to be small for example the first South African CDM project on Low-Income Housing Energy Upgrade to be registered by the CDM Executive Board on 29th August 2005 can only generate 2.85 CO₂ equivalent tones per household per year over 21 years (South-North Africa, 2005). In addition, UNIDO's identified CDM projects in Senegal, Nigeria, Zimbabwe, Kenya and Zambia can only generate 1.17 million tones of CO₂ equivalent (UNIDO-COP8 Side event October 26th 2002). These indicative total emissions from Africa are almost equivalent of one CDM project in Brazil, Mexico, India, China or Poland. Although emissions in South Africa, Nigeria and Egypt are seemingly higher, Africa, in particular is behind the rest of the world as far as sustainable development is concerned. This is unfortunate, considering that in the period 2000–2003, Africa's overall share of Direct Foreign Investment (DFI) was about 5.6% of the total compared to 4.7% for economies in transition⁵.

3.2. Clean technologies transfer to developing countries

Article 4.5 of the United Nations Framework Convention on Climate Change (UNFCCC) states that developed country Parties and other Parties included in Annex II "shall take all practicable steps to promote, facilitate and finance, as appropriate, the transfer of, or access to, environmentally sound technologies and know-how to other Parties, particularly developing country Parties, to enable them to implement the provisions of the Convention."

Transfer of clean technologies to developing countries has lately had a lot of political attention as they would be win-win situations, providing both development and mitigation of greenhouse gas emissions.

⁴ In 1970, at the UN General Assembly, donor governments agreed to increase their ODA up to 0.7% of GNI. To live up to these commitments, the European Heads of State announced in June 2005 a time-table to reach 0.7% of GNI by 2015.

⁵ Lecocq and Capoor, 2003.

However, as argued in the previous paragraph mechanisms stimulating the transfer of clean technologies do not mix well with development. Investment through the CDM focuses mostly on rapidly developing countries such as India, China, Brazil and Mexico. **The number of CDM projects in the Least Developed Countries is marginal.** The market in these countries is either too small or not attractive for investors.

The CDM aims at both a relative cost effective reduction of greenhouse gas emissions of developed countries and sustainable development in developing countries. Review of CDM projects showed that the sustainable development benefit is very limited (Olsen 2007). Within the market in which CDM is functioning trade-offs are being made between sustainable development and reducing the cost of GHG emissions. In most cases **sustainable development is ignored and the highest market benefit is reducing emission costs.** Also in regions where development is most needed such as sub-Saharan Africa the number of CDM projects and the total investment is very low. So the CDM projects have mainly helped the developed countries reducing their emissions and from a sustainable development policy point of view they have failed.

The main question for future policy is how to respond to the fact that CDM projects are missing the sustainable development goal and how and if CDM could be used to also support sustainable development. One option is to change the rules of the game in order to give more opportunities and incentives for the CDM systems to better achieve the sustainable development goal. In a recent IISD⁶ report, Cosbey et al. (2005) give a few options to do this. For example, due to the difficult approval and monitoring process the transactions costs of CDM projects are high which works against small projects which tend to have more of a sustainable development benefit. Reducing this transaction cost, especially for small projects could increase the number of CDM projects contributing to development. Another possibility is to spend more development assistance funds on CDM's. However before doing this it should be investigated whether Official Development Assistance (ODA) funds directly invested into development is not more efficient in reducing poverty than through the CDM. The last option is accepting that the CDM works in terms of efficient mitigation for the developed countries and developing separate policies for the support of sustainable development. Sometimes separate policies work better than looking for hard to find win-win situations.

The EU is committed to a balanced geographical distribution of CDM projects and tries to increase the number of CDM projects in particularly Africa. To do this the EU is investing in capacity building projects raising the knowledge and awareness for CDM in Africa and other regions. Until now these efforts are not very successful, still less than 2% of the CDM projects and investments are in Africa. Projects which have been identified to be suitable for CDM in Africa tend to be small scale and getting CDM approval for these projects is often difficult and relatively expensive.

The recently launched *Global Energy Efficiency and Renewable Energy Fund (GEEREF)* is **likely to target the same market as the CDM.** This fund is requesting significant co-investment from the private sector and currently it is very difficult to find private investor for the least developed countries. This GEEREF is thus also unlikely to fund the transfer of clean technologies to the least developed countries. The projects announced in the ACP-EC energy facility however are promising. In June 2005, this facility was created to support sustainable energy services for rural communities in Africa, the Caribbean and the Pacific.

⁶ IISD, International Institute for Sustainable Development

Currently, the programme is in its contractual stage and the projects announced in the July 2007 newsletter sound promising⁷. Especially, in rural communities which are far away from the countries' main electricity grid, local energy projects can sustainably use low emission technologies. For example, solar, biomass and small scale hydropower are excellent options for small scale isolated rural energy supply. In addition to low emissions these projects also have other advantages. By using technologies like solar, wind and hydropower, the rural communities do not depend on energy supply from the major cities. When connected to the main grid or depending on fossil fuel these communities often have the lowest priorities. In case of electricity or fuel shortage these communities are to first to be cut off. The main problems with these rural projects will be with capacity and spare parts to repair breakdowns. Previously, projects related to for example water have shown that introduced new technologies often fail due to improper maintenance. It is important to honestly monitor the ACP-EC energy facility and if it works to expand investment in these kind of initiatives.

In conclusion, the CDM system seems to work in terms of investment in rapidly developing countries such as Brazil, India, China and Mexico and this system needs continuous support in order to continue investment in clean energy in these countries. **In terms of sustainable development the CDM is not delivering** and investment in LDC countries are very low. For the transfer of clean technologies to these countries other initiatives, such as the ACP-EC, are necessary.

3.3. EU development policies regarding deforestation

EU development policy explicitly states the importance of integrating environmental protection. In developing countries, poverty reduction is often the most fruitful aim to integrate aspects of climate change mitigation, adaptation, biodiversity conservation, as well as conservation of natural resources essential to communities (clean water, air, soil fertility and stability). In general, in combating both poverty and deforestation, it is important to take a 'holistic' view of a region, where the 'services' of forests 'paid' to local, regional and national communities are well-defined and accounted for. Emerging services, such as carbon conservation, should be included if only for the high potential of direct economic benefit. International trade to the EU of commodities produced either in intact forest or in deforested land needs to be regulated according to their impacts on deforestation and finally, it should be realized that forest conservation in isolation of protection of environment and global climate is likely to be less effective as the stability of intact forest may be affected if the world around them changes. The following paragraphs highlight three issues that may be topical to current EU development policy.

3.3.1. Policies in the area of climate change mitigation

So far, in the first commitment period of the Kyoto protocol, counting carbon losses and gains through deforestation or avoiding it were not allowed for non-annex-I countries. The only mechanism that could contribute to a net reduction in forest loss was the CDM, but the rules in this measure are such that **only limited amounts of re/afforestation activities can be implemented**. Present negotiations for the next commitment period of the Kyoto protocol indicate that the parties are agreeing that forest conservation should be allowed in a next 'CDM'.

⁷ http://ec.europa.eu/europeaid/where/acp/regional-cooperation/energy/documents/newsletter/newsletter_energy_july2007_en.pdf

Discussions have revolved around the way this could be achieved without stimulating negative activities, such as enhancing deforestation outside conservation areas ('leakage') or only postponing deforestation ('permanence'), etc. Issues include whether only reductions in deforestation rate should be acknowledged or also preventing increases; whether benefits should be counted in carbon equivalents; whether sequestration potential of intact forest should be counted; and whether forest *degradation* should also be counted. Current negotiations indicate that the most likely mechanism will be to account for 'Reduced Emissions from Deforestation and Degradation' (REDD), where the if and how of the last 'D' is still under discussion. Because of the enormous difficulties to accurately quantify actual carbon stocks in tropical forests and associated changes due to deforestation, and because of the even larger difficulty in defining baselines against which benefits of measures should be quantified, the tendency is to keep things as simple as possible. For example, to avoid complex rules about leakage, it is proposed to apply REDD at national levels only, counting national deforestation rates and awarding those countries that reduce rates below previously agreed thresholds.

Which mechanisms should be used to apply REDD is another issue. Should there be a (regulated) carbon market for this, or should REDD be implemented through the establishment of funds? The EU seems to favour market mechanisms for this. Probably, a mixture of mechanisms is needed, and it could be left to individual countries to decide which mechanisms and which activities would work best for them.

It is unlikely that all CO₂ emissions caused by deforestation can be avoided this way. It is also unlikely that all deforestation can be stopped this way. Governance is never ideal and other markets will compete with the carbon market, so that only partial effect will be achieved. To make transparent what would be the cost of stopping deforestation, so called 'choking prices' could be quantified that indicate what investment would be needed to completely out-compete other economic activities causing deforestation. The results of such calculations indicate that prices are very reasonable, in the same order or less than current rates for carbon sequestration at the 'Kyoto market'.

EU needs to actively contribute to the search for optimization of benefits for both reducing carbon emissions and deforestation. Also, especially relating to the EU development policies, measures should be integrated with other objectives, such as protecting watersheds and other essential resources for communities, and seeking ways to combine conservation with the reduction of poverty.

3.3.2. Policies related to soy bean trade

Formerly, soy beans did not grow well in moist tropical regions. Recently, new varieties have been developed that can grow in rainforest areas. This poses a great threat to rainforests, especially in South America. In an intensive agriculture system, with fertilizer input, soy bean culture can now be economically feasible even in the Amazon. Presently it is not yet grown at a large scale there, but it is in the Southern and South-Eastern margins of the Amazon and in the savanna regions (Cerrado) of Brazil and Bolivia. Scenarios for the development of soy bean culture and trade between Amazon countries and the global market vary widely, but there is growing concern that the demand from Europe, the USA and especially the growing economies of Eastern Asia will be dominating these developments. Apart from that, in Brazil there is a substantial internal market. Also in Brazil, concerns for conservation are rising at government and state levels. There is a strong movement towards the design of sustainable development schemes, including controlling the expansion of soy bean culture. It is realized that with good governance, much of the demand could be satisfied by optimizing the use of already deforested, now abandoned, areas. There is a movement to call for a moratorium in soy bean expansion.

The EU could contribute to these developments by appropriate support to **developing alternative planning and by imposing regulations on the international trade in soy beans**. Of course this is not an easy task, as soy beans are produced in many other regions than moist tropical climates only, and trade volumes are hard to separate. Nevertheless, the feasibility of some kind of subsidized ‘sustainable quality label’ should be investigated.

3.3.3. Policies related to the timber trade

As the density of valuable timber varies by continent, the role of the timber trade in deforestation varies. In South-America the direct effects of wood extraction is limited, whereas in SE Asia this is a major factor, with Africa as an intermediate case. Nevertheless, wood extraction is almost everywhere the first step in deforestation: loggers, whether companies or individuals, are the first to go in and provide access to settlers. The control on these activities is limited, especially if wood is extracted for domestic markets. Especially in countries such as Brazil and Indonesia these markets are dominant. Illegal activities are prominent and enforcement is difficult as often the primary logging activities are not visible with remote sensing means. At international levels, of course, regulating the wood trade is relatively easy and controllable. What is needed here is political will and consensus among traders. The EU adopted in 2003 the Action Plan for Forest Law Enforcement, Governance and Trade (FLEGT). The Action Plan blends measures in producer and consumer countries to facilitate trade in legal timber, and eliminate illegal timber from trade with the EU⁸. The EU development policies could help in supporting development of sustainable extraction methods, and by helping to provide alternatives for the poor, landless people who are the first to follow the loggers, illegally squatting land.

3.3.4. Infrastructural aid

There is a **demonstrable link between access and deforestation**. Access to forests is a prerequisite for settling and subsequently for trade in forest and/or agricultural products. However, a causal link is not entirely certain. It is also possible that roads are built primarily in those areas where deforestation has already started, driven by subsequent demand for transport. But in any case, it is clear that **spatial planning and infrastructure policies do affect the dynamics and speed of deforestation**.

The EU DG Development actively promotes improvements in infrastructure in developing countries⁹. This policy does account for sustainability and environmental effects of road building. Of these effects, effects on land-use change is only one of many. If the EU is to establish an effective policy to combat deforestation, the effects of providing access to remote forest areas for people and trade should be a much more prominent element in the development aid to infrastructural improvement. This can be achieved by combining scenarios, predictive land-use change models and by training authorities in sustainable spatial planning methods.

3.3.5. Policies related to biofuels

The increasing demand for biofuels, as a means to combat atmospheric CO₂, is a potentially large threat to tropical rain forests. An environmentally sustainable biofuel culture should look for crops (like oil palm) that can grow on poor, degraded soils and concentrate the production in already deforested areas. As with soy bean, EU could influence this market with subsidies, specific projects on planning and production, and by assigning a sustainability label to imported fuels. As with soy bean, it is very hard to enforce and control such labels because fuels will be mixed and cannot carry physical labels.

⁸ http://ec.europa.eu/development/Policies/9Interventionareas/Environment/forest/flegt_en.cfm

⁹ COM(2000) 422 of July 2000

Finally, measures in the area of soy bean trade, wood trade, biofuels and infrastructure alone are unlikely to make a big difference for deforestation. The internal markets are strong, and only integrated approaches are promising, combining the various issues, also providing incentives for changing internal markets.

3.4. Options for climate change mitigation in developing countries

Eradicating extreme poverty should be the main priority for development policies. The prospects of people living on less than one dollar a day should not be undermined by issues like mitigation of greenhouse gas emissions. Energy use and greenhouse gas emissions by the poor from fossil fuel burning are generally low, and **most emissions come from land use change (including deforestation) and agriculture**. So to reduce the emissions of the poor one should focus on these sectors.

In order to keep future emissions as low as possible, developing countries should be supported to take a different development path than western countries. The earlier decisions are made to take a sustainable, low emission development pathway, the easier it is. For example once large coal power stations are built it is much harder to replace them by renewable energy such as solar, wind or hydropower. However, if there are no power stations yet there will be much more support for these renewable energy sources.

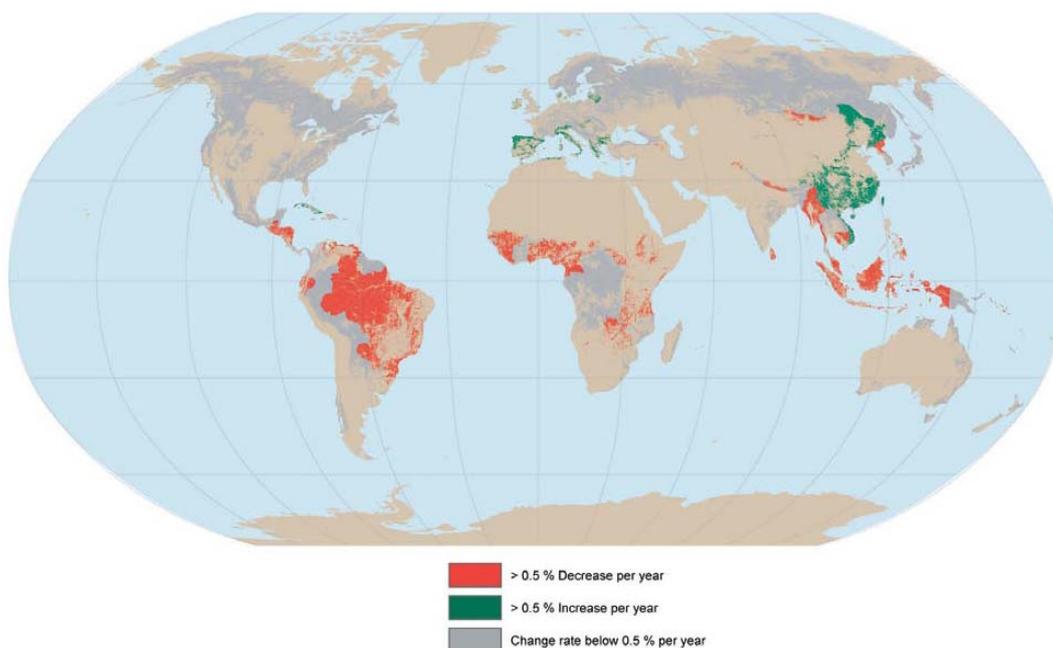


Figure 5: Net change in forest area between 2000 and 2005.
Source: IPCC 2007

3.4.1. Reducing greenhouse gas emission from land use and agriculture

Both land use change and agriculture are responsible for a significant part of greenhouse gas emissions in the developing world. These are also the sectors which are most suitable for mitigation measures. In 2004, land use change accounted for 17% of all greenhouse gas emissions¹⁰. As shown in figure 8 developing countries in Latin America, Africa and Asia are responsible for most reduction in forested area during recent years.

IPCC report (2007) identified three **major barriers for effective measures** in order to reduce deforestation. (i) **Profitability incentives are often stronger** and work against forest conservation strategies, (ii) Many drivers of deforestation, such as agricultural policies and markets are **outside the influence of the forestry sector** and (iii) **limited institutional and regulatory capacity** in combination with low resources reduce the ability of governments to implement policies related to reducing deforestation. Especially, for this last point there is a link with poverty; in poor countries few resources are available and there is a lack of capacity. So it is likely that development and reducing poverty will have a positive impact on forest protection and reducing greenhouse gas emissions.

The **positive link between development and reduced deforestation** is also shown by the fact that especially countries which are developing rapidly such as China, India and Thailand are mentioned as positive examples in the latest IPCC report (2007). In these countries a combination of public support and a strong and motivated government resulted in successfully reducing deforestation.

In general, however, non-climate policies have been very unsuccessful in reducing deforestation. Although looking at the positive examples it seems to be possible, with sufficient funding and political will, to reduce deforestation. Within poor countries the extra funding will probably have to come from outside. A potential source of funding would be by linking avoided deforestation to the carbon market.

Currently, there are no policies to reduce emissions from deforestation under the UNFCCC and Kyoto protocol. As **preventing further deforestation is much cheaper than other mitigation options**, there are good opportunities in this sector if the right funding mechanisms are developed. For example developing countries could (on a voluntary basis) choose to reduce their emissions from deforestation and get carbon credits for these actions which they could sell to other countries.

In general, policies on deforestation should be left to developing countries but with support from the EU. In order to build support from local communities, the funding the EU provides for preventing deforestation should also be of benefit to the local communities and should not automatically go to the central government. By focussing these funds to the local communities it is possible to combine mitigation and poverty reduction.

Another important link between mitigation and poverty is the use of traditional biomass as source of fuel. About 2.5 billion people still depend on fuel wood and charcoal as their main source of energy for cooking. The use of this biomass is a source of greenhouse gas emissions. **Biomass burning is a relatively inefficient fuel** source and emissions can be reduced by using modern and cleaner cooking fuels. The use of wood and charcoal also has other negative environmental and health impacts. Smoke from biomass cooking causes severe local air pollution while biomass collection results in deforestation, land degradation and desertification. Stimulating the use of alternative fuels thus has multiple benefits: reducing climate change and improving health and the environment.

¹⁰ IPCC 2007

Agriculture is responsible for a relatively large percentage of the emissions in many developing countries. In this sector there are **many win-win options both reducing poverty by increasing productivity and reducing GHG emissions**. The main win-win options have to do with increasing production efficiency. Production per unit of land area is still very low in developing countries and increasing productivity is likely to reduce greenhouse gas emissions and will in general have a positive impact on poverty reduction (IPCC 2007). There are a range of options to increase productivity. For example adding fertilizer (organic or inorganic) often greatly increases productivity. Although adding extra nitrogen can increase N₂O emissions (a powerful greenhouse gas) and offset part of the benefits. Improved water management can have a very positive impact on productivity. Introducing agroforestry where growing trees is combined with crop or livestock production reduces greenhouse gas emission through increased carbon storage. Agroforestry is also a powerful tool to reduce poverty because it diversifies the incomes of the local community and it helps to prevent erosion and land degradation. Improving the management of grazing lands through avoiding overgrazing and underutilization is likely to increase animal production and reduce desertification. Usually carbon storage increases if management of grazing lands is improved having a positive impact on the reduction of greenhouse gas emissions. Preventing desertification is also very important in improving livelihoods and reducing poverty.

Improved fire management can also reduce greenhouse gas emissions at low extra costs. Due to bush-land fires large amounts of methane are emitted into the atmosphere. Fires also indirectly increase the tropospheric ozone concentration, a powerful greenhouse gas. Reducing the frequency of these fires should be done by educating local communities about the impact of fires and by actively discouraging them. Local communities could be educated through doing example experiments showing them that reducing the number of fires has no negative impacts on the landscape.

3.4.2. Supporting sustainable and low emission development pathways

While for the least developing countries most mitigation gains can be made in agriculture and land use, in rapid developing countries most emission comes from fossil fuel burning. **It is important that India and China will develop more sustainably and have a less carbon intensive economy**. Current energy use of the least developed countries is still very low and emission levels from fossil fuel burning are likely to increase when these countries (further) develop. It is probably unrealistic to expect a no emission growth for these countries but a lot can be done by supporting sustainable development and choosing a low emission development pathway.

One of the conclusions of the IPCC report was that lower emission development pathways are *not* associated with lower economic growth. **The best way to minimise future global emission is to stimulate sustainable development around the globe**. The development pathway countries, regions or communities chose have large impacts on future emissions. Currently, one of the main limitations of developing sustainable pathways of growth is institutional capacity both in the planning and implementing phase. Developing plans for sustainable development often requires the input from several ministries and multidisciplinary teams. The capacity built up in these teams and links between the different departments is often not available in developing countries. Furthermore, important decisions on industry, transportation and energy are made by ministries which have no knowledge on climate change and sustainable development. The EU should stimulate sustainable development plans in developing countries and help building the capacity needed for the design of these plans. After plans are developed there is often also a lack of capacity and resources to implement them.

For example, in many African countries there are good laws to protect nature conservation areas but the laws and regulations are often not implemented due to insufficient funds and badly trained and unmotivated personnel. For sustainable development to succeed, local and regional governments need to be involved but the capacity at these lower levels is often much lower than at the central government. The EU should stimulate and make funds available which help developing countries implementing sustainable development measures.

Not only the state is responsible for the environment but also civil society and the private sector. To reduce emissions all three sectors should be involved. Industry is responsible for a significant part of the emissions. In many developing countries the production process is often not very efficient and significant emission reduction can be achieved by using energy more efficiently. With environmental and emission regulations in Europe becoming stricter, some industries move to the developing world to avoid these strict rules. The EU should develop regulations to stimulate clean development and industry in developing countries. These could be done for example through stimulating or forcing more openness and communication to consumers about the impact of the production process on the environment. Also the civil society and the consumers have an important role in stimulating sustainable development. NGO's often have an important role in awareness raising and in setting up sustainable development projects. Especially in countries where the state government is weak, working with the private sector and civil society could be the most efficient way to reduce emissions.

Increasing energy efficiency is one of the best ways to cut GHG emissions without other negative impacts. In many developing countries still a lot can be done through increasing efficiency. Increasing energy efficiency also has a positive impact on competitiveness and can relax some of the supply constraints. The EU should stimulate technology transfer and governance structures which increase energy efficiency. Part of this efficiency is ensuring that everyone pays for all electricity used. In many developing countries large part of the electricity is not paid for due to illegal use and corruption. Energy efficiency issues should also be included in the stimulation and limitation of international trade patterns. Currently, many products are made in China and exported to Europe and North America which could have been made much more energy efficient in Europe or the USA. Basically, **energy is wasted in return for cheap imports.**

In rapidly developing countries like China, India, Brazil and Mexico there is a large gap between rich and poor people. A large part of the population still lives in extreme poverty but the number of rich people is rapidly increasing. These rich people have a lifestyle and emission pattern which is similar of people living in the EU or US. However, currently they have no obligation to do any mitigation. In order to limit future emissions it is extremely important that richer people in these countries will develop a sustainable, low emission lifestyle as this group will be the example for all those people which will escape from poverty in the future. When considering future mitigation options not only greenhouse gas emissions *per capita* of individual countries should be important. Within large countries specific regions, groups of people or sectors with high emission patterns should also be targeted for mitigations. So within a future UNFCCC protocol maybe China and India will not agree on targets for the whole country but will commit to mitigation within certain regions, sectors or societal groups. This can create immediate opportunities for mitigation within the rapidly developing countries without compromising development of the poor.

3.5. Food miles: An inadequate indicator

The term “food miles” refers to the distance food travels between the farm gate and the consumers. The term was introduced about 10 years ago to highlight negative impacts on the environment of increasing food transport. One of the main goals of introducing food miles is to stimulate more locally organized food systems. One of the main advantages of local food systems would be reduced transport. In general, less transport would mean reduced energy use and lower greenhouse gas emissions. However, the relation between distances travelled and the amount of greenhouse gases emitted is far from linear. For example, how the food is transported is very important: sea freight for example is much less energy intensive than air freight and also the kind of fuel used is important. Also while international transport of food crops can be energy-intensive, the energy use may be (partially) compensated by lower energy demand for growing food crops in developing countries. For example, in developing countries, food production and agriculture is often less intensive and less or more organic forms of fertilizer are used. Reduced use of fertilizer also reduces the emissions of N₂O which is a very powerful greenhouse gas. These comparative advantages are foregone when food systems are “localized”.

Agriculture also has many other environmental impacts of which some are related to climate change. For example, most land clearing is done to create space for agriculture. In addition, land management choices have important impacts on the environment. For example, is the land totally cleared or are some trees around paddocks still left in place. Also the choice of the agricultural system has important impacts on the environment and potential greenhouse gas emissions. Agroforestry systems are usually more sustainable and capture more carbon than monocultures.

In conclusion, the distance travelled (food miles) is one of only many impacts food production has on the environment. A recent report for DEFRA (2006) concluded that: “A single indicator based on total food kilometres is an inadequate indicator of sustainability”. The EU should be committed to reduce the negative impacts of food production on the environment, including lower greenhouse gas emission. More environmental friendly production should be stimulated both within and outside the Union and labelling initiatives should be developed which make it easier for consumers to choose environmental friendly products. However, **the use of “food miles” would only capture a small part of the impact agriculture has on the environment and would be unfair to developing countries.** Developing countries tend to be relatively far away from Europe and if food miles would be used as an indicator it could reduce the export potential of developing countries.

The carbon footprint is a more appropriate measure to provide information on the energy needed or emissions produced to get a product to the consumer. It provides information on all emissions related to the full life cycle of a product (including production, processing, packaging and consumption). Transport is included in this measure but not singled out as the overruling factor. In some cases, **food can be produced with a much lower energy input in developing countries** than in Europe so the carbon footprint will give developing countries some advantage and it will stimulate low energy transport such as sea freight compared to air freight. The use of carbon footprints will also stimulate more food production in countries where it can be done with the lowest emissions.

The carbon footprint provides only information on the emissions related to the life cycle. Clearly economic and social aspects are not included. These aspects are however equally important when assessing the sustainability of a value chain or a life cycle or defining policies and measures to assist countries and regions in their development. Single issue indicators, like the carbon footprint, may provide clear information on one aspect and should be used with great care.

4. Climate change adaptation in developing countries

As summarized by IPCC in its Fourth Assessment Report (AR4) (IPCC, 2007), and already highlighted in earlier sections of this report, adaptation will be necessary to address impacts resulting from global warming which are already unavoidable due to past emissions. There is a need for adaptation, independent of how much mitigation will be done. Following chapters discuss the EU assistance towards developing countries to cope with the effects of climate change (paragraph 4.1) and available instruments for adaptation (paragraph 4.2).

4.1. EU assistance to developing countries to cope with the effects of climate change

4.1.1. Review of current funding mechanisms for adaptation in developing countries

Currently funding available for adaptation projects is distributed by Global Environmental Facility (GEF). The instruments available via the GEF are: the GEF Trust Fund, and special funds like the Least Developed Countries Fund (LDCF), the Special Climate Change Fund (SCCF) and the Adaptation Fund (AF), the latter two established under the Convention (UNFCCC).

Least Developed Countries Fund was established under the Kyoto protocol to support a work programme to assist LDCs to carry out, among others, the preparation and implementation of National Adaptation Programmes of Action (NAPAs). The GEF, as the entity that operates the financial mechanism, has been entrusted to operate this fund. Pledges for the LDCF are US\$ 115.8 million (April 2007)¹¹.

Special Climate Change Fund was established in 2001 to finance projects relating to adaptation; technology transfer and capacity building; energy, transport, industry, agriculture, forestry and waste management; and economic diversification. This fund should complement other funding mechanisms for the implementation of the Convention (Decision 7/CP.7). The GEF, as the entity that operates the financial mechanism, has been entrusted to operate this fund. Pledges for the SCCF are US\$ 62 million (April 2007)¹².

Adaptation Fund was established to finance concrete adaptation projects and programmes in developing countries that are Parties to the Kyoto Protocol. The AF receives, besides funds from other sources, a 2% share of the proceeds of the CDM, i.e. 2% of certified emission reductions issued for a CDM project activity. How much money this will be is depending on the use of CDM and the price of carbon, and might range in the order of 100-500 million by 2012 (Mohner and Klein, 2007).

Originally, the **GEF** supported initial studies, to gather information, vulnerability and adaptation assessments, and capacity building. More recently, the UNFCCC asked the GEF to support pilot and demonstration projects in the field of adaptation. Under its strategic priority Piloting an Operational Approach to Adaptation, the GEF supports projects that provide real benefits and may be integrated into national policies and sustainable development planning. In addition, the GEF supports adaptation activities through the LDCF and the SCCF¹³.

The amount of funds available under the GEF Trust Fund, the LDCF and SCCF is at least 250 million USD on a yearly basis (GEF website¹⁴). Since 1991, the Global Environmental Facility has committed approximately USD 1.98 billion to climate change activities, most of it for mitigation activities (UNFCCC Handbook, 2006).

¹¹ EU COM (2007) 540 final

¹² EU COM (2007) 540 final

¹³ http://www.gefweb.org/interior_right.aspx?id=16696

¹⁴ http://www.gefweb.org/interior.aspx?id=232&ekmense1=c580fa7b_48_126_btlink

As expressed in UNFCCC Decision 3/CP.12, developing countries have indicated their concern about the possibility to use the funds available for adaptation. It is too complex to obtain the funding, partly because it is difficult to proof the exact climate change for which adaptation is required.

4.1.2. The link between adaptation and development

The best adaptation strategy is probably development or as the Stern Review (2007) put it: “Development itself is key to adaptation”. Stimulating development and reducing poverty will increase the adaptive capacity of people and is likely to make them less vulnerable to climate change. Stern also stated that, in general, adaptation should be an extension of good development and as such it should focus on: the growth and diversification of the economy, improving education and health, and improving disaster preparedness. As argued by Swart et al. (2003), there is a mutual dependence between climate change and sustainable development (Figure 9).

R. Swart et al. / Climate Policy 3S1 (2003) S19–S40

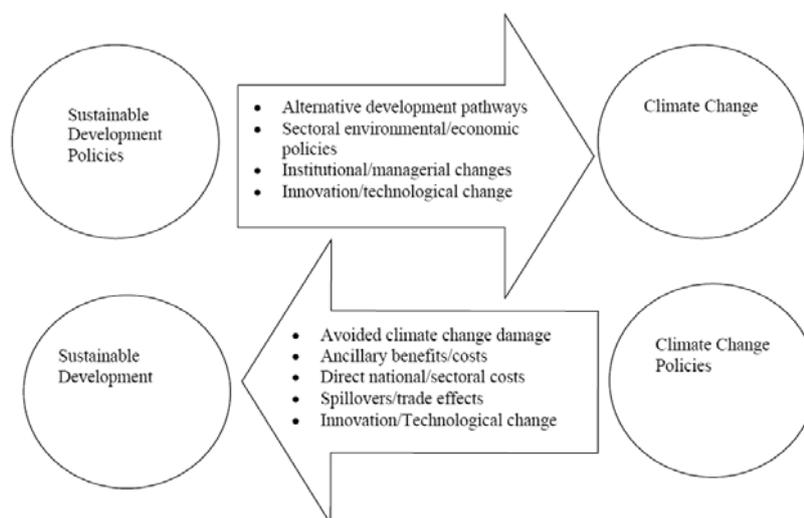


Figure 6: Linkages between sustainable development, climate change, and policies in these areas
Source: Swart et al, 2003, in: IPCC, 2007

An example of a win-win situation in terms of both addressing adaptation to climate change and development is diversifying agriculture to improve food security. A more diverse agriculture system is likely to be more resilient to changes in climate. Also improved water management through for example more efficient irrigation improves development and is a good adaptation practice because more efficient systems will be it easier to cope better with reduced supplies. In many countries, current climate variability already has a large impact on the economies and livelihoods. Although droughts have always occurred in many developing countries the preparedness for such droughts are still not well developed. Preparations for the next drought should start during periods with sufficient rainfall. During these periods buffers should be created which prepare people for periods with no or fewer rainfall. Improving the management of and ability to cope with climate variability will have immediate benefits and will be a very good first step to adapting to future climate change.

Also in terms of disaster preparedness there are important links between development and adaptation. Natural disasters from floods, droughts and cyclones have major impacts on developing countries not only in terms of human loss but also having a direct impact on long term development. Disasters can easily remove the progress of years of development and significantly increase poverty.

To help developing countries in the aftermath of disasters large amounts of ODA are spent on emergency aid. It is estimated that in 2003, 7.8% of all ODA was spent on emergency and distress assistance (Stern 2007). It is however much more efficient to invest in disaster preparedness and management. **For every Euro spend on disaster preparedness, seven Euros can be saved by reducing the impacts of disasters** (ERM 2006). With climate change, disaster preparedness is becoming more and more essential because the number of extreme events such as droughts, floods and hurricanes are likely to increase.

4.1.3. Funding for adaptation and poverty reduction in developing countries

There is a general consensus that funding for adaptation currently available through the mechanisms described in 4.1.1 is insufficient. The total costs of adaptation are still unclear but the Stern review estimated that it will run into the billions of dollars per year. In addition to insufficient funds for adaptation also the structures which are currently in place to finance adaptation are limiting effective action (Smith 2006). To get funds for adaptation it is often necessary to prove that the proposed adaptation is needed because of explicitly identified climate change. As described in the previous paragraphs there are many links between adaptation and development and often it is not 100% clear whether actions are taken in the perspective of climate change or whether they focus on sustainable development. For example is a project focusing on improving preparedness to climate variability sustainable development or adaptation to climate change? . Also many adaptation actions such as increasing resilience and improving adaptive capacity cannot be done separate from other actions in development and because these actions do not explicitly focus on a particular climate change threat they cannot be funded by GEF.

In many developing countries, economies and communities are not well adapted to current climate variability. Improving the capacity of communities to better cope with current climate variability delivers immediate benefits and can reduce poverty. Communities which are able to manage droughts and floods without extensive external help are less likely to suffer from extreme poverty and hunger. Also communities which can better cope with current climate variability are likely to be better adapted to future climate change. However projects focusing on improved management of climate variability are currently not supported by the different adaptation funds.

Due to the mutual benefits of sustainable development and adaptation it would be better to integrate funding and mainstream adaptation into sustainable development projects. However, among multilateral and bilateral donors there is great hesitation to integrate funding for adaptation into mainstream development because it goes against the stipulation of the UNFCCC that adaptation funding should be in addition to ODA. For example, in a report for the Dutch government Van Aalst et al. (2007) argue that if climate change adaptation would be paid through ODA it will be in competition with other programmes focusing on poverty reduction. To avoid this dilution of ODA money climate change adaptation should be paid through a different mechanism, for example through a levy or tax on carbon emissions according to a "polluter pays" principle. Although paying for adaptation in developing countries through a polluter pays principle is morally superior than using ODA, the pragmatic solution of increasing ODA up to promised standards would be a more efficient way of supporting adaptation because: (i) Except for the funds available through the UNFCCC no polluter pays principle is in place yet and the funding adaptation should not be put on hold until such a mechanism is in place. (ii) Due to the mutual benefits of adaptation and development, funds should be integrated and a separate mechanism which would mean getting funding from 2 different sources would reduce the efficiency of the integration. (iii) The cost and benefits of adaptation are often hard to estimate.

Studies on the costs of adaptation are necessary and useful but for the time being they are unlikely to give a full picture. For example it is impossible to calculate which part of the damage caused by the recent floods in Africa (September 2007) is caused by climate change. Also it is very hard to estimate which part of the benefits of a programme focussing on managing climate variability in agriculture can be contributed to adaptation and which part is poverty reduction. The first part should then be paid by the polluter pays principle while the second part should come from ODA.

In conclusion this study suggests funding more climate change adaptation projects and studies through ODA as long as these adaptation projects focus on sustainable development and alleviating poverty.

4.1.4. Capacity building, data availability and research

In most developing countries the main limitation in coping with the impacts of climate change is a lack of capacity. Climate change often has complicated impacts with large uncertainties. Very few people and institutions have the capacity to do impact studies and identify climate change adaptation options. If capacity in developing countries, in particular the LDCs is not improved than increasing funding for adaptation is unlikely to have an impact.

To interpret climate change information, for designing adaptation strategies and to implement adaptation projects highly educated people are needed. Adaptation needs to differ locally and strategies should be tailor-made to address local adaptation needs. Local knowledge and experience are thus important to implement adaptation. Implementation of adaptation measures should not depend on international consultants or personnel from UN offices so building local capacity should be started as soon as possible. So far, a lot of capacity building in developing countries is still focused on mitigation, for example in relation to the CDM. However, the least developed countries do not need CDM projects but they have to start adapting to climate change. So **capacity building in climate change in the least developing countries should focus on adaptation in stead of mitigation.**

In addition to a low adaptive capacity in many developing countries, there is significant lack of data and knowledge on climate change impacts. Developing countries should be stimulated to improve data gathering and make existing data more easily available. Too often developing countries cannot fully benefit from international research projects because of the unwillingness to share data. Strategies should be developed which stimulate developing countries to collect and share data. For example within international research projects the in-kind contribution of developing countries should be through making the data freely available. The EU should also stimulate data gathering in developing countries not only climate data but also for example hydrological and biodiversity data. In order to do this the EU should support research not only on a short term project basis but also through longer term monitoring projects.

Lastly, scientific research in developing countries in relation to climate change should be stimulated. This can be done through for example increasing the number of projects focussing on, or including, developing countries within FP7. Research institutes participating in current EU research programmes (e.g. FP7), should be encouraged to work together with researchers from developing countries on case studies focusing on developing countries.

4.2. Available EU instruments for development policy in relation to climate change adaptation

Resources for development assistance are made available through the regular EU budget, as well as through the European Development Fund (EDF). At present, the 9th EDF is on-going, and in 2008 the 10th EDF will start (till 2013). The EDF is the main instrument for providing aid for development cooperation in the ACP States and overseas countries and territories (OCT). For the 2007 aid budget, the EDF contributes EUR 3.5 billion and the regular EU budget for aid foresees EUR 2.2 billion¹⁵.

Instruments under this funding are *e.g.* the European Neighbourhood and Partnership Instrument (ENPI), the Development Cooperation Instrument (DCI) and the European Water Initiative (EUWI). These instruments are discussed below in relation to funding of climate change adaptation. **Until now, climate change adaptation is mostly absent in the development oriented funding mechanisms.**

European Neighbourhood and Partnership Instrument (ENPI)

The ENPI is particularly targeting the neighbouring countries of the EU (25) and as such this instrument does not provide many possibilities for funding in developing countries. Climate change is an element in 11 of the 12 ENP Action plans. The activities mainly refer to implementation of the provisions under the Kyoto Protocol and UNFCCC. Only in the case of Azerbaijan, where collaboration for the Nation Action Plan on Adaptation is part of the ENP Action Plan, adaptation is explicitly referred to.

Development Cooperation Instrument (DCI)

The Development Cooperation Instrument (DCI), as agreed in December 2006 (Regulation EC 1905/2006), targets 7 thematic programs: Climate change is part of the theme 'Environment and sustainable management of natural resources, including energy'. The challenge for the Environment theme is to address the increasing global environmental pressures, *e.g.* the need for sustainable energy services, or the unsustainable use or degradation of ecosystems which inhibit achievement of the MDGs. The purpose of the programme is 'to address, through a single coherent programme, the environmental dimension of development and other external policies as well as to help promote the European Union's environmental and energy policies abroad. The programme will complement environmental and energy actions undertaken through country and regional programmes'¹⁶.

For the period of 2007-2013 a total of €16.9 billion is available for the DCI instrument, distributed geographically and thematically. Only 4.7 percent (€800 million) is allocated to the theme of environment. One of the activities of the DCI environment theme is the EU Action Plan on Climate Change in the Context of Development Cooperation 2004-2008¹⁷. The aim of this Action Plan is to combine development cooperation and other priorities. Currently, the Action Plan is under review – as the first phase, 2004-2008, is nearing its end. In the framework of this Action Plan, yearly US\$ 369 million (approx. EUR 3 million) will be available for developing countries - predominantly bilateral assistance as part of the commitment in the "Bonn Political Declaration" on climate change funding for developing countries¹⁸.

¹⁵ http://ec.europa.eu/budget/library/publications/budget_in_fig/dep_eu_budg_2007_en.pdf

¹⁶ Text EU REGULATION (EC) No 1905/2006

¹⁷ (CEU, 24 Nov.2004, 15164/04, DEVGEN241, ENV637)

¹⁸ http://ue.eu.int/ueDocs/cms_Data/docs/pressdata/en/envir/82253.pdf

The Action Plan on Climate Change (APCC) has five strategic objectives:

- Raising the policy profile of climate change;
- Support for adaptation;
- Support for mitigation and low GHG development paths;
- Capacity development;
- Monitoring and evaluation of the Action Plan.

The objective of raising the policy profile has, among others, also lead to other agreements like the Joint Declaration on Climate Change and Development (EU & ACP, 2006) and the EU Strategy for Africa (Dec 2005).

EU Water Initiative¹⁹

The EU Water Initiative (EUWI) is an effort to increase the effectiveness of the significant financial and technical resources available within the EU and its Member States for overseas development assistance, in order to maximize individual and joint efforts in meeting the needs of the world's poorest and achieving the MDG targets for water and sanitation. On an annual basis, available resources are about EUR 1.7 billion (2004). Addressing adaptation to climate change is currently not a target of the EUWI.

In conclusion, there are very few EU programmes in relation to development aid which include climate change adaptation. Within most programmes adaptation plays no or only a minor role.

¹⁹ www.euwi.net

5. Challenges for EU policy coherence

The EU recognizes the importance of policy coherence, and in particular for development cooperation. This chapter introduces briefly the EU policy coherence for development–initiative, followed by a discussion on policy coherence related to issues following from the earlier chapters.

5.1. Policy Coherence for Development

The issue of environment, climate and development is one of the 12 policy areas identified within the ‘Policy Coherence for Development’ (PCD) document. (COM(2005)134-final). A first mid-term ‘Policy Coherence for Development Report’ is expected in the second half of 2007. While a full review of the PCD mechanism is beyond the scope of this study, the report focuses on the issue of **vulnerability** – and how the most vulnerable people in development are affected.

The challenge for EU policy coherence will be to combine policy measures to speed up mitigation and enhance adaptation within the EU (trade and profit central), with sustainable development support initiatives in the least developed countries. The major aim of development policies is to have countries and people take control over their own development. However, trade and aid are central to EU development policies. Therefore, it will be a challenge for EU policy coherence to stimulate development, improving food security and sustainable rural development, as it requires coordinated coherent policies and effective instruments (e.g. financial, technical).

At the international level, the MDGs as leading development goal do not include reference to addressing climate change or variability. However, in Chapter 2.3 it is made clear that there are important links between climate and the MDG. The EU should take up the challenge to **build better links between the MDGs and climate change**.

One of the main policy coherence challenges in relation to climate change is the production of biofuels. The EU is promoting the use of bio-fuels (10% in 2010) to reduce greenhouse gas emissions from burning fossil fuels. However, increased production of biofuels in developing countries is likely to increase deforestation. This deforestation causes higher GHG emissions. For example, in Brazil and Argentina large areas of land are cleared to produce soy beans and in Indonesia native vegetation is replaced by palm oil plantations. Due to increased emissions caused by land clearing it is no means certain that biofuels production reduces the total amount of GHG emitted into the atmosphere. The EU should develop a biofuel policy which ensures that the production of biofuels has a net positive impact on reducing GHG emissions.

5.2. Green Paper on Adaptation

The EU has recently started an open policy dialogue on adaptation. As a start, the ‘green paper on adaptation’ was presented in June 2007. The European Commission organises a web-based public consultation open till the end of November 2007.

The green paper clearly states that Europe must adapt to climate change. Early action is preferred, because it will save on future costs, and might give the European companies a leading role.

Adaptation efforts are sub-divided into four pillars:

1. Early action in the EU;
2. Integrating adaptation into EU external actions;
3. Reducing uncertainty by expanding the knowledge base through integrated climate research;
4. Involving European society, business and public sector in the preparation of coordinated and comprehensive adaptation strategies.

The link of EU with developing countries is an element of the second pillar. The green paper points out that developed countries will need to support adaptation actions in developing countries. The **general approach discussed in the Green paper is very good as it supports integration of adaptation into other external policies and funding mechanisms** and stresses the importance of integrating adaptation into poverty reduction strategies. These are all clearly new approaches which are currently not operational within the EU. To achieve these goals the green paper suggests three action points (see box 2). In contrast to the general text in the green paper the **three actions points are rather limited and not very ambitious**.

Box 2 Action points from the Green Paper on Adaptation in relation to developing countries

To promote adaptation in developing countries, the European Union should act at both global and European level:

- In the context of the UNFCCC, the EU will continue to advance the issue of adaptation, and promote the integration of adaptation into national development plans (e.g. through the National Adaptation Programmes of Action (NAPA) and the 5-Year Work Programme on Adaptation recently adopted in Nairobi). EU leadership will be required to help ensure the availability of sufficient financial and technical resources, including through the Adaptation Fund under the Kyoto Protocol, the Global Environment Facility and bilateral channels, to implement NAPAs and similar strategies.
- The 2004 EU Action Plan on Climate Change and Development already includes support strategies for adaptation in developing countries that can, for instance, be supported under the Environment and Natural Resources Thematic Programme and through geographical funds at country and regional level. The inclusion of adaptation measures in geographical programming will have to be strengthened. The next occasion for this is the mid-term review of country and regional strategies in 2010. The ongoing mid-term evaluation of the Action Plan provides the first opportunity for review of the plan in the light of accelerating climate change.
- The Commission is examining how to promote and enhanced dialogue and cooperation between the EU and developing countries on climate change, through the building of a Global Climate Change Alliance. The Commission has earmarked a total of € 50 million over the period 2007-2010 for dialogue activities, and to support developing countries through targeted mitigation and adaptation measures. Actions could include providing follow-up to the National Adaptation Programmes of Action through concrete pilot projects in particular regarding integration of adaptation activities in key sectoral policies. Moreover, the forthcoming EU strategy on Disaster Risk Reduction will build a bridge between adaptation and disaster response.

The first action point considers continued support of adaptation in the context of the UNFCCC. Politically this is a safe option, however, if adaptation is continued to be funded through the UNFCCC and the GEF, opportunities for integration with other development issues remain very limited. Also the success of promoting adaptation through the UNFCCC is until now very limited.

The second action point mentions the Action Plan on Climate Change (APCC) and Development and suggests incorporating adaptation in geographical programming and the Environment and Natural Resources Thematic Programme. The APCC is however still very mitigation focused. While supporting integration of adaptation into other programmes is important, the Green Paper is very vague how this should be achieved and does not suggest immediate action but proposes to wait until the midterm reviews in 2010.

The third action point is the Global Climate Change Alliance. The communication of the Commission on the Alliance is discussed in the next paragraph. It is clear that this alliance was prepared before the green paper and this is not a new or additional policy. Also the funds for this policy are limited (EUR 50 million) and this amount needs to be shared between adaptation and mitigation efforts.

In addition, the part on developing countries in the green paper does not mention vulnerability while particularly for developing countries it is important to focus on the most vulnerable.

In conclusion, it is good that there is specific attention in the EU for adaptation, but it would be good if the EU would develop a clear well funded strategy specifically on adaptation in developing countries including a focus on poverty and vulnerability. 'Poor and vulnerable' is currently considered at the level of countries, while it would be much more useful to call for a focus on the poor and vulnerable also within countries.

5.3. The Global Climate Change Alliance (GCCA) initiative

In September 2007, the EU has launched the Global Climate Change Alliance (GCCA) initiative. The objective of the GCCA is 'to provide a platform for dialogue and exchange among the EU and poor developing countries most vulnerable to climate change, in particular the LDCs and SIDS²⁰, on practical approaches to realising the integration of development strategies and climate change.' Besides, it provides technical and financial support for adaptation and mitigation measures, and for the integration of climate change in development strategies (EU COM(2007)540 final).

Financing of the GCCA is foreseen with €50 million additional resources to the thematic environmental program (ENTRP), within the framework of the 10th EDF, and by additional resources from the Development Cooperation Instrument (DCI). Further, the EU Member States are sought to join forces on this issue.

There are five areas of focus:

1. Adaptation to climate change;
2. Reducing emissions from deforestation;
3. Enhancing participation in the Clean Development Mechanism;
4. Promoting disaster risk reduction;
5. Integrating climate change into poverty reduction efforts

²⁰ SIDS, Small Islands Developing States

The GCCA can be a first step on building the links between climate change and development. The focus on adaptation, deforestation and disaster risk reduction as most important climate change issues in the least developed countries seems promising and links well with the recommendations of this report. Also very important, is that the Alliance focuses on building a knowledge base. Although there is a general consensus that adaptation in developing countries is important, most knowledge - where adaptation measurers need to be based on - is still lacking in most developing countries. As far as this study is concerned, the weak point of the GCCA is the focus on 'Enhancing participation in the CDM'. As discussed previously in this report, the CDM is a good market based mechanism for the rapidly developing countries such China, India and Brazil, but not very suitable to the LDCs. It is probably better to develop other mechanisms to support and pay for mitigation in these poor countries than to continue to push the CDM.

6. Conclusions and recommendations

6.1. Conclusions

Without serious mitigation and adaptation, climate change is likely to have a significant impact on developing countries and the poor are likely to suffer most. The later serious actions are taken, the worse the impacts and the higher the future costs will be. Taking actions now on climate change mitigation and adaptation will significantly reduce future damage. In order to minimize future climate change, efforts to reduce the emissions of greenhouse gases in the developed world should be increased. The EU should continue to stimulate this within their member countries and should improve efforts to stimulate the US to join the Kyoto agreement and commit itself to future targets. If the developed countries are doing more to reduce their emissions, rapidly developing countries are much more likely to join mitigation efforts. Getting developing countries to commit to mitigation is very important because reducing future emissions of India and China is essential for slowing future climate change.

The European Union should have different focuses for different countries in terms of climate change adaptation and mitigation. For rapidly developing countries such as China and India the EU should focus on mitigation of greenhouse gas emissions. For the least developed countries there should be a focus on adaptation.

Greenhouse gas emissions from developing countries are rapidly increasing. Reducing the growth of emissions from these countries is in the interest of the EU because it will slow down climate change. In developing countries, a lot can be done in terms of mitigation without slowing down the economy; especially in terms of increasing energy efficiency, reducing deforestation and improving efficiencies in agriculture. It is also important that developing countries are stimulated to choose a sustainable, low emission development pathway. It is often much easier and cost effective if the choice for more sustainable, low emission technologies is made early in the process. Currently, the EU is stimulating mitigation and transfer of clean technologies through the Clean Development Mechanism. Although it is still unclear what the mitigation potential of the CDM is, especially in India the investment in CDM projects is significant. However, to really stimulate mitigation in developing countries, the EU should take a much wider approach in stimulating sustainable development in these countries. Obviously it must be left to the individual countries on how they develop but especially in terms of production of goods imported in the EU, there are possibilities to **stimulate cleaner production**. For example by developing labelling systems or import duties depending greenhouse emission and/or on how sustainable goods are produced. These mechanisms should not be used as a new instrument for protectionism, but should stimulate more environmental friendly production. Reducing GHG emissions should be integrated into the next round of trade negotiations and the WTO should also acknowledge to role of trade in causing and preventing dangerous climate change. Currently, the world market is stimulating the production of goods at the lowest price without taking the environment into consideration. By putting a price on greenhouse gas emissions, there will be a stimulation to produce goods where it can be done with the lowest energy input (for production and transport).

Also in the least developed countries there are options for mitigation but they should *not* focus on the energy or transport sector but on agriculture and forestry. First of all, new mechanisms should be developed in such a way that the protection of forest can be paid through well constructed carbon markets. The EU should actively support post-Kyoto mitigation options in reduced deforestation and/or forest conservation, but only if it does not provide incentives for Annex-I countries to realize most of their commitments abroad.

This can be achieved by combinations of higher commitments, imposing limits or by designing an independent mechanism, committing developed countries to both national emission reductions *and* supporting reductions abroad. In agriculture the EU should look for win-win situations where both productivity and/or efficiency are increased without compromising the environment, while at the same time reducing emissions.

Especially the least developed countries should get help from the EU for climate change adaptation. Currently, most funds available are through UNFCCC process. There are many complaints from developing countries that it is very hard to get funding for adaptation projects through the GEF. The recently started GCCA might provide an opportunity to work on adaptation outside the sphere of negotiations. Also there is an increasing consensus that the funds currently available are not enough to support developing countries to cope with the impacts of climate. What seems forgotten in the discussion about funding for adaptation is that most adaptation is very similar to good development practices. Due to the close links between adaptation and sustainable development it makes much more sense to **mainstream adaptation into sustainable development** and built better links between the adaptation and development funds.

The major reason that many developing countries are vulnerable to climate change is a lack of adaptive capacity. General adaptive capacity and resilience is likely to increase with development. However, to take specific adaptation measures a certain knowledge base is necessary. The knowledge base on climate change is often very limited in developing countries. There is lack of data, studies and trained personnel. The EU should actively support increasing (scientific) knowledge on climate change impacts and adaptations in developing countries and improve capacity building on climate change adaptation. Still a lot of capacity in the least developed countries is focusing on mitigation (*e.g.* CDM training) while these countries would benefit much more from capacity building related to adaptation.

6.2. Recommendations for new EU policies to support climate change adaptation and mitigation in developing countries

To minimize future impacts of climate change in developing countries **action should be taken urgently**. Actions should focus on:

- *Minimizing greenhouse gas emissions* within Europe and help developing countries reduce their emissions;
- *Helping developing countries adapting* to climate change by reducing their vulnerability.

6.2.1. Recommendations related to Mitigation

1. Mainstream and integrate climate change mitigation into development projects and programmes.
2. Differentiate mitigation options among different developing countries:
 - a. Focus mitigation efforts in least developed countries on land use change, agriculture and sustainable development.
 - b. In rapidly developing countries (India, China and Brazil) focus on supporting lower energy intensive development and cleaner energy production.
3. Actively support post-Kyoto mitigation options in reduced deforestation and/or forest conservation

4. When defining emission strategies not only greenhouse gas emissions *per capita* should be important. Within large countries specific regions, groups of people or sectors with high emission patterns should be targeted for mitigations. This creates immediate opportunities for mitigation in countries like China and India without compromising development of the poor.
5. Avoid oversimplified indicators like food miles and use single issue indicators with great care
6. Bio-fuel production should not undermine development and food security

6.2.2. Recommendations related to adaptation

1. Mainstream and integrate climate change adaptation into development projects
 - a. Check current projects whether they are vulnerable to climate change
 - b. Incorporate adaptation to climate change and variability systematically into (existing and new) development projects
2. Official Development Assistance (ODA) funds should be made available for adaptation projects.
3. Incorporate impacts of and adaptation to climate change into projects and programmes aimed at achieving the MDGs.
4. Capacity building related to climate change within developing countries should first and foremost focus on adaptation with particular attention to reducing vulnerability of the poor.
5. The European Union should support more collaborative research projects in order to enable knowledge based adaptation and facilitate knowledge exchange in a science/policy dialogue between EU and developing countries and among developing countries.
6. Build on existing processes addressing adaptation within the UNFCCC (NAPA's, National Communications) and outside the UNFCCC (WTO, Poverty reduction, MDGs).
7. Increase investment in disaster preparedness and disaster risk reduction. Investing before disasters is much more efficient and saves considerable spending on emergency aid.

7. References

- Biemans H, Bresser T, Van Schaik H and Kabat P (2006) Water and Climate Risks: A plea for climate proofing of water development strategies and measurers. Co-operative programme on Water and Climate, Delft, 2006, 35 pp.
- Cosbey A, Parry J-O, Browne J, Babu YD, Bhandari P, Drexhage J, Murphy D (2005). Realizing the Development Dividend: Making the CDM Work for Developing Countries. IISD. Available at <http://www.iisd.org/publications/pub.aspx?pno=694> [Accessed October 5, 2007]
- De Bruin, KC Dellink and Tol RSJ (2007). AD-DICE: An Implementation of Adaptation in the DICE Model, Nota di lavoro 51.2007 FEEM.
- DEFRA, <http://statistics.defra.gov.uk/esg/reports/foodmiles/default.asp> [Accessed October 5, 2007]
- EDF (2007), http://ec.europa.eu/budget/library/publications/budget_in_fig/dep_eu_budg_2007_en.pdf [Accessed October 5, 2007]
- ENPI, http://ec.europa.eu/world/enp/policy_en.htm [Accessed October 5, 2007]
- ERM (2006). Natural disaster and disaster risk reduction measurers-a desl review of costs and benefits. London : DFID
- European Commission (2004). Action Plan on Climate Change in the Context of Development Cooperation 2004-2008 (CEU, 24 Nov.2004, 15164/04, DEVGEN241, ENV637).
- European Commission (2007). Green Paper – Adapting to climate change in Europe – options for EU action. SEC(2007) 849, COM(2007) 354 final, Brussels, 29.6.2007
- European Commission (2007). GCCA - COM92007) 540 final
- European Commission (2005). Policy Coherence for Development (PCD), COM(2005)134-final
- EUWI www.euwi.net
- FAO (2006). Livestock's long shadow, FAO, Rome.
- GEF, http://www.gefweb.org/interior.aspx?id=232&ekmense=c580fa7b_48_126_btnlink. [Accessed October 5, 2007]
- Gonzalez P (2001). Desertification and a shift of forest species in the West African Sahel. Climate Research 17: 217-228
- Heller TC., Shukla PR (2003) Development and climate: engaging developing countries In: Beyond Kyoto: Advancing the International Effort against Climate Change Washington, DC: Pew Center for Global Climate Change. 111 – 140.
- IEA (2001). International Emission Trading - From Concept to Reality, OECD/IEA, Paris.
- IPCC (2007). Climate change 2007. Fourth Assessment Report. Cambridge University Press, Cambridge, UK www.ipcc.ch [Accessed October 5, 2007]
- Karani P Gantsho M (2006). The Role of Development Finance Institutions (DFIs) in Promoting the Clean Development Mechanism (CDM) in Africa. Environment, Development and Sustainability

- Lecocq F Capoor K (2003). 'State and trends of the carbon market in 2003. Working paper', Washington, DC, World Bank, December 2003
- Mohner A, Klein RJT (2007). The Global Environment Facility: Funding for adaptation or adapting for funds. Working Paper. Stockholm Environment Institute.
- Ionescu C, Klein RJT, Hinkel J, Kavi Kumar KS, Klein R (2005). Towards a formal framework of vulnerability to climate change. Newater Report Series No. 2. http://www.usf.uni-osnabrueck.de/projects/newater/downloads/newater_wp02.pdf [Accessed October 27, 2007].
- Raworth, K (2007). Adapting to climate change: what's needed in poor countries and who should pay. Oxfam International. www.oxfam.org/en/files/bp104_climate_change_0705.pdf/download
- Senhaji F (2004) Moroccan CDM projects: energy efficiency, a presentation at the first Carbon Exhibition in Northern Africa and Middle east region, Djerba on 22–24
- Smith D (2006). Just one planet: poverty justice climate change. Practical Action, Warwickshire, United Kingdom.
- Sperling F (2003). Poverty and climate change: Reducing the vulnerability of the poor through adaptation. AfDB, ADB, DFID, EC DG Development, BMZ, DGIS, OECD, UNDP, UNEP & World Bank, Washington, DC, USA.
- Stern N (2007). The economics of climate change. Cambridge University Press. UK. Available at http://www.hm-treasury.gov.uk/independent_reviews/stern_review_economics_climate_change/stern_review_report.cfm Stern, 2007 [Accessed October 5, 2007]
- Swart R, Robinson J Cohen S (2003) Climate change and sustainable development: expanding the options. Climate Policy 3: S19-S40.
- UNDP (1995) Human Development Report. New York: Oxford University Press
- Van Aalst M, Hirsch D, Tellam I (2007) Poverty Reduction at Risk - Managing the Impacts of Climate Change on Poverty Alleviation Activities. ETC, Leusden, The Netherlands. http://www.nlcap.net/uploads/media/Poverty_Reduction_at_Risk_Synthesis_Report.v1.pdf [Accessed October 5, 2007]
- Van Duivenbooden N, Abdoussalam S, Ben Mohamed A (2002) Impact of climate change on agricultural production in the Sahel - Part 2. Case study for groundnut and cowpea in Niger Climatic Change 54, 349-368.
- World Bank, 2006. Clean energy and development: towards an investment framework.
- UNFCCC, 2007. Background paper on "Analysis of existing and planned investment and financial flows relevant to the development of effective and appropriate international response to climate change.

List of Figures

Figure 1: Comparison of observed changes in temperature (black lines) with results simulated by climate models using only natural forcing and using both natural and anthropogenic forcing (including greenhouse gases)	2
Figure 2: Projected surface temperatures changes for the 2020-2029 and the 2090-2099 period for three different emission scenarios. The left panel shows uncertainties of temperatures rises as the relative probabilities of estimated global average warming from different models	4
Figure 3: Relative changes in precipitation (in percent) for the period 2090-2099 relative to 1980-1999. Values are based on multi-model comparisons for December to February (left) and June to August (right). White areas are where models disagree on the sign (increase or decrease) of the change and stippled areas where more than 90% of the models agree on the sign of change	7
Figure 4: Vulnerability to climate change: the IPCC Third Assessment Report.....	8
Figure 5: Net change in forest area between 2000 and 2005.....	24
Figure 6: Linkages between sustainable development, climate change, and policies in these areas	30

List of Abbreviations

ACP	Africa, Caribbean and the Pacific
AF	Adaptation Fund
APCC	Action Plan on Climate Change
BAU	Business As Usual
CDM	Clean Development Mechanism
CER	Certified Emission Reductions
DCI	Development Cooperation Instrument
DFI	Direct Foreign Investment
EDF	European Development Fund
ENPI	European Neighbourhood and Partnership Instrument
EUWI	European Water Initiative
FLEGT	Forest Law Enforcement, Governance and Trade
GCCA	Global Climate Change Alliance
GDP	Gross Domestic Product
GEEREF	Global Energy Efficiency and Renewable Energy Fund
GEF	Global Environment Facility
GHG	Greenhouse Gas
GLOF	Glacial Lake Outburst Flood
IAM	Integrated Assessment Models
IISD	International Institute for Sustainable Development
IPCC	Intergovernmental Panel on Climate Change
JI	Joint Implementation
LDC	Least Developed Countries
LDCF	Least Developed Countries Fund
MDG	Millennium Development Goal
NAPA	National Adaptation Programmes of Action
OCT	Overseas Countries and Territories
ODA	Official Development Assistance
PCD	Policy Coherence for Development
REDD	Reduced Emissions from Deforestation and Degradation
SCCF	Special Climate Change Fund
SIDS	Small Islands Developing States
UNFCCC	United Nations Framework Convention on Climate Change
WSSD	World Summit on Sustainable Development
WTO	World Trade Organisation