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ANALYSIS

Climate Change, Food Security and the Right to Adequate Food

Diakonie Katastrophenhilfe

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D-70784 Stuttgart
Phone: ++49 (711) 2159-0
E-Mail: info@brot-fuer-die-welt.de, info@diakonie-katastrophenhilfe.de
www.brot-fuer-die-welt.de
www.diakonie-katastrophenhilfe.de

Germanwatch e.V.
Kaiserstr. 201
D-53113 Bonn
Phone ++49 (228) 60492-0
E-mail: info@germanwatch.org
www.germanwatch.org

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Authors: Christoph Bals, Sven Harmeling, Michael Windfuhr, with contributions from Stephen O. Anyango (Department of Environmental Science, Kenyatta University, Kenya) and Victor Orindi (International Development Research Centre, Kenya), Ferdausur Rahman, Mizanur Rahman Bijoy, Nusrat Habib (alle Network on Climate Change, Bangladesch), Umme Kulsum (Climate Change Focal Point, Prodipan)
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Climate Change, Food Security and the Right to Adequate Food

Christoph Bals
(Germanwatch)

Sven Harmeling
(Germanwatch)

Michael Windfuhr
(Brot für die Welt)

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Abbreviations

AAUs	Assigned Amount Units
ADB	Asian Development Bank
AGGG	United Nations Advisory Group on Greenhouse Gases
AF	Adaptation Fund
AoA	WTO Agreement on Agriculture
AOSIS	Alliance of Small Island States
AU	African Union
BCAS	Bangladesh Centre for Advanced Studies
CAADP	Comprehensive Africa Agriculture Development Programme
CBA	Community-based adaptation
CCS	Carbon Capture and geological storage
CDM	Clean Development Mechanism
CEGIS	Center for Environmental and Geographic Information Services
CESCR	UN-Committee on Economic, Social and Cultural Rights
CO_2	Carbon dioxide
CO_2e	CO_2 equivalent
COP	Conference of the Parties
CRI	Climate Risk Index
CSO	Civil Society Organisations
CTA	Technical Centre for Agriculture and Rural Cooperation ACP-EU
DAE	Department of Agriculture Extension
DfID	Department for International Development
DPA	Deutsche Presse-Agentur
EEA	European Environment Agency
EC	European Commission
ENSO	El Niño Southern Oscillation
EU	European Union
FAO	Food and Agriculture Organisation
FAR	IPCC Fourth Assessment Report
FIVIMS	Food insecurity and vulnerability information mapping systems
GCM	General Circulation Models
GDP	Gross Domestic Product
GDPRD	Global Donor Platform on Rural Development
GEF	Global Environment Facility
GHG	Greenhouse gas emissions
GNI	Gross National Income
GoB	Government of Bangladesh
GTZ	German Agency for Technical Cooperation
HDR	UNDP Human Development Report
IAASTD	International Assessment of Agricultural Knowledge, Science and Technology for Development
IAGW	Interagency Working Group
ICDDR, B	International Center for Diarrhoeal Diesease Research, Bangladesh
ICESCR	International Covenant for Economic, Social and Cultural Rights
IDP	Internally displaced persons

Abbreviations

IDS	Institute of Development Studies
IFAD	International Fund for Agricultural Development
IFPRI	International Food Policy Research Institute
IGES	Institute for Global Environmental Strategies
IGO	Intergovernmental Organisation
IISD	International Institute for Sustainable Development
IPCC	Intergovernmental Panel on Climate Change
IPR	Intellectual Property Rights
LACC	Livelihood Adaptation to Climate Change
LDC	Least Developed Countries
LDCF	Least Developed Countries Fund
LIFDC	Low-income food deficiency countries
MDG	Millennium Development Goals
NAPA	National Adaptation Programmes of Action
NEPAD	New Partnership initiative of the African Union for African Development
NWP	Nairobi Work Programme on Impacts, Vulnerability and Adaptation to Climate Change
NTFP	Non-timber forest products
ODA	Official Development Assistance
OHCHR	Office of the High-Commissioner on Human Rights
OECD	Organisation for Economic Cooperation and Development
PPCR	Pilot Programme for Climate Resilience
Ppm	parts per million
PPP	Power purchasing parities
PRSP	Poverty Reduction Strategy Paper
RBM	Rights-based monitoring
RCI	Responsibility and Capability Index
SAARC	South Asian Association for Regional Cooperation
SADC	Southern African Development Community
SAP	Structural Adjustment Programme
SCCF	Special Climate Change Fund
SIDS	Small Island Developing States
SLE	Centre for advanced training in rural development
SLR	Sea-level rise
SPA	Strategic Priority on Adaptation
SRES	Special Report on Emission Scenarios
SSA	Sub-Saharan Africa
SST	Sea-surface temperature
TAR	IPCC Third Assessment Report
TERI	The Energy and Resources Institute
TNC	Trans-national Corporation
TRIPS	WTO's Agreement on Trade Related Aspects of Intellectual Property Rights
UN	United Nations
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme

Abbreviations

UN-ESA	United Nations – Department of Economic and Social Affairs
UNFCCC	UN Framework Convention on Climate Change
USD	US-Dollar
WBGU	German Advisory Council for Global Change
WDR	World Bank World Development Report
WFC	World Food Council
WFS	World Food Summit
WFP	World Food Programme
WMO	World Meterological Organisation
WTO	World Trade Organisation
WWF	World Wildlife Fund

Foreword

Climate change threatens to make the already difficult situation of food security in the world even worse. The Fourth Assessment Report of the Intergovernmental Panel on Climate Change (IPCC) – based on the evaluation of many scientific studies – has made a critical assessment of the possible impacts of climate change on agriculture, livestock and fishing, particularly in the countries of the tropics and sub-tropics. The Food and Agriculture Organisation of the United Nations (FAO) also warns about the negative consequences, in particular for smallholder subsistence farmers in what are in any case marginalized regions of Africa, Asia and Latin America. In view of the threat of more famine, the Human Rights Council of the United Nations has also started to examine the question of the responsibility of the international community of states in terms of human rights when it comes to dealing with the need to adapt to climate change. In particular, there is a need to provide support for vulnerable people in special need of protection, who are not able to cope with the consequences of climate change on their own.

"Bread for the World", the development organisation of the Protestant church in Germany, has always paid particular attention to fighting hunger and its structural causes. Climate change presents this work with a new challenge, as it threatens what has already been achieved in some areas and causes new problems in other areas of the world. Food security and climate change is therefore a strategic topic both in the international programme work and in respect of lobbying on development policy.

"Germanwatch", an environmental and development organisation, which has closely observed and followed the international negotiations on climate change since their inception, has placed great emphasis on food security during climate change from an early stage, including the aspect of climate policy. Here the significance of adaptation and the financing of adaptation has become increasingly important over recent years, because this issue is decisive for the poorest developing countries and island states.

"Diakonie Katastrophenhilfe", the humanitarian aid organisation of the German Protestant Church, is striving to embed disaster-risk reduction and adaptation to climate change as crossing-cutting issues in both relief and rehabilitation. "Building back better" concerns not only houses but also livelihoods, therefore "Diakonie Katastrophenhilfe" closely cooperates with "Bread for the World" to strengthen the common approach to food security as well as to adaptation to climate change.

Together we want to document in this study important facts about the relationship between climate change and food security, evaluate these facts systematically and incorporate them in policy recommendations for the national and international level, focussing on the development of policies to adapt to climate change.

Stuttgart, October 2008

Danuta Sacher
Head of the Policy & Campaign Department
Bread for the World

Klaus Milke
Chairman
Germanwatch

Volker Gerdesmeier
Head of Department Diakonie Katastrophenhilfe

Executive summary

1. This study has been written in order to get a good overview about the impacts of climate change on food security and the relevance of the right to adequate food. This study process was started with two specific motivations:

(1) While the number of publications and studies on climate change and its impact is rapidly growing, less information is available to understand the particular risks for those persons and groups who are malnourished or at the brink of becoming hungry. This study shall therefore sharpen the view of the problems these groups face and it shall systematize how the global mega trend of climate change might impact these marginalized groups.

(2) The study shall secondly look into the political dimension of climate change. Policy decisions of the next decade will largely determine the dimension of the problem in this century.

2. This study is based on the assumption that a two-dimensional response to climate change is needed: avoiding the unmanageable (mitigation) and managing the unavoidable (adaptation).

(1) Avoiding the unmanageable is directed to the need to prevent dangerous climate change. According to an emerging consensus among scientists, it is needed to limit global warming to a temperature increase below 2°C as compared to pre-industrial levels. In order to stay below that limit, industrialized countries need to take the lead for a drastic cut in emissions. Globally, emissions have to be reduced by 50 to 85 percent until 2050 against 1990 levels. The global emissions should peak during the next decade.

(2) Managing the unavoidable means that sound adaptation policies are needed to deal with the consequences of climate change, which are already increasingly visible today. The special focus of the study is on the adaptation needs particularly related to food security and the realization of the right to adequate food. But the authors see that unmitigated climate change could easily overwhelm adaptation possibilities in many parts of the world.

3. The impact of climate change on food security will be substantive. The increasing surface temperature influences factors very relevant for food security as precipitation, water availability, weather extremes, and sea level rise. If certain tipping points are passed, entire continents can be heavily affected. Better regional and local assessments are needed to identify more specifically the risks of climate change, especially in developing countries. The debate so far is biased towards global food security concerns, i.e. the global balance of how much and where food can be produced. But the impact on hunger and malnutrition can only be well estimated, if the effects on the household level are taken into consideration. Climate change will impact persons and groups that are already vulnerable to food insecurity. But there will also be new groups affected by climate change.

4. Adaptation to the adverse impacts of climate change has long been neglected as a development issue, both by most governmental and nongovernmental organisations. Until recently, adaptation was also not at the centre of UN-climate negotiations. By now it has become clear that the additional benefits of adaptation to climate change will be huge and that early action is cheaper than a post-disaster response, even though there are still many uncertainties in existing adaptation cost estimates.

5. Adaptation requires substantive investments in infrastructure such as dams, flood-resistant storage facilities, and techniques for reducing water loss in distribution systems etc. It requires monitoring weather extremes and developing disaster preparation strategies. Higher prices for agricultural inputs, water, and food imports must be expected. Capacity building in communities particularly at risk, in national, regional, and local administrations etc. is of utmost importance and will require resources.

The direct and indirect consequences of climate change on food, water and health have the potential to influ-

ence the realization of the MDGs. Additionally, climate impacts and adaptation needs will use resources that would have otherwise been available to realize the Millennium Development Goals (MDGs).

> *„How the world deals with climate change today will have a direct bearing on the human development prospects of a large section of humanity" (UNDP 2007, 8).*

6. One clear recommendation of this study is that UN climate negotiations should create a reliable financial basis in order to manage the unavoidable. Substantial financial resources in addition to existing commitments of developing countries to provide 0.7 percent of their GNI are needed to cope with the expected adaptation needs for developing countries. However, more funding does not necessarily mean that the money reaches the most vulnerable groups. The rights-based framework should be considered by UNFCCC, as it has the potential to help measure progress, review government activities, and generate resources.

Climate change, food security and groups at risk

7. Key concept in the United Nations to measure the food and nutrition situation of people and groups is the term „food security". The latest standard definition used in the FAO (2007b, 6) is

> *„Food security exists when all people at all times have physical or economic access to sufficient, safe and nutritious food to meet their dietary needs and food preferences for an active and healthy life. To achieve food security, all four of its components must be adequate. These are: availability, stability, accessibility and utilization."*

Additionally, food security depends on a variety of underlying determinants. Food must be nutritious and safe. The body must be in a condition to consume food without becoming ill. UNICEF and other nutritionists emphasize the fact that half of the children dying from hunger are not dying because of missing food supply, but because they cannot digest this food due to sickness, e.g. diarrhea (Eide 2001). The study uses the three different levels of food security (global, national and household food security) to describe the effects of climate change.

8. In order to deal adequately with the impact of climate change on food security, the work has to start with a good analysis of those groups which are particularly marginalized today. They will often be the most affected by climate change and they have very limited coping capacities. Given the crucial role of marginalization in the food security debate, it is clear that agricultural and food production problems cannot be tackled at the technical level. The situation of the rural poor has been aggravated by the fact that rural areas were neglected in regional, national, and international policy making.

9. A person or a family is a vulnerable person or family due to their livelihood situation and their factor endowment. Often government response is decisive in whether the vulnerable situation translates into persistence of or additional hunger or malnutrition. A given (insufficient) factor endowment of families is already partially a result of government policy. Using the right to adequate food will therefore be very helpful in designing adaptation policies. In regard to increasing the accountability of governments, it will help guide the implementation of effective adaptation policies.

10. By now it is scientifically well established, that

> *„the impacts of climate change will fall disproportionately upon developing countries and the poor persons within all countries, and thereby exacerbate inequities in health status and access to adequate food, clean water, and other resources" (IPCC 2001, 12).*

The impact of climate change will be particularly substantial on smallholder and subsistence agriculture. Their livelihood systems, particularly in low latitudes, will be affected by major changes due to climate change. The farming system will be directly affected by changing weather patterns, sea level rise, and the increase

in frequency and intensity of extreme events. The productivity of livestock and fisheries systems will also be affected, as well as potential income from collecting activities in forests.

11. The impact analyses of the study concludes that the specific family situation needs to be taken into account, because livelihood systems are typically complex and a number of factors interfere. Several crops and livestock species are involved (in intercropping systems etc.) and many smallholder livelihoods have a variety of income sources, such as the use of wild resources (from forests), remittances, and other non agricultural income strategies. Government support can also play a role, but so far many of the smallholder farmers are faced with marginalization processes in national and international agricultural policies. Therefore, support is often unavailable or insufficient. Effective adaptation policies should start with supporting existing coping and adaptation strategies of poorer groups in rural as well as urban environments.

Response capacities to climate change – nationally and internationally

12. Many developing countries will be most heavily affected, but they have limited response capacities. These limitations contribute largely to their particular affectedness. They have limits in forecasting changing weather conditions, particularly extreme weather events, or to invest in infrastructure such as dams or other mechanisms of flood control.

Response capacities are also needed to enable changes in the use of agricultural crops and varieties and irrigation and land use techniques to support affected families in order to cope with the need to migrate or to cover the cost of other forms of damage to the house or the land of the family. It is important to differentiate what part of adaptation can be done at the household level, locally, by national governments and where is international support needed.

13. While some priority action needs to be urgently implemented in adapting to the short-term consequences of climate change, adaptation must be viewed as a long-term challenge for societies. „Mainstreaming“, or integration of this challenge into sectoral and other policies and programs at different levels of decision making is necessary.

One priority must be the reduction of vulnerability to climate change. At the same time, adaptation policies must address negative effects on the most vulnerable groups in order to avoid hardship for groups most affected by climate change. Ecosystem management plans that allow for multi-sectoral response dealing with whole livelihood systems are needed in addition to sectoral responses. This study summarizes the instruments available for a response at different levels and in key vulnerable sectors. The study recommends that adaptation policies need to be closely monitored in order to guarantee that the means are spent meaningfully.

14. A human rights-based assessment can help to best orient adaptation policies and the use of all instruments towards most vulnerable groups and to set priorities on who should get support first and what can be implemented progressively.

One of the strengths of this approach is that it helps to set up procedural guarantees for the affected communities and people for participation. This includes having access to relevant information (transparency) and the right to complain. A second strength is that a rights-based approach requests a specific outcome. Governments have to prove that they focus their policy and budget decisions toward the most vulnerable groups and that no group is overlooked. Governments have to prove that their own adaptation policies do no harm i.e. deprive people from access to food or water.

15. Development cooperation can play a crucial role in all stages of the adaptation policies. Different actors can play different parts. Bi- and multilateral aid can help integrating adaptation into policy development. Capacity must be built at all stages of the adaptation process in developing countries, from disaster preparedness and early warning to insurance schemes and policy design issues. Other stakeholders, such as the scientific com-

munity and NGOs, should be included into adaptation planning. Aid organisations often have access to the most vulnerable groups and they can assist with their experiences in project management and implementation and also by mobilizing internationally available knowledge.

16. The financing of adaptation measures will need adequate international support. The study discusses the UNFCCC-supported National Action Plans for Adaptation (NAPAS) as well as the strenght and weaknesses of the newly introduced Adaptation Fund under the Kyoto Protocol. The UNFCCC process will likely take major decisions about the future adaptation process at the end of 2009.

17. This study contains chapters that summarize the regional effects of climate change on food security. This is followed by an identification of key affected, vulnerable groups and a discussion of the available response capacity of governments and local actors in the regions. These regional chapters are summaries of the regional studies that have been written in parallel to the cover study.

Climate change and human rights

18. National policies – regarding health, education, social services, taxation and subsidies, property rights and their legal protection etc. – often reflect the interests of powerful sectors and are seldom oriented towards the needs of vulnerable and marginalized groups. This is true for formal and informal political decision-making structures.

Particularly, marginalized women and men in rural areas and in poor quarters of urban conglomerates don't benefit from them. They usually have no access to a functioning legal system, land-registration systems, justice and appeal mechanisms for checking discriminatory laws or their practices etc. Not only national governance, but also international policies can be determinants of poverty and exclusion.

International trade policies often do have a direct impact on the income of poor producers or consumers. Policies of multilateral institutions can and sometimes do limit states' capacities to act in favor of poorer segments of their societies.

A rights-based orientation for adaptation policies can help to overcome such forms of discrimination and exclusion. It will probably not be able to overcome all forms of institutionalized, historic marginalization, but they can at least avoid aggravating existing inequalities. Moreover, if adaptation policies are not well designed, they might not achieve their own objective – supporting those affected the most. Instead, the money is again directed towards those more powerful within the society.

A rights-based approach stimulates analysis and reflection on the causes of entitlement-failure and allows a more precise description of roles, obligations, and responsibilities of different actors in the development process. It is a way of reducing the accountability-gap works against the poor in many countries.

19. A rights-based approach not only asks for an end to violation of and for positive outcomes for the most vulnerable groups. They also set result-oriented standards for the political processes. They must be participatory, transparent, and non-discriminatory. To sum it up, rights-based adaptation policies are a good tool to ensure that the money earmarked for adaptation is spend reasonably. It would be helpful if the Office of the High Commissioner for Human Rights, the FAO, and the UNFCCC would develop a rights-based adaptation policy checklist that could help governments design adaptation policies accordingly.

> *„The impact of climate change will fall disproportionately on the world's poorest countries, many of them here in Africa. Poor people already live on the front lines of pollution, disaster, and the degradation of resources and land. For them, adaptation is a matter of sheer survival" (UN Secretary General Kofi Annan, addressing the 12th Conference of the Parties to the United Nations Framework Convention on Climate Change, 15 November 2006, Nairobi, Kenya).*

Introduction

Bread for the World (BfdW) and Germanwatch have initiated this study process on the impact of climate change on food security in 2006. BfdW has a particular focus in its development work on people and groups who are hungry and malnourished or who are at the risk of becoming hungry. Germanwatch has a particular focus on „climate change and development“ and has been following the UN climate change negotiations for many years. This study process was started with the motivation to learn more about the potential impact of climate change on the food security of these most vulnerable groups.

While the number of publications and studies on climate change and its impact is rapidly growing, much more information is still needed to understand the particular effects on those persons and groups who are malnourished or at the brink of becoming hungry. Hunger goes hand in hand with poverty. The study shall therefore sharpen the view of the problems that these groups face and it shall systematize how the global mega trend of climate change will impact on these marginalized groups.

At the same time, it is clear that the size of the problems generated by climate change will depend on the political decisions of today as well as on the implementation of these decisions. Part of climate change is already unavoidable. However, the less emission reductions will be achieved and the higher the temperature increase will be in the future, the more severe the implications for food security will be, in particular in the low latitude areas (IPCC 2007b). Already, the unavoidable consequences will severely challenge people around the globe. However, in order to avoid large-scale adverse impacts from global warming, global temperature increase should be limited to well below 2°C compared to pre-industrial levels.

New scientific information points in an even more ambitious direction (Hansen et al 2008). This will require global emission reductions of at significantly more than 50 percent by 2050 compared to 1990. This is a huge challenge, while at the same time the potential impact on food security for different mitigation scenarios has to be investigated. Some guiding questions for the debate are posed here: What are the variations in the impact of climate change in a continental and regional perspective? What type of impact will the different emission and temperature scenarios have? And what does this mean for adaptation policies at the local level?

Secondly, the study shall look into the political dimension of climate change. Climate change is already visible and measurable. The future impact is dependent on the effectiveness of climate change mitigation and adaptation policies at the international and national level. The specific impact at the local level will, however, depend very much on the political adaptation decisions that are being taken at the national level and the support vulnerable groups receive nationally as well as from the international community. These will determine the quality of adaptation policies.

What do local or national climate change policies look like? What are the financial and regulatory capacities of relevant actors for the design and implementation of adaptation policies? What international conditionalities are influencing national level policy reaction? These are the questions of interest which need to be studied in order to understand what impacts climate change will have on hungry and marginalized people.

Policy decisions at the national and international level and the quality of government response will be key for the capacity of people to cope with the adverse effects of climate change. They will define, to a large extent, the severity of its consequences.

The study shall therefore look into the politics of adaptation and help to analyze which policy decisions are needed and how national and international policies should be designed in order to adequately respond to the challenges ahead. The analysis of policies done in the study is guided by an understanding of governments‘ roles which is derived from the right to food framework. More than 30 years ago most countries in the world had ratified the International Covenant for Economic, Social

and Cultural Rights (ICESCR) and thus committed in a legally binding manner to protect basic rights, in particular the right to food.

The overview of research results shall be the basis for conclusions on the question: How to effectively strengthen the adaptive capacities of the vulnerable groups and how to minimize the expected damage of climate change on food security? The results shall guide on the one hand the future advocacy and project work of BfdW and its partners. On the other hand, it shall provide those involved in the climate change and food security debate to build on these results.

This study was conducted by Germanwatch in cooperation with Bread for the World and research partners in Africa[1] and Asia[2]. The final product consists out of following elements:

(1) Cover study

The cover study will start (I) with an overview of the current status of climate change research and food insecurity. It is based on currently available literature, in particular the Fourth Assessment Report (FAR) of the Intergovernmental Panel on Climate Change (IPCC), which was released throughout 2007. The International Panel on Climate Change is the most authorative research body on climate issues. It brings together the peer-reviewed, relevant research results and models the potential impact of climate change in different scenarios. The third assessment report (TAR) was presented in 2001 and the fourth one (FAR) was published between February 2007 and August 2007 (IPCC 2001 and IPCC 2007a-d).

The study describes the major trends that climate change will have on food security by using all levels of food security. It gives also an overview of the latest research on hunger trends, including an analysis of those groups most affected by hunger and malnutrition. It further discusses what the potential impacts of climate change are on these groups.

This first part is followed by a second part (II) looking into the response capacity in developing countries and at the international level.

Part III of the study summarizes the key aspects of three regional studies that are being written. The assessment of climate change impacts at the regional level is based on the projections of current climate models for the different regions in the developing world, namely Africa, Asia, and Latin America.

Each of the chapters will first look into the expected effects of climate change in the region and particularly on the most vulnerable groups, followed by a subchapter on the size and quality of adaptation policies needed in order to deal with these problems. It will finally look into the response capacity at the regional/national level. The study will end with a chapter discussing the way forward (Part IV), the conclusions and recommendations.

(2) Regional studies[3]

The three regional studies will look, in more detail, into expected climatic changes and the consequences, particularly for the most vulnerable groups of the society. They shall give an overview of the available literature

1 Stephen O. Anyango (Department of Environmental Science, Kenyatta University, Kenya) and Victor Orindi (International Development Research Centre, Kenya)

2 Ferdausur Rahman, Mizanur Rahman Bijoy, Nusrat Habib (all Network on Climate Change, Bangladesh) and Umme Kulsum (Climate Change Focal Point, Prodipan)

3 The regional studies that have contributed to this study have been prepared with financial support of the German Ministry for Economic Cooperation and Development (BMZ). The content expressed exclusively represents the opinions of the authors and the publishing organisations.

and try to answer the question: Which consequences from climate change have to be expected on food security at a regional or at a country level?

They will not cover the whole region in detail, but give a comprehensive overview accompanied by more in-depth research on specific countries. Still it is difficult to understand the consequences of climate change at the local level in detail. This makes these assessments and conclusions more difficult. Progress and more efforts in regional and national studies are needed in order to better understand the specific needs for adaptation policies. But there is also a need for new policy models to adapt to a future, where weather patterns will be much more uncertain.

Assessing the political response capacity in developing countries is particularly relevant to the impact of climate change on food security which is discussed both in the cover study and in the regional studies. Responding to the impacts of climate change will be a very challenging task for many developing countries, as the country/regional examples will show. This challenge comes on top of existing problems that are due to a variety of different reasons, both internal and external ones. Poverty is widespread in many countries.

Quite a number of countries are involved in substantive internal conflicts or civil wars which are binding most of their capacities. Others are badly governed by non transparent and non accountable elites. Corruption can be a substantive element that hinders effective governance.

External reasons that limit the governmental response capacity are as complex as the high debt burden (limiting the use of available national resources) or international policy conditionalities and international agreements that restrict the capacity of governments to choose the best policy alternatives.

It is therefore very relevant to study how the current status of governance will impact countries‘ ability to adopt adequate adaptation policies. While such an analysis will require very good and detailed country studies in the long run, the present study will look into the matter, because it is often neglected when adaptation policies to climate change are discussed. The three regional studies which are part of this study process shall have a particular focus on the political response capacity of governments in their region and shall highlight these capacity problems in a systematic way.

The political response capacity and willingness to act is of high relevance to judge the impact of climate change on groups and persons facing hunger and malnutrition today, and on other groups threatened to become hungry or malnourished in the future. As we will see below, far too many of those groups facing hunger and malnutrition today are already faced with a non-responsive or not sufficiently responding government. When marginalization in national politics is already at the core of their problems it is very relevant to consider what happens to these groups when their problems might be aggravated through climate change.

The challenge of the study will be to bring these different levels of analysis together: The factual impact of climate change on agriculture and water, the response capacity of political systems to the increasing problems and the particular situation of those already faced with hunger and malnutrition and those most likely to be threatened by hunger. Finally, implications and also potentials of the right to food debate for adaptation to climate change have to be examined.

Part I

Climate change and food insecurity

1 Climate change and food security – the development of the debate

1.1 General observations

The impact of climate change on food security will be huge and substantive. The latest forecast by the IPCC has been presented with a high degree of certainty. After an increase of 0.74°C during the last century, globally averaged surface temperature is projected to rise by between 1.1°C up to 6.4°C by the last decade of the 21st century (IPCC 2007a, 13). This temperature increase will change the timing and amount of precipitation, and the availability of water. It will alter weather trends such as wind patterns, and also the intensity and frequency of weather extremes, such as droughts, heat waves, floods or storms. All key elements of food security are affected by climate changed. Generally, there is little doubt that the higher the temperature increase the more severe the impacts on food security in developing countries will be. The latest research results will be presented below (chapter 3).

There is no doubt: Climate change is already happening. At a civil society meeting in the Food and Agriculture Organization (FAO) at the beginning of 2008, farmers' representatives from different regions of the world reported the many changes they are already recognizing. Science tells the same story.

> *„Observational evidence from all continents and most oceans shows that many natural systems are being affected by regional climate changes, particularly temperature increases" (IPCC 2007b, 2).*

Eleven of the last twelve years (1995-2006) belong to the warmest years since the measurement of global surface temperature. The increase in global average temperature during the last 50 years has been twice as much as in the first half of the 20th century. The increase in temperature differs regionally. It is higher in the temperate climates of the northern and southern hemisphere.

A part of climate change can no longer be avoided: Anthropogenic greenhouse gas emissions accumulate in the atmosphere and have a lifetime of several decades, thus today we feel the consequences of past emissions. This leads to the undeniable fact that even if all anthropogenic emissions were to be stopped immediately, the temperature would continue to increase for some decades, by an estimated 0.6 °C, according to IPCC projections (IPCC 2007d, 7). However, the world is still far away from substantial reductions in greenhouse gas emissions.

Global emissions have increased by more than 25 percent since 1990, with a strong acceleration since the year 2000. The increase has three main reasons: In Eastern Europe emissions have grown again after a decade of strong decline, emissions in rapidly developing countries – first of all China – grow quickly, and high gas prices have caused a strong worldwide shift fom gas to coal. As a consequence, worldwide emissions per GDP unit increased the first time during the last hundred years.

The world now faces the challenge to avoid a level of climate change that leads to large-scale dangerous consequences, as spelled out in Article 2 of the United Nations Framework Convention on Climate Change (UNFCCC), which was signed by 191 countries (including the US) in 1992:

> *„The ultimate objective of this Convention and any related legal instruments that the Conference of the Parties may adopt is to achieve, in accordance with the relevant provisions of the Convention, stabilization of greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system. Such a level should be achieved within a time frame sufficient to allow ecosystems to adapt naturally to climate change, to ensure that food production is not threatened and to enable economic development to proceed in a sustainable manner" (United Nations Framework Convention on Climate Change/UNFCCC 1992, 4).*

Even that early it was recognized that climate change may have a negative impact on food production. Although this recognition is increasingly being underpinned by scientific findings, relatively few studies have looked into the matter of climate change and food security in detail.

The second working group, „Climate Change 2007: Impacts, Adaptation and Vulnerability", of the IPCC's FAR addresses agricultural issues in several chapters, in particular in chapter 3 (Fresh water resources and their management, Kundzewicz et al. 2007), chapter 4 (Ecosystems, their properties, goods and services, Fischlin et al. 2007) and chapter 5 (food fibre and forest products, Easterling et al. 2007). The fact that the Third Assessment Report (TAR) of the IPCC, published in 2001, did not contain a chapter on food and fibre shows the increasing attention that scientists now pay to this problem (IPCC 2001).

1.2 The initial FAO debate: optimism on climate change and food security

The Food and Agriculture Organization (FAO) of the United Nations has also started to intensify its work on the impacts of climate change on food security. The High-Level FAO conference held in June 2008 in Rome was originally intended to focus on the issue of climate change, bio energy and food security, as an expression of this increasing attention. The soaring food crisis made the organisers change the focus.

The main FAO reports on climate change published in the last several years have investigated possible impacts of future climate change on global food security. However, these reports reflected the still unresolved uncertainties of the projections and scenarios available at that time (e.g. FAO 2002, 79). The first major chapter on the issue of agriculture and climate change was included in the 2002 outlook of the FAO: „World agriculture: towards 2015/2030."

The main reason for the fact that predictions and analysis about costs of adapting to future impacts in the area of food production, food security and agriculture vary significantly is that the climate models available so far are still not best equipped to be precise in the forecast for micro or meso changes in the national and regional manifestations of climate change. This has different reasons. It is due to limited availability of analyses and a larger natural climate variability at the regional scale (compared to the global scale). The chaotic nature of many of these processes will always limit the possibility to forecast them.

Last not least, other factors (such as land-use change) are more influential on the local climatic conditions (IPCC 2007b). However, with the recent increase in disaggregation of the climate models and scenarios, and with more research being done on the regional and national outcomes, more reliable impact assessments can be elaborated on now. One consequence thereof is that the available literature on the tools, policies and costs for adaption policies is continuously growing.

While the latest models have become more precise on the regional variation of the effects of climate change, it has to be noted that most potential feedbacks are not yet included. And small scale forecasts have many more uncertainties than large scale forecasts. Also, particularly in developing countries, less and poorer quality data is all that is available. Thus, much caution has to be used making predictions at smaller scales.

> *„Difficulties remain in reliably simulating and attributing observed temperature changes at smaller scales. On these scales, natural climate variability is relatively larger making it harder to distinguish changes expected due to external forcing. Uncertainties in local forcing and feedbacks also make it difficult to estimate the contribution of greenhouse gas increases to observed small-scale temperature changes“ (IPCC 2007a, 9).*

This also means that adaptation strategies have to be developed in a way that they are flexible and can cope with the scientific uncertainty as much as possible (see also chapter 4.1).

When FAO started some years ago to look into the potential impact of climate change on food security the initial conclusions were quite optimistic for the global level. However, they took into account adverse effects for certain countries. The FAO concluded that in the next three decades, climate change is not expected to depress global food availability, but that it may increase the dependence of developing countries on food imports and accentuate food insecurity for vulnerable groups and countries (FAO 2003a, 361f).

In that report, the organization highlighted both areas or regions with potential losses and areas or regions with potential gains. The FAO estimated that an increase in global carbon dioxide concentrations in the atmosphere would cause plant stomata to narrow, so helping to reduce water losses and to improve the water efficiency in agriculture.

Increasing atmospheric concentrations of carbon dioxide were supposed to have a fertilizing effect on many crops because they stimulate photosynthesis. Parallel to this overall potential positive outcome, it was estimated that an increase in surface temperature would create benefits for the agriculture in temperate latitudes.

The FAO projected an increase of areas suitable for cropping, an expansion of the length of the growing period and reduced cost for overwintering livestock. However, an overall comprehensive analysis of the impacts would also have to acknowledge that these gains, combined with predicted increasing yields (fertilizer effect of CO_2), were calculated against losses from adverse impacts, such as the loss or reduced productivity of fertile land caused by flooding (due to sea-level rise or extreme precipitation events), droughts and other relevant factors.

In less well-watered areas, particularly in the tropics, the FAO estimated that the rise in temperature would increase evapotransporation and lower soil moisture levels. Both would lead to processes that render some cultivated areas unsuitable for cropping as well as the increasing aridity of tropical grassland. The reduction of the overall availability of water for irrigation would limit the possibility to extend irrigated areas for agriculture and would therefore constrain a fast increase in future yields. In addition to the water scarcity on arid lands, salinisation processes also adversely impact soil productivity. Most of the high-yielding varieties used in agriculture today require irrigation and optimal inputs in form of fertilizer and pesticides in order deliver the high yields.

Another important reason for the optimistic conclusion was that the analysis of the impact of climate change on food security was still basically oriented towards the global equation of food produced versus the world‘s population, i.e. „food security“ as global food security.

1.3 From optimism to acknowledging climate change risks

Today three processes are nurturing a change in this relative optimism:

(1) First, the potential losses are becoming clearer, while the potential gains are being judged much more skeptically. The predictions presented above are only five years old but knowledge has increased fast. The evolution of our understanding will be summarized below in chapter 2 and for the regional level in the chapters 7 to 9. In general the latest trend can be summarized thus:

■ Impacts will be more severe and adaptation costs will be higher than expected some years ago, while the potential gains in a warmer world are smaller, particularly the gains for agriculture in temperate climates.

■ The fertilizer effect of CO_2 has been overestimated and parallel climate stress on crops is limiting its effects.

■ And the effects of an increasing number and intensity of weather disasters is becoming clearer.

(2) Second, the analysis is moving ahead and puts more emphasis on the assessment of the impact of climate change on particularly vulnerable groups, including the interplay of these impacts with factors that determine the peoples' vulnerability and adaptive capacities.

(3) The third aspect is the recent development in world agricultural markets. The prices for many key agricultural products have gone up to levels unseen in the last three decades, caused by factors such as:

■ the increasing demand for meat and milk products in Asian developing economies such as China and India;

■ the demand for liquid agro fuels for transportation in industrialized countries and in some emerging economies;

■ and the high volatility in harvests at the global level (see chapter 2.4).

The combination of these three factors has led to a situation where production no longer meets demand, and the reserves for major crops have been declining rapidly. The situation is further worsened by the annual loss of productive land.

This new scenario has triggered alarm bells inside the FAO discussions on climate change. As long as a global surplus situation was a regular phenomenon, climate change was seen as one of many factors influencing production. But in a context of increasing problems in keeping pace with demand and with the increasing world population, the assessment of the severity of the impacts has been modified.

The latest studies express increasing concern regarding the negative impact of climate change on food security.

In order to better understand the impacts and associated costs of both damages and adaptation measures on policy-relevant levels, particularly with regard to the most vulnerable groups of society and countries, it is of utmost importance to have a second focus, next to global food security, on the level of household food security. The picture of threats clears when the hungry and malnourished of today and those currently living at the brink of hunger are placed directly in the focus of the analysis.

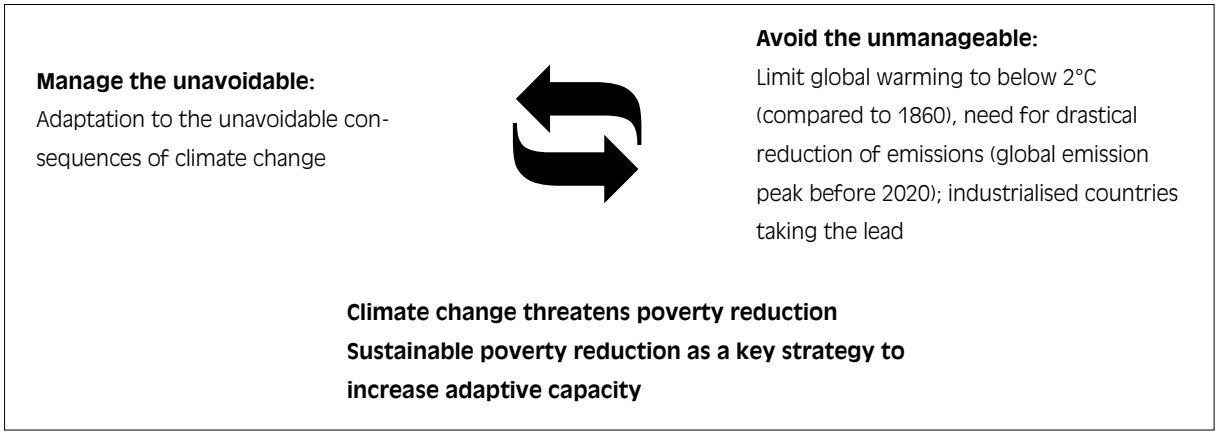
Global food markets will provide those with purchasing power with sufficient agricultural products and food supply. Those who lack an adequate income, those who cannot produce enough from their own resources, those who do not have enough labor capacity in their family or those affected by weather disasters or irregularities will have major problems in buying food. The negative impact of climate change on food production will have an important impact on food prices. The recent fast increase in food price is very likely to trigger an increase in relative factor prices for land, water and other productive assets.

1.4 A two-dimensional response is needed: avoiding dangerous climate change and adapting to the unavoidable

This study project is based on the assumption that a two-dimensional response to the challenge of climate change is needed: to avoid the unmanageable and to manage the unavoidable.

Without increased efforts to limit global warming, adaptation to its adverse impacts is likely to become impossible for millions of people around the world. At the same time the unavoidable consequences of climate change require the urgent development of effective adaptation

Figure 1: A double response to climate change



Source: Germanwatch illustration

strategies. Climate change threatens progress in poverty reduction in developing countries, but at the same time sustainable poverty reduction strategies generally have to be seen as a key element of policies to reduce the vulnerability of the poor and to increase their adaptive capacity.

1.4.1 Avoiding dangerous climate change: limit global warming to below 2°C

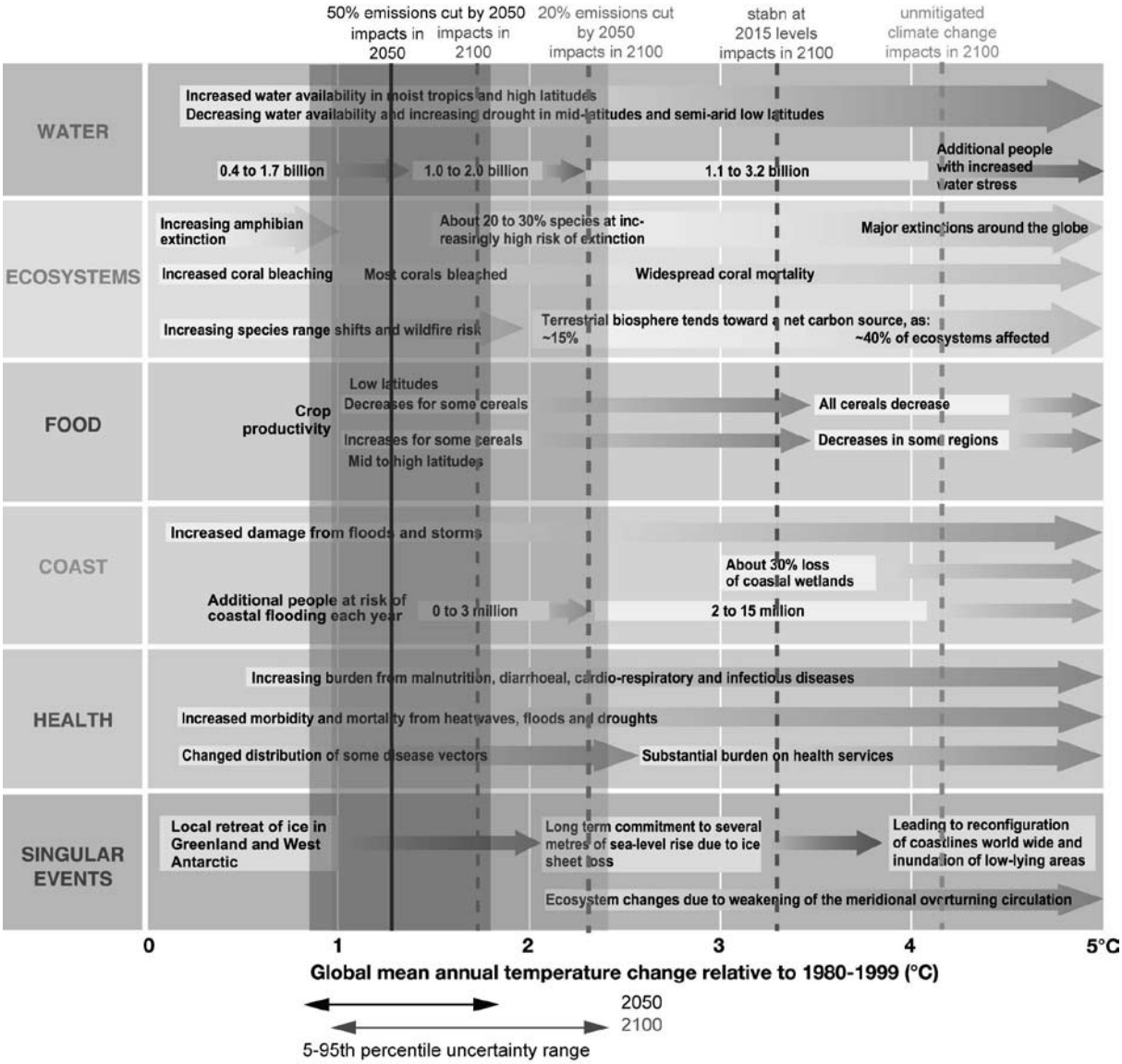
There is now little doubt that the higher the global temperature increases the more severe will be the consequences particularly in developing countries. The level of global warming depends on how much the world will be able to curb its greenhouse gas emissions in the next decades. Many of the investment decisions which are relevant for decades to come (e.g. coal power plants, airplanes) will be made in the next 15 years.

Figure 2 shows the projected sectoral impacts according to different levels of temperature increase (above 1980-1999 levels), and subsequently certain levels of greenhouse gas emissions.

These projections are based on the modeling of future development – one important pillar of climate change research. Such models have – especially on regional scale – major uncertainties. Most of the regular models look for linear trends that climate change might cause, such as the increase in temperature and its impact on water availability. Such linear scenarios help to calculate the size of change and to design adaptation measures. But quite a number of atmospheric or related processes are non linear. There, development can reach threshold levels where the whole development of the studied system might dramatically change directions or speed up. Climate researchers are increasingly investigating these so-called tipping elements, which are in most cases temperature thresholds where non-linear systems might be triggered, including several feedback loops.

When such a threshold – the tipping point – is reached, the system element might change in a relatively short time span; in other cases, it changes slowly but irreversibly. We have to expect tipping points at all levels, but usually this expression is only used if the scale of the affected tipping element is at least sub-continental (Lenton et al. 2008). Many of the discussed tipping points could be reached during this century. These tipping elements have the potential to lead to unprecedented threats to humankind. During the last three years there has been major scientific progress in understanding them. Knowledge has dramatically increased, but there is still a lot of uncertainty in defining the exact threshold for

Figure 2: Selected global impacts from warming associated with various reductions in global greenhouse gas emissions



Vertical lines indicate likely impacts of the median warming expected to result from indicated emissions scenarios (percentage cuts are from 1990 levels); shaded columns show 5 to 95% uncertainty ranges for impacts of a 50 percent cut.

Source: Parry et al. 2008, 1

these dramatic developments. (The risks associated with tipping elements in the climate system will be explained in much more detail in chapter 3.)

Thus, limiting global warming to a degree which keeps the likelihood that tipping points are passed as low as possible is one crucial criterion to avoiding dangerous climate change. More and more climate researchers agree that based on this risk analysis global warming should be limited to well below 2°C above pre-industrial levels, or about 1.3°C above present levels. This is indicated by the black line in Figure 2.

In November 2006, the former chief economist of the World Bank, Nicholas Stern, released his report „The economics of climate change". This „Stern Report" highlights that tackling global warming will become economically much cheaper than dealing with the damages of a non-mitigation future (Stern 2006). This conclusion has been underlined by the findings of the IPCC (IPCC 2007c).

The IPCC suggests that in a scenario where global greenhouse gas emissions (GHG) would be reduced by 50 to 85 percent until 2050 (compared to 2000), the temperature increase could be limited to 2.0 to 2.4°C above pre-industrial levels, at an atmospheric concentration level of 445 to 490 ppm CO_2 equivalent. Global GHG emissions would have to peak and then decline by no later than 2015 (IPCC 2007c, 22). However, the actual development in global emissions is the opposite: They have increased 24 percent since 1990 (IPCC 2007c, 2), with rapidly increasing growth rates in the past years compared to the 1990s. However, assessments undertaken by Stern show that even this scenario would leave a 78 percent probability that global temperature increase would exceed the threshold of 2°C (Table 1).

A recent paper released by a group of scientists associated with James Hansen from the NASA advocates for a stabilization target of 350 ppm CO_2 equivalent. The result of the study is based on a more detailed analysis of feedback effects in the earth system that are not sufficiently addressed in the IPCC scenarios (Hansen et al. 2008). This is significantly below present levels and would need more drastic emission reductions plus increased efforts to take CO_2 out of the atmosphere (e.g. by reforestation and changed agricultural techniques).

Achieving such targets will be quite challenging, because „climate change mitigation is about transforming the way that we produce and use energy" (UNDP 2007, 20). In addition, trends like tropical deforestation have to be reversed.

The UN climate change negotiations are currently in the process of discussing long-term global emission reduction targets as a starting point for sustainable emission

Table 1: Likelihood of various CO_2 equivalent concentrations exceeding various increases in global mean surface temperature in percent

Stabilization level (in ppm CO_2 eq)	2°C	3°C	4°C	5°C	6°C	7°C
450	78	18	3	1	0	0
500	96	44	11	3	1	0
550	99	69	24	7	2	1
650	100	94	58	24	9	4
750	100	99	82	47	22	9

Source: Stern 2008

pathways, but also a new round of national reduction targets for industrialized countries for the period from 2013 to 2020.

The first commitment period of the Kyoto Protocol which was agreed in 1997 and which finally came into force in 2005, has already set such targets for industrialized countries, however at a scale far from being sufficient to prevent dangerous climate change. These targets are thought to result in a reduction of the industrialized countries emissions of 5.2 percent by 2012 (compared to 1990). But the USA, which had signed the Protocol under the Clinton administration, refused to ratify it. Only Europe has managed to significantly reduce its emissions during the last 18 years. However, much of these reductions were due to de-industrialization in East and Central Europe. The downward trend has been primarily caused by emissions savings in Germany and the United Kingdom, due to different climate and energy policy measures (EEA 2008, 14).

The Kyoto Protocol has been an important first step, but is far from changing the emission pathways on the necessary scale. In 1994 the UN Framework Convention on Climate Change (UNFCCC), upon which the Kyoto Protocol is based, had already come into force (UNFCCC 1992). It introduced the principle of common but differentiated responsibilities and respective capabilities of industrialized and developing countries. This means that industrialized countries, which have historically contributed the most GHG emissions and have the most resources, must take the lead in international climate policy (IPCC 2007b).

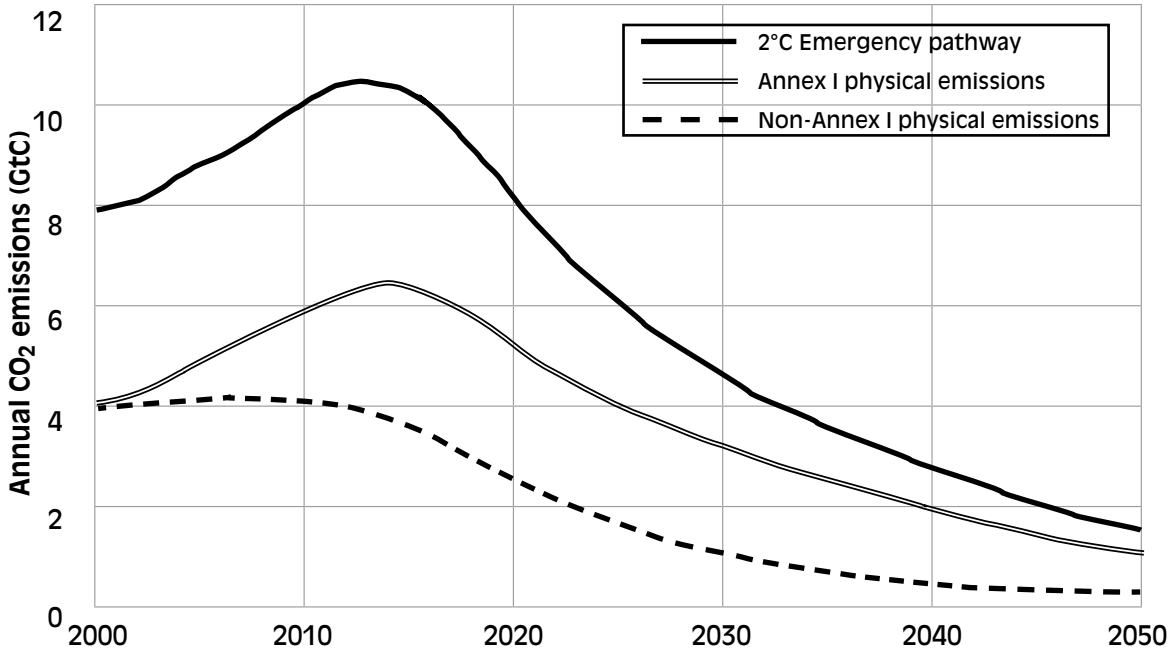
Emissions are still on the rise in most developed countries and emerging economies are increasingly playing a role as additional causers of climate change. China has now become the biggest emitting country and was responsible for two thirds of the emissions growth in 2006 (MNP 2008). For the climate, this is an alarming trend. The same is – on a lower level – true for India. However, from an equity perspective it is important to note that developing countries in general still have a much lower output of emissions on a per capita basis. They claim their right to development and are not yet willing to accept ceilings for emissions based on an historic date – such as 1990 – because they fear that this might hinder their further economic development. China now is one of the few examples of developing countries where average per capita emissions have reached a level which is higher than the global average (MNP 2008).

The different per capita emissions are one key reason why developed countries are expected to reduce their emissions much more drastically and rapidly than any of the developing countries, by at least 25 to 40 percent by 2020 and at least 80 percent to 95 percent by 2050 (both compared to 1990 levels) (Gupta et al. 2007). Some projections even see steeper reduction efforts as necessary, given the uncertainties entailed in the climate system. Figure 3 shows the implications of a global reduction of 80 percent by 2050 (compared to 1990), developed countries' (Annex I) reduction efforts of 90 percent, and the implications for emissions in developing countries (non-Annex I).

This analysis reveals on the one hand that even if developed countries were to reduce their emissions to zero, it would not be sufficient to avoid dangerous climate change if present emissions trends continue in the developing world. On the other hand, it also shows that the less the developed countries reduce, the higher the reduction requirement for developing countries would be if the 2°C limit were to be taken seriously. At the same time, population growth is expected to continue until the middle of the century.

The challenge now is to reconcile global emission reduction efforts with the legitimate developmental aspirations of developing countries. Achieving this is not a question of lacking technologies or scarce resources, but primarily of the political will to cooperate and to tackle one of the greatest challenges ever faced by mankind. Some of the most important instruments to reduce GHG emissions and to realize a low-carbon economy are carbon markets, carbon taxes, new and additional technology deployment instruments to the support of large scale energy efficiency, and renewable energy. Carbon capture and geological storage technologies (CCS) may also play a role, if they prove functioning.

Figure 3: Global emissions scenario with peak CO_2 emissions in 2015, falling to 80 percent below 1990 levels in 2050. Annex 1 emissions decline to 90 percent below 1990 levels in 2050



Source: based on Baer et al. 2008, 3

A combination of many instruments and technologies will be needed to limit global warming to well below 2°C, and simultaneously to satisfy the increasing energy demands of rapidly developing countries with growing populations.

Agriculture itself is a significant source of greenhouse gas emissions. The GHG emissions from agriculture contributed more than 13 percent of total anthropogenic greenhouse gas emissions in 2004 (Barker et al. 2007, 5). Emissions from fossil energy use in the agricultural sector are not included here, since IPCC accounts them with the building or transport sector, but they are estimated to be rather low compared to the CH_4 and N_2O emissions (Smith et al. 2007). Taken together with the forestry sector, where a large share of the emissions is caused by deforestation for agricultural purposes, this figure is estimated to be over 30 percent (Barker et al. 2008, 5).

The livestock sector accounts for more than half of the GHG emissions coming from agriculture. This amount is equivalent to more than two-thirds of the total emissions attributable to deforestation and to more than one-third of total agricultural release of methane (CH_4) and nitrous oxide (N_2O) (FAO 2007b, 10). There is a huge potential for reducing emissions of greenhouse gases through changes in production patterns in agriculture and also in forestry, where emissions often happen for agricultural purposes.

1.4.2 Scenarios of different climate futures

Our response to climate change will be decisive for our planet's future. Taking into account the growing public perception of climate change as a matter of increasing urgency, more and more heads of governments express the willingness to act – but so far it is not clear how far this moves beyond rhetoric.

Figure 4: Four scenarios of the global climate future

Our Climate Future

- **Scenario A:**
  Large-scale Experiment with Mankind and Nature
  Unmitigated climate change
- **Scenario B:**
  Climate Apartheid (with Elements of a Climate Dictatorship)
  Major concern of the industrialising and developing countries: serious climate protection limiting growth in developing countries
- **Scenario C:**
  Global Climate Partnership
  Combination of binding UN process, bi-/trilateral agreements, technological innovations, self-financing process (auctioning emission trading etc.)
- **Scenario D:**
  Planet Earth on the Heart-Lung machine (geo-engineering)
  Self-regulating mechanisms of the earth collapse. Large-scale technical measures of permanent adjustments; significant sideeffects and potential for misuse.

Source: Germanwatch illustration

In order to facilitate the assessment of different futures that would develop from different global climate policy approaches, Germanwatch developed a set of four scenarios (Figure 4). They provide a simple and intuitive overview of the variety of possible futures. The scenarios mainly differ in three aspects: First, in the magnitude of emission reductions envisaged, second in the degree of equity that is reflected in the implied application of opportunities and risks related to climate protection, adaptation and possible catastrophes, and finally in the legitimacy of the applied measures and the participation of most most-affected countries.

The first scenario (A) expects the continuation of the current trend. Global emission trends show that unmitigated climate change will result in a large-scale uncontrolled experiment with mankind and nature. While some political speeches at climate negotiations such as in Bali in December 2007 may create the impression that the problem of climate change might be solved soon, the development of global emissions however tells so far a different story. The current emissions pathway is therefore at the upper end of the most energy intense IPCC scenario, which could easily lead to temperature increases beyond 5°C, i.e. most severe of the projected adverse impacts (Rahmstorf et al. 2007).

Scenario B, the so-called „climate apartheid“ scenario, can help explain why most developing countries remain unwilling to accept their own reduction commitments in the climate negotiations. The US has bound its own progress in emission reduction to comparable reduction efforts in rapidly developing country economies. These countries fear that industrialized countries will not take the lead in immediately reducing emissions but instead intend to deny the right of developing countries to end poverty and to develop through economic growth. Why should they consider commitments as long as the United States, whose per capita emissions are five times as high as in China and twenty times as high as in India, are not willing to reduce drastically? Since the Industrial Revolution, European and American progress has been built on fossil energy sources such as coal, oil, and gas.

> *„And just when we – the Chinese and the Indians – are about to develop they say: You*

cannot do that anymore," Armatya Sen points out, Indian Nobel Prize winner for economics (Germanwatch 2007).

Although they promised in Kyoto in 1997, to take the lead in this regard, the developed world has as yet failed to show how a wealth model that combines prosperity and development with the continuously decreasing burning of fossil fuels.

Scenario C must be seen as the desirable result of international climate negotiations and complimentary bilateral actions, leading to a global partnership of climate protection and energy security. This must be based on a substantial commitment by industrialized countries to take stronger domestic mitigation action (mainly energy efficiency and renewable energies) and to support mitigation and adaptation in developing countries. In addition complementary and fair contributions in the emerging economies following the principle of common but differentiated responsibilities and respective capabilities are needed. Furthermore, the inclusion of missing sectors like international aviation and maritime transport and a regime to curb emissions from deforestation needs to be agreed upon. Additional bilateral agreements with key actors, e.g. between the EU and China and India will also have to play an important role.

Scenario D is based on countries' and expert views that look to geo-engineering solutions for the rapidly growing global emissions. Often, they do not trust or believe in the slow political processes of climate negotiations. Proposals are made to use technical means of geo-engineering to take control of the Earth's self-regulating systems, such as depositing iron in the oceans, spreading reflective material in the atmosphere, or using other reflection systems. The latest IPCC report is very skeptical about such promises:

„Geo-engineering options, such as ocean fertilization to remove CO_2 directly from the atmosphere, or blocking sunlight by bringing material into the upper atmosphere, remain largely speculative and unproven, and with the risk of unknown side-effects. Reliable cost estimates for these options have not been published" (IPCC 2007c, 20).

These technological promises go hand in hand with the hope that technical solutions might be available soon and are less expensive than mitigation. Therefore, politicians might begin to rely on them as an alternative to reducing emissions. Next to the risk of unknown side effects, geo-engineering solutions also carry the risk of military misuse.

These four scenarios show the current variety of possible positions in international climate diplomacy. It becomes obvious that a meaningful path to emission reductions is only available with an international framework as the key pillar, where different actors contribute based on their responsibilities and capabilities. The task of negotiating such an agreement among almost 200 governments with the goal of limiting temperature increase to well below 2°C is quite ambitious. So, additional negotiations with key emitters and key affected countries can play a complementary role. Judging the effectiveness of domestic and international commitments will require a detailed and comprehensive analysis of the proposed instruments, and their consistency with the 2° limit are the crucial benchmark, as is the case for the recent EU climate policy discussions. Table 2 shows how different choices for domestic mitigation in Annex I countries and mitigation achieved through offsetting emissions through carbon credits from developing countries might impact on global temperature increase. Only strong domestic action in developed countries plus support for mitigation in developing countries allows a pathway to stay below 2°C above pre-industrial levels.

1.5 Adaptation to the unavoidable consequences

Along with the effort to limit increasing emissions, the second pillar of climate change policy is adaptation to changing climatic conditions. Adaptation measures were not at the centre of climate negotiations in the first few years. They were often seen as a road to distract attention from the most difficult and politically controversial

Table 2: EU emission reduction proposals and its implications for global temperature increase

CO_2-eq concentration (ppm)	Global mean temperature increase above pre-industrial levels	Annex I reduction by 2020	Non-Annex I 2020	EU post 2012 package proposals extrapolated to other Annex I countries
445-490	2.0-2.4	-25 to -40%	Substantial deviation from baseline in Latin America, Middle East, East Asia and centrally-planned Asia	-30% domestic + 850 Mt CO_2-eq support for GHG emissions limitation in non Annex I
490-535	2.4-2.8	n.a.	n.a.	-30% + off-setting (meaning 22% domestic and around 450 Mt off-setting in non-Annex I per annum)
535-590	2.8-3.2	-10% to 30%	Deviation from baseline in Latin America, Middle East, East Asia	-20% + off-setting (meaning 17% domestic and around 200 Mt off-setting in non-Annex I per annum)
590-710	3.2-4.0	0 to -25%	Baseline	-20% + more flexibility than European Commission proposal (meaning less than 15% domestic)

Source: CAN 2008, based on Smith et al. 2007, Annex I: developed countries (according to the Annex I to the UNFCCC), Non-Annex I: developing countries, Mt: Million tonnes (Megatonnes)

task of reducing emissions, particularly in countries that have contributed most to climate change. Since then, it has become clear that the additional benefits of adaptation to climate change will be huge and that early action is cheaper than a post-disaster response, even though there are still many uncertainties in the existing adaptation cost estimates (see Table 3). A more detailed analysis of the economics of adaptation is provided in chapter 6.

Adaptation requires substantive investment in infrastructure such as dams, flood-resistant storage facilities, and techniques for reducing water loss in distribution systems etc. It requires monitoring weather extremes and developing disaster preparation and early warning strategies. Last but not least, capacity building in communities particularly at risk, in national, regional and local administrations etc, is of utmost importance and will require resources. Empowerment of local communities is often more effective than huge technical solutions.

Adaptation to the adverse impacts of climate change has long been neglected as a development issue, both by governmental and nongovernmental organisations, despite the fact that the developing countries in 2001

Table 3: Additional costs of adaptation in developing countries

Source	Annual cost estimate
Oxfam 2007	At least 50 billion USD
UNDP 2007	86 billion USD by 2015
UNFCCC 2007a	28-67 billion USD by 2030

– and even much earlier – were already identified as being the most affected by climate change:

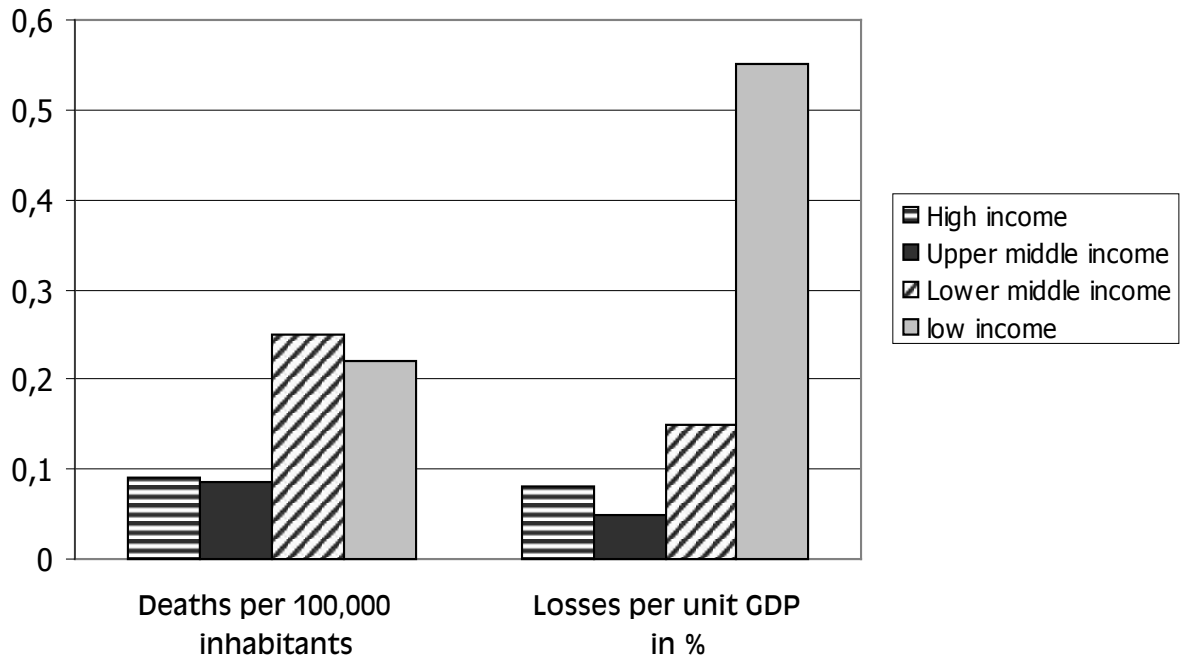
> *„The impacts of climate change will fall disproportionately upon developing countries and the poor persons within all countries, and thereby exacerbate inequities in health status and access to adequate food, clean water, and other resources. Populations in developing countries are generally exposed to relatively high risks of adverse impacts from climate change. In addition, poverty and other factors create conditions of low adaptive capacity in most developing countries" (IPCC 2001, 12).*

Changes in weather patterns are already happening and are affecting countries worldwide. Figure 5 below shows an analysis of relative impacts of extreme weather events on countries grouped to their development status. Although the absolute damage costs of weather extremes are usually higher in developed countries, the picture changes significantly if relative impacts are taken into account. This is only one indicator among several which imply the particular affectedness of developing countries.

Developing countries are particularly affected due to their geographic location and because the sectors which are among the most sensitive sectors to climate change like agriculture, forestry and fisheries, play a particularly important role in their economies. Nevertheless, effects of climate change vary from country to country and must be assessed nationally or regionally.

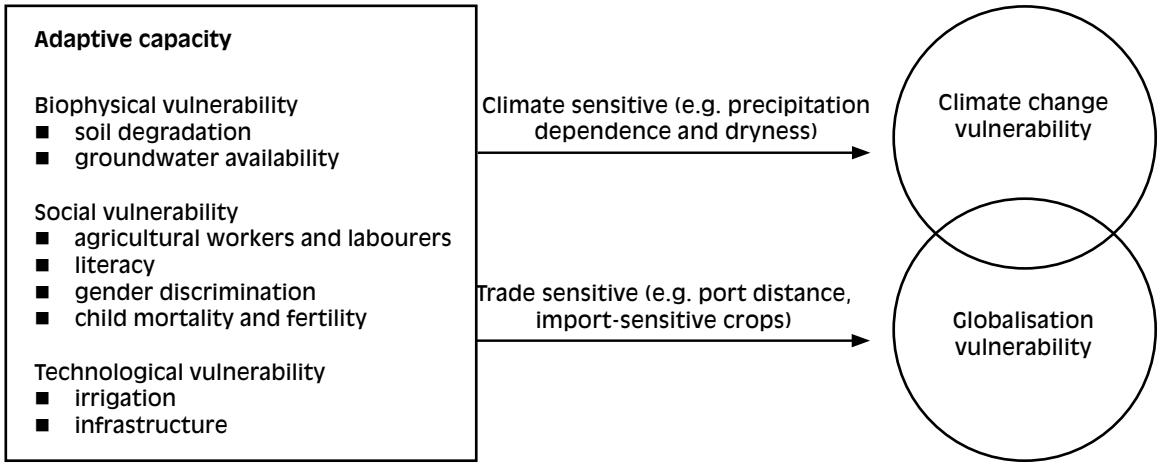
The definition of vulnerability used by the IPCC is focusing on the vulnerability of systems.

Figure 5: Relative impacts of extreme weather events in 2006 according to World Bank country groupings



Source: Harmeling 2007, 17

Figure 6: Elements of vulnerability profiles



Source: based on TERI 2003

> *„Vulnerability is the degree to which a system is susceptible to, or unable to cope with, adverse effects of climate change, including climate variability and extremes. Vulnerability is a function of the character, magnitude, and rate of climate change and variation to which a system is exposed, the sensitivity and adaptive capacity of that system" (Parry et al. 2007, 6).*

The term system is used in relation to ecosystems, but can also refer to production or societal systems. The overall vulnerability of agricultural production systems to external stressors, including climate change risks and their adaptive capacities, depend on different specific vulnerabilities (see Figure 6).

Particularly in the food sector, the interdependence of these vulnerabilities has to be taken into account. E.g. globalization impacts may also help increasing the capacities to adapt to climate change. Climate change is now increasingly an additional factor which might prevent vulnerable people from securing their rights to livelihoods, food security, access to clean water, human security etc. and thus negatively impact on their adaptive capacities.

In this sense and that is the focus of this study, vulnerability and adaptation to climate change entail a human rights dimension. Climate change is a process that will impact human beings and their livelihoods. They might lose water, food-producing resources or access to these sources.

They might also lose access to or be hindered to achieve an income which secures their right to food or health. Thus, they will have to play an important role in response strategies that governments design to react to the challenges arising from climate change (see chapter 2).

The design and proper implementation of adaptation measures will become an area of work central to coping with potential impacts of climate change. Numerous concrete adaptation options exist on different levels, including the agricultural sector (chapter 4 to 6). Some options are of a more technological nature while others require more specific policy approaches.

Adaptation will require assessment and monitoring work, research, and an adequate policy response. In most cases, the design must address the need for close

integration with general development work in order to avoid stand-alone processes and to deliver adaptive development.

The FAO has developed a useful systematization of adaptation measures with respect to food security. In their contribution to the Bali Climate Conference in December 2007, the FAO differentiated five different areas of adaptation policies in the context of food security (FAO 2007b, 4ff):

1. Adaptation policies: Adaptation measures will first cover a broad range of actions, from policies oriented to manage risks posed by climate change to policies protecting people's lives and livelihoods.

2. Response to local circumstances: Second, they cover the response to local environmental circumstances and needs, based on different livelihood circumstances. It will be important that development strategies rely not only on national, but also on community-level responses to the risk exposure of different ecosystems.

3. Secure food supplies: A third set of measures will be oriented to secure food supplies by helping avoid disruptions or declines in global, national, or local food supplies.

4. Adjust consumption to health needs: At the fourth level, measures will adjust consumption and orient it to protect health.

5. Meet growing demands: Finally, adaptation policies need to give answers as to how the growing demand for energy can be met (in a climate-friendly way) as a prerequisite for growth and development.

The results from the Bali climate summit (2007) help to put adaptation work and policies on equal footing with the negotiations related to mitigation. The Bali Action Plan was adopted to establish a roadmap for the negotiations on a new international climate treaty, which is supposed to enter into force in succession to the first commitment period of the Kyoto Protocol in 2012 (UNFCCC 2007b, Decision 1/CP.13). Adaptation work became the second building block of international climate negotiations for a post-2012 agreement in Bali. The two enabling building blocks (technology and finance) address adaptation as well as mitigation.

Because many countries will have to cope with severe impacts of climate change in the future, developing countries demanded that industrialized countries offer massive support for adaptation measures in the most affected states and regions, while simultaneously increasing their mitigation efforts to limit global warming. According to the Bali Action Plan, those countries identified as particularly vulnerable are the Least Developed Countries, Small Island Developing States, and countries in Africa affected by drought, desertification and floods (UNFCCC 2007b, 2). Under the current funding mechanisms, less than 1 percent of the estimated necessary adaptation costs have been delivered:

- Investments through integration of adaptation in Official Development Assistance: approx. USD 100 million for five years (UNFCCC 2007a);

- Funds under the Convention: approx. USD 73 million (pledged: 90 million) for the Special Climate Change Fund (SCCF) and USD 92 million for the Least Developed Countries Fund (LDCF) (pledged: 172 million) (Global Environment Facility GEF 2008);

- Global Environment Facility (GEF) Strategic Priority for Adaptation: USD 50 million (UNDP 2007).

After extensive debate in Bali and previous negotiations the conference decided about the governance structure of the Adaptation Fund (AF), which is supposed to become a key funding instrument for action on adaptation. For the credibility of this instrument, it will be important that the needs of particularly vulnerable groups and countries around the world will be adequately reflected.

Further negotiations on the Bali Action Plan will have to consider the need for international assistance to the most vulnerable countries in their adaptation efforts through „innovative means of funding“ (UNFCCC

2007b). Questions concerning access to „adequate, predictable and sustainable financial resources“ as well as the exploration of new and additional resources will be debated until the end of 2009 when the adoption of a new international climate treaty is being envisaged at the UN climate conference in Copenhagen.[4] There is little doubt that significantly increased adaptation funding will play a key role in these negotiations. The Bonn negotiation session in June 2008 was the first incident that Parties are beginning to take these questions more seriously (Harmeling 2008). A number of interesting funding proposals were put on the table.

Substantial additional financial resources are needed to cope with the expected adaptation needs for developing countries. However, more money does not necessarily mean that more funds are reaching the most vulnerable groups. This is one reason why the UNFCCC negotiations must discuss which frameworks can incentivize adaptation, but also which frameworks measure progress, review activities, and generate resources.

Those groups which are already marginalized rarely receive adequate attention in national or regional policies. More attention and policy innovation must be devoted to these groups in order to ensure that marginalization is not reiterated or passed on in adaptation policies. Rights-based policy approaches offer good opportunities to make policies more poverty-oriented. National policies also need to set up the right incentive structure for community-based adaptation (CBA).

The Adaptation Fund under the Kyoto Protocol

The Adaptation Fund has many innovative features. For example, resources for the AF are being mobilized through a levy on emission reductions generated and traded under the Clean Development Mechanism (CDM). The CDM is the first international environmental levy imposed on the trading of emission reductions achieved in developing countries. The fund is other than some voluntary funds under the UN-Framework Convention the first concrete step to construct a reliable international finance structure needed to deal adequately with the consequences of climate change. Depending on how the CDM market will develop, it is estimated that the resources generated will amount to some 150 to 900 million USD by 2012, and probably much more after 2012, depending on developed countries mitigation targets and the future of the CDM (UNDP 2007). In 2008, the Adaptation Fund Board, the newly appointed governing body, will have to agree on funding modalities including prioritization for the most vulnerable countries.

1.6 Climate change and development

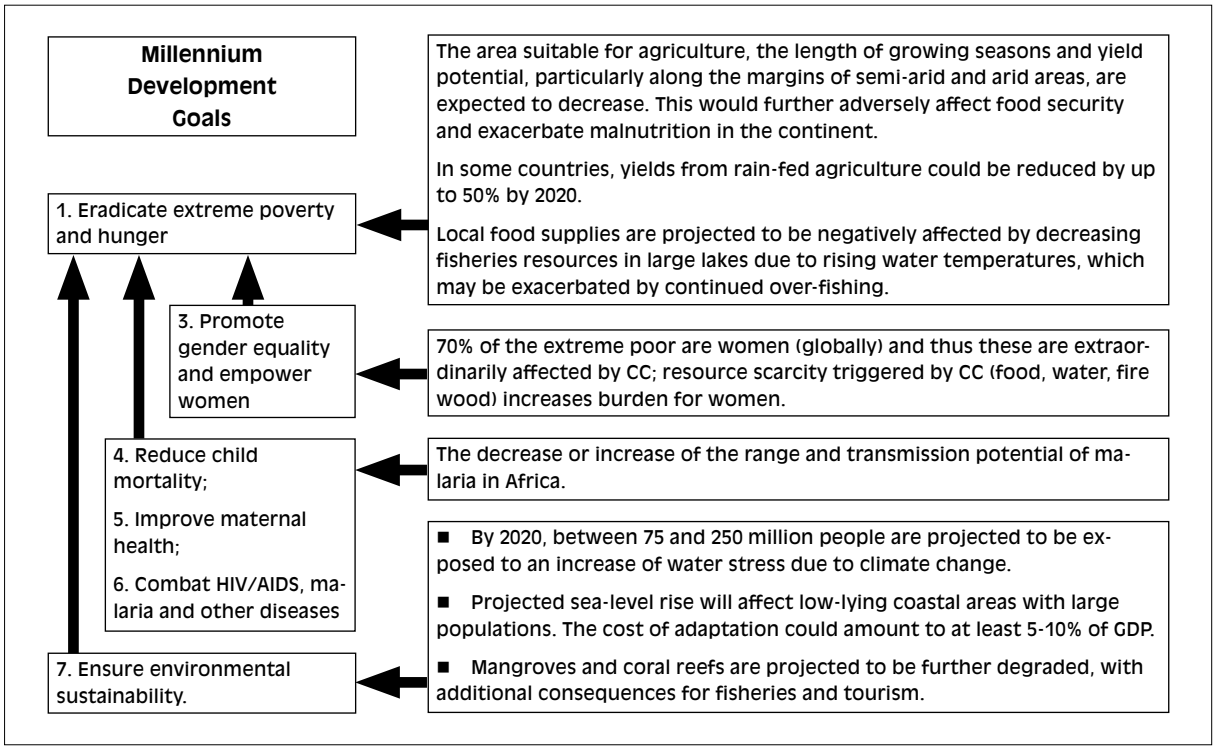
Climate change will have a substantial impact on the pace of development progress in many regions. Developing countries will need economic human development to overcome current shortages of basic goods and services. The Human Development Report 2007/2008 of the Development Program of the United Nations (UNDP), which analyses the connection between climate change and human development, comes to an alarming result:

> *„In the long run climate change is a massive threat to human development and in some places it is already undermining the international community‘s efforts to reduce extreme poverty“ (UNDP 2007, v).*

The report highlights the fact that the world is a heterogeneous place, where people have unequal incomes and wealth, and that climate change will affect regions very differently. Therefore, adaptation to climate change will be relatively easy in regions with lesser effects and sufficient resources, whereas poorer regions, with higher risks and vulnerability, will be disastrously affected. Existing income gaps might be increased and deepened.

[4] For a discussion of the process leading to the Copenhagen climate summit (December 2009) and potential outcomes end of 2009 see Bals 2008.

Figure 7: Climate change impacts and the Millennium Development Goals in Africa



Source: Germanwatch illustration based on IPCC 2007b

Africa's variable climate is already contributing significantly to its development problems (Hellmuth et al. 2007, 8). Key factors for the development of agriculture, a very important sector in African economies, such as water, energy, transportation and health, are all particularly sensitive to climate variability and the increase of weather-related disasters. Other sectors of the economy, like industry and tourism, are also put at high risk by climate change and water shortages. Vulnerability of economies to climate shocks is unequally distributed, and the risk increases dramatically as poverty increases.

> *„Some 262 million people were affected by climate disasters annually from 2000 to 2004, over 98 percent of them in the developing world" (UNDP 2007, 16).*

It will be poorer people who will suffer most. They will be confronted with substantive changes in their livelihoods and many will be at the fringe of their coping capacities. They will have severe difficulties to dealing with weather extremes and other shocks. Poverty-stricken people who never contributed to climate change are most at risk to be heavily affected by climate change. Their right to development will be seriously threatened. The process of human development is increasingly going to be influenced or hindered by climate change. The fight against poverty and the fight against the effects of climate change must be seen as interrelated issues. Figure 7 shows that climate change is expected to substantially impact the realization of most Millennium Development Goals (MDGs) in Africa. In addition, investments in adaptation will require financial resources, which in turn would bind resources needed to invest in poverty reduction. The additional challenge of climate change thus requires additional resources. The Human Development Report (HDR) 2007/2008 summarizes the challenge quite well:

> *„How the world deals with climate change today will have a direct bearing on the human development prospects of a large section of humanity. Failure will consign the poorest 40 percent of the world's population – some 2.6 billion people – to a future of diminished opportunities. It will exacerbate deep inequalities within countries. And it will undermine efforts to build a more including pattern of globalization, reinforcing the vast disparities between the ‚haves´ and the ‚have nots´" (UNDP 2007, 8).*

The recent rounds of climate negotiations after Bali – in March/April 2008 in Bangkok and in June 2008 in Bonn – have shown that the costs of adaptation and present underfunding by the perpetuators of climate change remain a key contentious issue. This is true despite the goodwill of many developing countries to work jointly on developing a new climate regime. Most developing countries have hardly contributed to the emissions which cause climate change, and see domestic emissions reduction as a hindrance to development. They see this as a justice issue. If such development rights are taken seriously, industrialized countries must invest in mitigation and reduce emissions more substantially. They will also have to finance and support deployment mechanisms for mitigation and adaptation technologies and make these technologies widely available.

At the same time, developing countries need to realize that climate change is a development issue, and thus the challenge has to be integrated into development policies and planning (chapter 4.4)

2 Trends and developments in food insecurity and hunger

In order to properly assess the possible impact of climate change on food security, it is helpful to first start with an assessment of the worldwide situation concerning food security and hunger. Such an overview allows the analysis of if and how societies, which are facing hunger and malnutrition today, will be additionally affected by climate change. This overview will also explore the risk of additional groups becoming exposed to food insecurity and hunger as a result of climate change.

2.1 Three levels of food security definition: global, national, and household food security

The term food security has been revised many times since the phrase's inception in the late 1970s. For a long time, many definitions of the term were used in parallel. The most widely accepted and authoritative definition is the one agreed upon during the World Food Summit in 1996:

> *„Food security exists when all people, at all times, have physical and economic access to safe and nutritious food which meets their dietary needs and food preferences for an active and healthy life" (FAO 1996, 1).*

This is both the vision and definition of food security used in the World Food Summit Plan of Action and on which the FAO co-ordinate „Food insecurity and vulnerability information mapping systems (FIVIMS)".[5]

However, food security is largely the definition of a goal, rather than a program with specific policy orientation. The implementation strategies required to achieve food security may need to change over time in order to address new threats or barriers.

The term food security was first developed within the context of UN-specialized agencies dealing with food and nutrition (FAO 1983a). It was developed to discuss long term trends in food availability at the global level. The question of worldwide availability of surplus products and the storage of food reserves was at the core of the discussion. Therefore, global food security is based on the comparison between how much food can be produced globally and the expected demand.

It soon became clear that measures at the national level are essential in order to secure enough food supplies. The Plan of Action of the FAO for World Food Security, which was adopted in 1979, therefore introduced the term „national food security" (FAO 1979). This expression was used to describe ways of achieving a better national distribution of food. Within the framework of national food security, aspects such as grain reserves, import and export quotas, food aid, agricultural techniques to increase production, and irrigation were discussed. These notions of food security were focused on the availability of sufficient food supplies in national markets and on population/food availability ratios. These notions strategically lead to the support for policies focusing on production increases.

But food security deficits can not be overcome by national level increases in food production alone. Deficits in national food production can also be overcome by imports. These imports need to be financed, which could be done through exporting other agricultural products. Hence, the World Bank developed recommendations for trade-based national food security strategies in the 1980s (World Bank 1986). The advice was that developing countries should concentrate agricultural produc-

[5] FAO 1996: The definition is included in paragraph 1 of PoA. FIVIMS is a tool developed in response to the World Food Summit results. A technical consultation on Food Insecurity and Vulnerability Information and Mapping Systems (FIVIMS) was held at the FAO in March 1997. It recommended developing guidelines for the establishment of FIVIMS at the national level. The Guidelines were published in 2000: IAGW-FIVIMS (2000). Guidelines for national FIVIMS. Background and principles, Rome.

tion on those goods for which the highest prices can be achieved on the market. Often these were cash crops and not food crops, because world market prices for most food products from temperate climates were very low during the last decades. This result can be attributed to high agricultural surpluses in the EU and the US as well as the regular use of export subsidies.

Export subsidies amounted to close to 40 percent of the EU-agriculture budget in the 80s and beginning of the 90s. Due to the pressure from the agricultural negotiations at the WTO the EU started to reduce export subsidies. Today they are about 1,44 billion Euro only a fraction of their former size. Current price trends on the word markets are reversed, but there are a variety of reasons for that recent change in price trends (http://www.tagesschau.de/wirtschaft/exportsubventionen2.html).

Even in the early 1980s it was questioned whether production-oriented policies alone would be helpful in alleviating hunger and malnutrition. Amartya Sen's seminal work on „Poverty and Famines" brought considerable change to the debate by highlighting the entitlements of individuals and groups as important elements to understand whether or not they get access to food (Sen 1981).

The debate on food insecurity and hunger has changed gradually since then from an analysis merely looking at overall availability of food to an analysis based on an understanding of individual access (entitlement) to food. At the eighth Ministerial meeting of the World Food Council (WFC) in 1982 a decision was passed with the title „food security for people" (World Food Council 1982). In 1983 the Council of the FAO and the WFC followed up with the recommendation for a new definition of food security including the access of the individual to food (WFC 1983). Since then, the concept of household and later individual food security has been developed, making the term food security increasingly comprehensive (Eide, Oshaug and Eide 1991).

The definition in the middle of the 80s was "access by people at all times to enough food for an active and healthy life", used by FAO and by the World Bank in 1986 (quoted from: Eide et al. 1991).

In academic literature, the determinants of food security are described very similarly to the definition of the right to food. Haddad and Gillespie collect the following determinants in their article: physical access at national level, physical access at local level, economic access, social access, food quality and safety, physiological access, risk of loss of access (Haddad and Gillespie 2001).

The latest standard definition used in the FAO is quite similar:

> *„Food security exists when all people at all times have physical or economic access to sufficient, safe and nutritious food to meet their dietary needs and food preferences for an active and healthy life. To achieve food security, all four of its components must be adequate. These are: availability, stability, accessibility and utilization" (FAO 2007b, 6; the second sentence is additional to the 1996 definition).*

To achieve food security, access to food must be physically available, e.g. food must be available in the region. But in order to guarantee that a family will have access to it, the food must be economically accessible, which is largely determined by family income. The food supply must also be stable, and shortfalls, e.g. in the months before the next harvest, avoided.

Hunger in rural areas, particularly among producers, is often a seasonal phenomenon. Many poorer producers have to buy the seeds and other agricultural inputs before the plant. Therefore, the month before the next harvest is due is often the worst concerning the family food security situation. The leftover food from the last harvest has already been eaten and the familiy's new income will only be secured after the new harvest.

Additionally, food security depends on a variety of underlying determinants: Food must be nutritious and safe. The body must be in a condition to consume food without becoming ill. UNICEF and other nutritionists

emphasize the fact that half of the children dying from hunger are not dying because of missing food supply, but because they cannot ingest due to sickness, e.g. diarrhea (Eide 2000).

To analyze the impact of climate change on food security, it is important to study all three levels of food security:

1. Food security on a global scale: It is important to analyze overall trends on a global scale and to understand which effects climate change might have on agricultural production, fishery production, and livestock production at the global level. This is important because these trends will translate into agricultural prices and will influence decisions of producers worldwide.

2. Food security on a national level: This level of analysis is equally as important, because the national level is where most agricultural policy decisions are made. It will be decided here if food security concerns are covered by imports and how much financial resources are made available for national agricultural policies. Central elements of adaptation policies will be defined at the national level.

3. Food security on a household level: Without a detailed look at the impacts at the household level, the analysis would lack an understanding of the difficulties and specific necessities each person faces in regard to food security. This knowledge is crucial in designing adequate adaptation policies that support those groups, particularly marginal producers and vulnerable consumers, which are most likely to become food insecure. All three levels of the food security definition will be taken into consideration in the following study.

In this context, the most relevant level for explanation of the impact of climate change on food insecurity will be the household level. As long as there is no global food shortage, the income of the household is the key determinant for whether or not a family becomes food insecure. Production and consumption-related aspects are not the only important determinants of food security. The whole food chain, including input factors, production, storage and processing, distribution, exchange, preparation, and consumption, must be analyzed because of its influence on the development of income, prices, and the availability of food.

> *„The food system is a set of dynamic interactions between and within the bio-geophysical and human environments that influences both activities and outcomes all along the food chain" (FAO 2007b, 6).*

Food security can therefore be seen as an outcome of the performance of the food system at the national level and the relevant international framework conditions (Figure 8). Bio-geophysical trends like those discussed in the climate change debate play an important role, but the human response and the political management of these trends are also decisive for the potential affects.

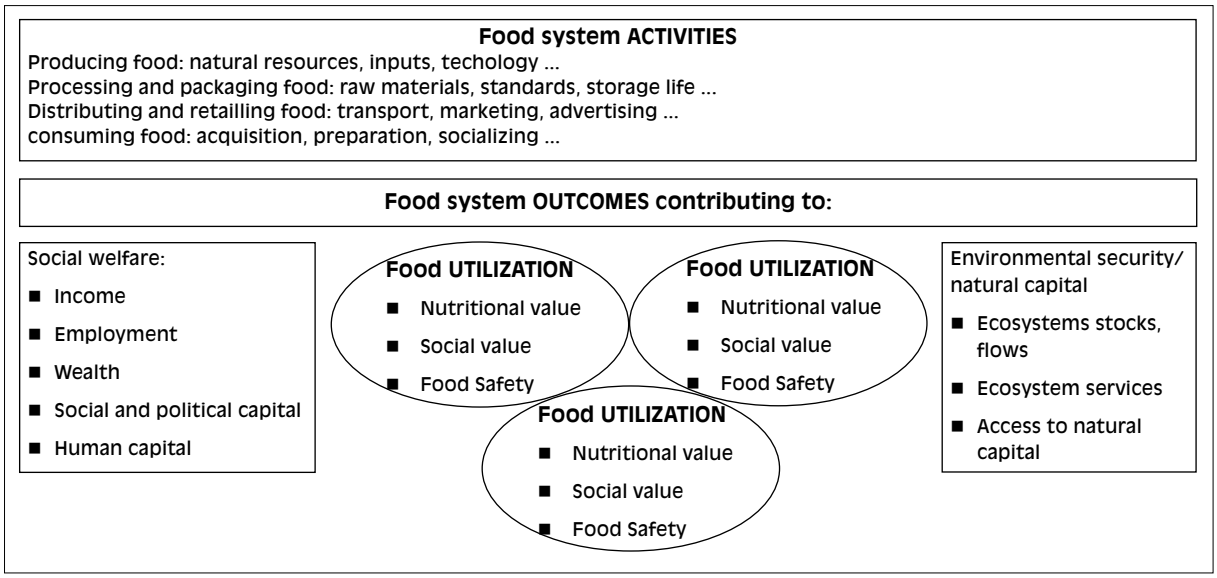
2.2 Who are the hungry today

Around 80 percent of the hungry live in rural areas; half of them are small-holder peasants, another 22 percent are landless laborers, and 8 percent are hunter-gatherers, fishers, and pastoralists. This situation is expected to persist.

While the urban poor are the fastest increasing group of food insecure people, more than 50 percent of the hungry are projected to live in rural areas in 2050 (FAO 2005). The majority of these groups live on extremely marginal conditions. They often live in remote geographical locations, in ecological vulnerable areas, or on slopes or drought prone areas/rainforest etc. They have difficulties accessing means of transport, such as roads, and thus to markets where they can sell their goods. Most have limited or no adequate access to extension services, credits or insurance mechanisms.

Absence of land reform forces poor and marginal farming households to use land highly exposed to catastrophes like floods or droughts. Usually, they are also politically marginalized, without an important voice in local or national politics.

Figure 8: Interaction of determinants for food security



Source: http://www.gecafs.org/glossary/index.html

According to FAO figures, more than 850 million people are facing hunger and malnutrition. 815 million of them are living in economically developing countries – 76 percent of whom live in rural areas (FAO 2006, 69). In this connection, a word of caution on the available data on hunger and malnutrition: All hunger figures are estimations with quite a degree of uncertainty, but the allow to identify trends and know the share of certain vulnerable groups.

All available data and studies show that the number of hungry and malnourished has not decreased in the last decade, even though enough food is produced globally to satisfy the needs of the world's population. Hunger and malnutrition today are not caused by food shortages or scarcity. Hunger is currently an issue of access to food, an adequate income, or productive resources that allow poor people either to produce or to buy enough food. Thus, the inequitable distribution of food, land, and other productive resources, as well as missing income are decisive factors for hunger and malnutrition. It will be discussed later if food surplus is going to be a continuing state, or if the world will increasingly face absolute shortages (chapters 2.4 and 5.1). It will be one of the decisive factors to overcome this marginalization, in order to reduce the number of hungry people worldwide. National and international agricultural policies have often forced marginalized populations to migrate to risk-prone areas. It would be irresponsible and impractical to focus more resources towards combating catastrophes instead of addressing underlying land access problems. A better approach would be to combat the marginalization of affected communities and people – this would also increase the resilience towards natural disasters.

The World Food Summit (WFS) in 1996 committed to halving the number of hungry people by 2015. The persistence of the problem can be observed, when we see that at the World Food Summit in 1974 government representatives declared that in ten more years "no child will have to go to bed hungry". This goal was later integrated into the first Millennium Development Goal (MDG) set by the General Assembly of the United Nations in 2000, although it was modified at that occasion. The MDG Goals demand the reduction of the

Table 4: Typology of hunger

Food-producing households in higher-risk environments and remote areas	roughly 50% of the hungry
Non-farm rural households	22% of the hungry
Poor urban households	20% of the hungry
Herders, fishers and forest-dependent households	8% of the hungry
Vulnerable Individuals	Vulnerable pregnant and nursing women and their infants, pre-school children, chronically ill or disabled
Affected people of extreme events	ca. 60 million
HIV-related food insecurity	Number of food-insecure households with adults or children affected by HIV: ca. 150 million

Source: UN Millennium Project/UNDP 2003

share of the hungry up to 2015 compared to 1990, while the WFS was demanding the reduction of the number of the hungry. Due to the fact that the world population is increasing, the MDG contains a softer reduction target, because of the number of hungry needs to be reducted to circa 600 Million people to achieve the goal, while the WFS goal demands a reduction to 400 Million people.

At the World Food Summit five years later in June 2002, it became clear that this goal would not be achieved unless substantial policy changes were to take place. Officially the FAO estimated before the WFS that the number of hungry people was reducted by six million a year between 1996 and 2002. It was already at the summit doubtfull if the figures were reliable, due to the fact that the numbers are based on a reduction of hungry people in China, while at the same time the number of hungry people has increased in many other countries.

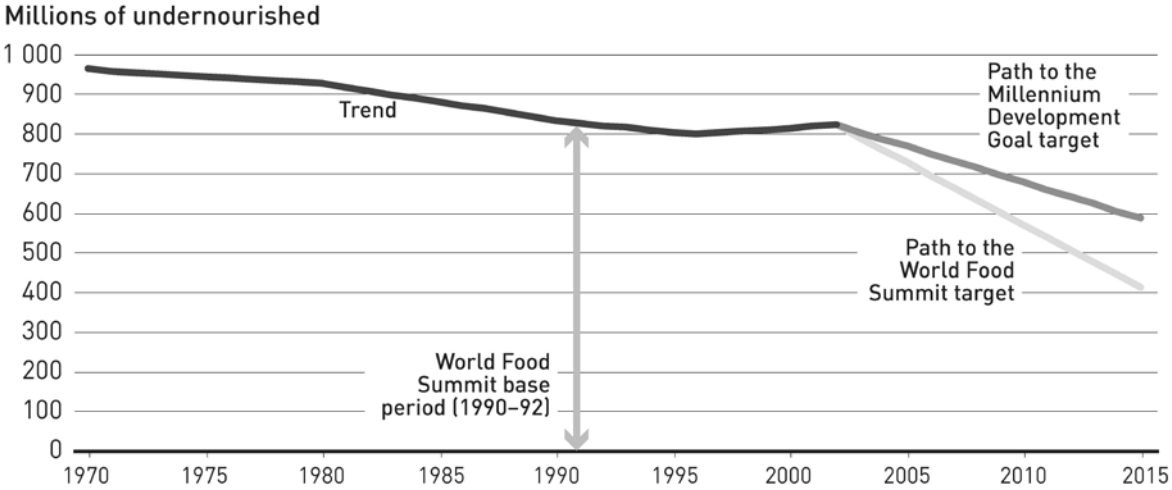
In between the FAO had to adjust the figures again to a number higher than 840 million. In October 2008 the FAO estimated that in 2007 the world had 923 million undernourished people. No process has been reached in reducing the total number since the WFS in 1996. FAO itself argued that the situation was caused by a lack of investment and a „lack of political will“ to implement policies that would reduce hunger. The financial means needed to close this implementation gap are estimated to be around USD 24 billion (FAO 2002, 3).

A 2006 analysis by the FAO showed that the world is still not on track to meet neither the goals of the World Food Summit nor the weaker Millennium Development Goal (MDG) target (Figure 9).

A comprehensive review of the status of hunger and malnutrition has been provided in United Nations reports presented by the Millennium Project. This group of experts was assembled by the Secretary General to give recommendations on how to implement the first MDG and halve the number of hungry and malnourished people by 2015.[6] Current estimates say that more than 75 percent of the world‘s poorest people live in rural areas and depend mainly or partially on agriculture for their livelihoods. The report also highlights that

[6] The first report of the hunger task force of the Millennium Project developed a typologie of the hungry worldwide. It was published in New York, April 2003. See also the excellent overview in IFAD 2001.

Figure 9: Number of undernourished people in the developing world



Source: FAO 2006, 5

natural and man-made catastrophes, which often trigger the need for food aid, are currently responsible for around 10 percent of all hungry and malnourished people in the world. 90 percent of the hungry suffer from chronic malnutrition.

Half of the world's hungry people are smallholder farmers who live off a limited area of land and without adequate access to productive resources. Two thirds of these people live on marginal lands in environmentally difficult conditions. Examples of such areas are hillsides or areas threatened by drought or other natural disasters like flooding or mud slides etc. Moreover, 22 percent of the hungry are landless families, who often subsist on income obtained under precarious working conditions as landless laborers. Additionally, 8 percent of hungry and malnourished people are found in fishing, hunting and herding communities.

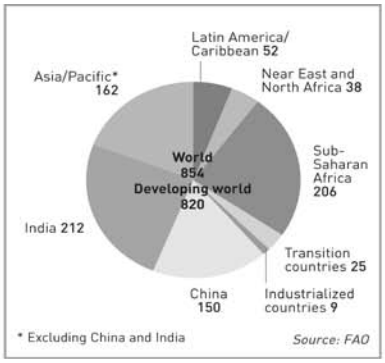
Secure access to productive resources – land, water, and agricultural inputs like seeds and livestock breeds etc. – is the key to improving the situations of these families. Such processes are exacerbated by the fact that the driving force of food and agricultural policies of many countries, in the industrialized North as well as the global South, has been industrial agriculture, livestock production, and commercial fisheries. The need of smallholder farmers, pastoralists, and fisher folk to secure access to productive resources is often overlooked.

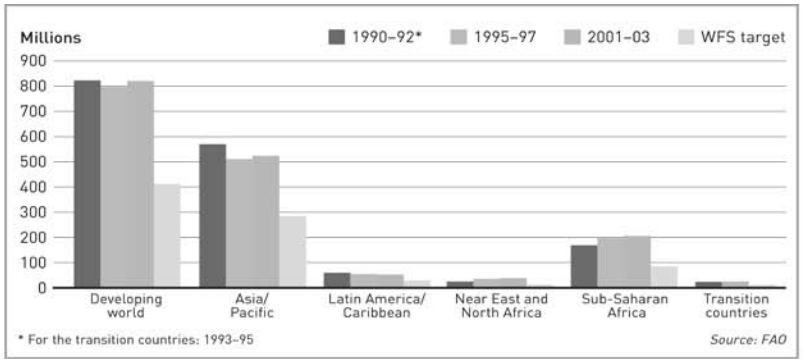
Most undernourished people live in India and China. In India, more people suffer from malnutrition than in sub-Saharan Africa as a whole (Figure 10). In the early 1990s, there was progress being made to reduce these numbers in Asia and the Pacific, but that trend seems to have reversed.

However, since population growth in most regions is larger than the increase in the number of the undernourished, most regions see slight progress towards the Millennium Development Goal of halving the percentage of undernourished people. Still, this result occurs at too slow a pace to reach the 2015 goals (UN 2007).

There are a number of myths and assumptions why hunger and malnutrition exist in a world of plenty. Many of these postulations refer to natural disasters and conflict. Environmental factors such as unreliable rain, storms and drought are often considered to be the main reasons behind famine and hunger. Complex political situa-

Figure 10: Regional distribution of undernourished people





Source: FAO 2006, 8, 9

tions, such as conflicts and civil war, are also thought to contribute.[7] According to the UN Millennium Project, around 60 million people are affected by civil strife and insecure political conditions (UN Millennium Project 2005). Even though these explanations are indeed increasingly relevant, they address more the symptoms that occur in situations where people are poor and vulnerable rather than the underlying causes. The reason why poor people are the most affected by natural disasters is due to their lack of reserves, power, and possibilities, and thus their lack of control over resources.

2.3 Marginalization of producers: a problem of development policies

Given the crucial role of marginalization in the food security debate, it is clear that agricultural and food production problems cannot be tackled at the technical level. The situation of the rural poor has been aggravated by the fact that rural areas were neglected in regional, national and international policy making. For a long time, the policy focus was on investments in industry and urban infrastructure, causing budget allocations for rural areas to be reduced substantially – often by more than 50 percent (FAO 2003). The same happened with bi- and multilateral aid budgets. According to FAO figures, the average budget of rural development in developing countries was reduced by 50 percent between the mid ,80s and mid ,90s. The same happened to bi- and multilateral aid. The World Bank, for example, dropped its lending to these sectors from nearly USD 6 billion in 1986 to USD 2.7 billion in 1996. Many reasons are given for this decline: the inherent complexity, relatively high transaction costs in agriculture and rural development projects (particularly with poor producers), aversions among bank staff and client to lend in those sectors, and the low effectiveness of institutions working with these sectors in many countries (FAO 2001).

Support for rural development and agricultural production were judged as outmoded. Only recently, international organisations have begun to recognize that the policy shift away from rural development policies was at least too radical and the policies are now being reversed. A decade of official work on poverty reduction without major results has lead to the realization that policies aiming at effective poverty reduction have to

[7] See e.g. the Global Information and Early Warning System on food and agriculture (GIEWS) of the FAO and its determination of countries in food crisis

address the needs of people in rural areas.[8] The FAO is also arguing that the hope of the 1990s, that poverty reduction will automatically lead to a decrease in the number of hungry and malnourished, can no longer be justified. In fact, the opposite recognition – that hunger needs to be tackled first in order to address the problems of poverty – is gaining ground. The FAO and others have therefore promoted a twin-track approach which against the background of the recent food crisis aims

> *„at (i) alleviating the impacts of high food and fuel prices on the weakest population groups through direct transfers and safety nets, while (ii) implementing policies and programs to promote agricultural and rural development both in the short and long run" (FAO 2008a, 16).*

In many developing countries agriculture is taxed, and support services are poorly equipped as described in the 2008 World Development Report (World Bank 2008). Agricultural research is directed only towards commercial crops. However, other negative framework conditions such as insecure land titles, problems with access to credit or capital, insurance etc often prevail. The result is that even if smallholders do have access to some land, they must endure poor conditions, lacking support and adequate economic frameworks. Governments seldom pay enough attention to these sectors and do not implement their human rights obligations to these groups. The recently published report of the „International Assessment of Agricultural Science and Technology for Development" IAASTD, is highlighting the potential positive effects, when small holder farmers would get sufficient governmental support. The IAASTD has been established at the Johannesburg Summit in 2002 and is a network set up in a similar way as the IPCC of currently up to 400 researchers. The report of the IAASTD can be downloaded from their official web-site: www.agessessment.org.

International policy conditions also have an important impact on marginal rural smallholder farmers' communities and those of pastoralists and fisher folk. As international polices set binding conditions for national policies, it is the combination of national and international policy frameworks, along with local situations, that together play a crucial role for the situation of these groups.

Structural adjustment policies, which have been implemented in most developing countries since the middle of the 1980s, have influenced national agricultural policies to a large degree. These policies were built around what the World Bank referred to as a „trade-based food security" policy package. Agricultural support was oriented towards fostering agricultural production for exports in order to increase income in hard currencies, which should help to finance the import of staple foods. Such policy recommendations often support the national bias against small holder production. This approach leads to a concentration in means available for agriculture and rural development concentrated in few sectors of export production. The later-developed instruments of the World Bank and the International Monetary Fund (IMF), the Poverty Reduction Strategy Papers (PRSPs), were created with the aim to direct policy processes for highly indebted countries; however they seldom take agriculture and rural development properly on board (SLE 2002). International policy advice was therefore rarely supportive to small-holder agriculture and rural development. It was only recently that several bilateral and multilateral donors started a newly created „Global Donor Platform on Rural Development" (GDPRD). The GDPRD held its second international conference in June 2007 in Berlin. The group was also influential in the preparation of the World Development Report (WDR) 2008 and it was established as a network for donor harmonization in the area of rural development. This is finally again focusing on agricultural issues including development (World Bank 2007).

At the same time international trade policy rules became increasingly binding for many countries when the World Trade Organization (WTO) was created in 1995,

[8] The importance is reflected in the IFAD analyses for rural development in 2001

particularly since they not only set the terms for tariffs, but also are signed as agreements that set stringent conditions and regulations for national policies. From food safety regulations to geographical indications and intellectual property, from agricultural subsidies to price support for basic staple foods, the WTO regulations are still deeply affecting national policy frameworks. One of the bigger problems linked to the WTO Agreement on Agriculture (AoA) is the imbalance in the level of liberalization obligations for different groups of countries. While developing countries have opened up their markets during the last fifteen years, their smallholder farmers still have to compete with subsidized production and subsidies exports from industrialized countries. Because poor countries are not able to pay subsidies to their farmers and are forced to remove trade barriers, hardly any agricultural policy instrument prevails in these countries (see FAO 2005, chap. 3). At the same time, industrialized countries are still paying subsidies to the farm sector, even though the bulk of it does not reach smallholder farmers, but rather goes to agribusinesses and the grain trading companies. OECD figures estimate that still around 300 billion US-Dollers are payed as subsidies to agriculture producers in industrialized countries. The export susidies went down during the last decade linked to the WTO-agricultural negotiations (see Dewbre, Thompson and Dewbre 2007).

Furthermore, the industrialization of agriculture is contributing to the trend which leads to a consolidation of agricultural land and assets in the hands of big landowners, agribusiness, and other large commercial entities. The most fertile and extensive areas of land remain in the hands of a decreasing number of producers, and in many countries smallholders are being excluded and forced onto unproductive or „low potential“ land (IAASTD 2008). Moreover, reduced resources and increased poverty force smallholders in many places to cultivate the land more intensively and to abandon more environmentally sustainable agricultural methods.

However, it would be wrong to conclude that it is smallholders that constitute the main threat to the environment. Obviously smallholder farmers, pastoralists and fisher folk can be responsible for causing environmental problems such as soil erosion, over-exploitation of soil fertility, or deforestation. But at the same time, they have been the main custodians of the environment for millennia. The diversity of sustainable uses of land, soil, water, forest, and genetic resources such as seeds and livestock breeds, represents the careful work and knowledge of many generations of rural and indigenous peoples. Important environmental threats in global agricultural production often come from the process of industrialization of production patterns often in more favorable areas. The overuse of water resources, the loss of soil through erosion and salinisation, the loss of agricultural biodiversity through the destruction of agro-ecosystems, intensive animal production patterns, and over-fishing are all at least partly results of the open world market that does not internalize these externalities and has put enormous pressure on producing as cheaply as possible (see also IAASTD 2008).

Large-scale industrial Trans-National Corporations (TNCs) are also exerting increased control over different parts of the food system, its markets and worldwide food production. The input-sectors for food production are undergoing rapid concentration (see Hines 2003). Many traditional seed producing companies have been bought by agrochemical companies or oil-companies. Intellectual Property Rights systems (IPRs) are promoted that provide monopoly privileges over what was once common property and thus facilitate the control over genetic material/life forms such as seeds and livestock breeds. The IPR agreements are also an obstacle to the spread of knowledge and technology among smallholder farmers and their access to seeds and livestock breeds (see Liebig 2005). They can hinder access to seeds farmers will need to adapt to climate change. The WTO‘s Agreement on Trade Related aspects of Intellectual Property rights (TRIPs) requires all members of the WTO to implement plant variety protection legislation, through patents or other IPR systems, at the same level as the most developed countries.

The process of concentration is also visible in other input sectors for agriculture, such as the production of pesticides, as well as in the food trade and the food-processing industry. All global transactions in cereals

and soybeans are controlled by a few companies. The same is true for other important international crops, such as tropical export crops like bananas, pineapples, coffee and cocoa etc. The strongest pressure on prices comes from international food processing industries (see e.g. UK Food Group 2003). It is not just at the input end of agriculture that corporate dominance prevails. Over the last two decades TNCs have increased their market domination of the processing and retailing of food. Smallholder farmers able to produce enough to trade are now facing an ever-harder struggle to exert any influence over the farm inputs they need, the farm-gate price for their produce, and the terms and conditions of its trade.

Local and national markets are currently becoming more dominated by retail chains even in poorer countries in Africa. The „supermarketization“ will make it more difficult for poor smallholder farmers to sell products. Local markets are changing fast to supermarkets and supermarkets buy – when they buy regional products at all – standardized products with a uniform quality. Smallholder farmers can seldom produce at such standards. A result of that process will be a separation among rural producers into those who have enough capital and skill to integrate into the global food market and the large majority of small holder units without sufficient resources to do so. New approaches to empower farmers and re-localize food systems are needed. In Europe, where TNC dominance of food retailing has been an issue for some time, there are already a number of farmer-based initiatives including farmers‘ markets, Fair-trade, farm retail, box schemes that help to „localize“ food systems and empower smallholder farmers (e.g. Sustain 2003).

Overall, it is recognized that rural development deserves much more attention than it did during the last decades. There are many signs that the issue will get more attention in the future than in the past. The most visible sign at the international level is the World Development Report 2008, which is demanding a refocusing of development aid to agriculture and the creation of the Global Donor Platform on rural development (World Bank 2007). The most important document at the regional level is the Comprehensive Africa Agriculture Development Programmed (CAADP), a document developed by the New Partnership initiative of the African Union for African Development (NEPAD). The head of states committed themselves to invest at least ten percent of the national budgets for rural development (NEPAD 2002).

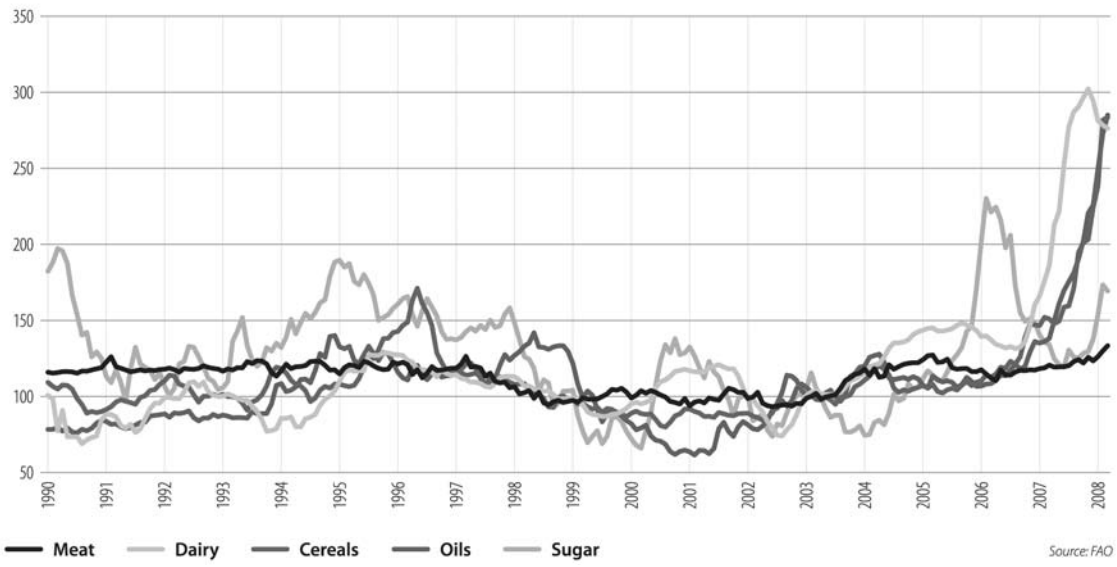
There seems to be a common understanding and a renewed recognition among many actors, from civil society up to the World Bank, of the importance of rural development in the combat against poverty. Yet there is no consensus on the specific policies that should get the most attention when fostering rural development and deciding how to spend the money. The title of the World Development Report already shows that conflict. The World Bank finally decided not to use „rural development“ but instead „agricultural development“ as the title for the World Development Report, because it focuses its strategy more on those farmers who have the potential to be integrated into global markets and to use agricultural development perspectives. The report develops an understanding that the rural world can be distinguished into “three different worlds“ that needs different policy treatment (World Bank 2007).

1. The first group covers those agricultural producers with products that have the potential and the assets to be integrated in the global markets. They can produce at competitive prices and internationally-accepted quality standards, and the products can be sold in supermarkets. The report argues that they should get all support possible to be successfully integrated into global markets.

2. The second group are the subsistence farmers that have a certain security in access to productive resources and the necessary skills to use them. They should be supported in improving subsistence agriculture. Moreover, when needed their income should be lifted by cash transfers, in order to bring them out of poverty.

3. The third group are marginal farmers with very limited assets. For these groups the Word Development Report recommends leaving the country side, migrating

Figure 11: Monthly FAO price indices for basic food commodity groups (1998-2000=100)



Source: FAO 2008a, 3

to the cities and sending back remittances from work in order to help the village to develop.

While the report makes a lot of proposals for how to improve spending in rural areas, it gives up on larger groups among the marginalized rural producers. Unfortunately, the report does not explain which alternative jobs are available for them in cities and what consequences new trends on world agricultural markets and rising food prices would have for them (see chapter 2.4). It also does not look at the question of how this strategy might influence greenhouse gas development, as the emissions of town citizens are usually much higher than rural smallholders.

How can rural, disadvantaged smallholders be best supported? This question is in the center of the current debate about rural development. The World Bank‘s model is generally market-oriented, while NGO and CSO which met in June 2007 before the Conference of the Global Donor Platform argued that support to marginalized producers cannot be given up, because the alternative scenarios of getting an income or adequate livelihood security are not available on a short term basis. Necessary structural change will require a long period of adaptation (see the positionpaper of NGOs “The Role of Agriculture and Rural Development in Poverty Reduction”). It was the World Bank director, Robert Zoellick, who recently and for the first time started to talk about the redirection of development aid to rural areas. In a press statement related to the fast increase of World Market Prices, he demanded that a new approach be needed, focusing less on supply and access to food and more on competing usage of food and issues such as the marginalization of female producers or other groups in rural livelihoods (World Bank 2008). This might only be the start of the necessary debate about necessary consequences of new trends in the markets for agricultural commodities.

2.4 Trends on world agricultural markets and agricultural prices

Given the current fast trend of rising world market prices for agricultural commodities, in particular for cereals,

Table 5: Net importers of petroleum products and major grains as a percent of domestic apparent consumption - ranked by prevalence of undernourishment

Countries	Petroleum % imported *	Major grains % imported **	% undernourishment ***
Eritrea	100	88	75
Burundi	100	12	66
Comoros	100	80	60
Tajikistan	99	43	56
Sierra Leone	100	53	51
Liberia	100	62	50
Zimbabwe	100	2	47
Ethiopia	100	22	46
Haiti	100	72	46
Zambia	100	4	46
Central African Republic	100	25	44
Mozambique	100	20	44
Tanzania	100	14	44
Guinea-Bissau	100	55	39
Madagascar	100	14	39
Malawi	100	7	35
Camboida	100	5	33
Korea, DPR	98	45	33
Rwanda	100	29	33
Botswana	100	76	32
Niger	100	82	32
Kenya	100	20	31

* Source: Energy Information Administration: International Energy Anual 2005, Washington D.C., US. Covers crude and refined petroleum products
** Source: FAOSTAT: Archives Commodity Balance Sheets. Average 2001-03 for wheat, rice and maize
*** Source: FAOSTAT: Food Security Statistics, Prevaleuce of undermourishment in total population (2002-2004 preliminary): www.fao.org/es/ess/faostat/foodsecurity

Source: FAO 2008a, 17

it becomes clear that the debate about the best approach to rural development – which Zoellick also addressed – must come back to the centre of the discussion.

Many authors warn that the situation of relative overproduction of food, which was characterizing world markets for the last decades, has changed. Several economists warn in the light of the 2007 price increases that the mid-term trend for food prices will be upwards.

The price index of the FAO showed an increase in prices of about 40 percent in 2007 for major staple foods, compared to an increase of 5 percent in 2006. In April 2008 the Asian Development Bank noted an increase in prices for rice from Thailand – one of the leading rice exporters worldwide has increased 30 percent in the first quarter of 2008 (Braun 2007). It is very important to note that many of countries with a high percentage of undernourished people are also highly dependent on

Table 6: Forecast import bills of total food and major food commodities (USD million)

	World		Developing		LDC *		LIFDC **	
	2006	2007	2006	2007	2006	2007	2006	2007
Total food	630 135	812 743	190 975	253 526	13 822	17 699	88 577	119 207
Cereals	186 794	268 300	74 615	100 441	6 101	8 031	31 363	41 709
Vegetable Oils	70 822	114 077	34 831	55 658	1 948	3 188	22 919	38 330
Dairy	45 572	86 393	13 593	25 691	824	1 516	5 079	9 586
Meat	78 704	89 712	17 064	20 119	872	1 079	6 295	8 241
Sugar	33 024	22 993	13 892	11 904	1 755	1 320	7 598	4 782

* Least developed countries
** Low-income food deficit countries

Source: FAO 2008a, 18

petroleum imports (Table 5). This leaves them with a double-fold increased bill: More money has to be spent on food, while the increased oil prices put further pressure on national budgets, which often subsidize the price people have to pay for petroleum.

A recent paper presented at the FAO Summit 2008 (FAO 2008) estimates how price increases in key commodities are expected to impact the import bills for food. It shows that the Least Developed Countries (LDCs) have to calculate expenditures increased by 25 percent in 2007 as compared to 2006. The estimates for the Low-Income Food Deficit Countries result in an even higher increase of more than 30 percent. This severely constrains governments‘ abilities to invest in the fight against poverty, malnutrition and other important developmental shortcomings.

Some researchers pinpoint the fact that the low price period of the last decades resulted in limited agricultural investments in many regions of the world. The „High level Task Force on the Global Food Crisis“, which was established in April 2008 by a meeting of the heads of all UN-Agencies, is making that point strongly in its report to the General Assembly (HLTF 2008, 8). Increasing prices will therefore be an incentive and will encourage a market response with more investments in agriculture with increasing outputs. While precise and accurate forecasts are still difficult to formulate and must be made with caution, more studies show that the price for most agricultural resources will most likely stay higher than in the recent past. Studies from FAO, IFPRI, and the World Food Program all expect similar trends: The prices will probably not decrease to the same level they experienced during the last decades, even if higher prices will stimulate additional agricultural output in the coming years. The High Level Task Force of the UN concluded.

> *„While food commodity prices now appear to be stabilizing, prices are expected to remain high over the medium or long term“ (HLTF 2008, 10).*

Many studies refer to several long-term trends, that will influence future agricultural production, and which have already partially contributed to recent price increases. Five trends are of particular importance and will limit a broad and sustained market response in the near future. The first two trends are related to factors that influence global demand, while the fourth and fifth relate to the global production potential on the supply side:

1. The demand for food and agricultural products is expected to grow rapidly in coming decades: The increased demand for food products is partially due to

the increasing population – current estimates result in a population of 6.5 billion to 9 billion people in 2050 (UN-ESA 2007). This growth will take place mostly in developing countries, but is also currently driven by the economic growth of several emerging economies. The increasing wealth (and images of modernity) in these countries leads to changes in diet towards more animal products and cereals. Meat consumption alone has doubled worldwide during the last 25 years (Ehring 2008). This is traditionally an issue documented by the former director of the World Watch Institute, Lester Brown (see Worldwatch Institute 2003). This trend has already contributed to the decline in food stocks. If global cereal consumption was comparable to the average European consumption level, two times more (6 billion tonnes) of cereals would be needed than are currently being produced.[9]

2. The demand for non-food use of agricultural resource is increasing along with oil prices: Agricultural products can be used as energy resources, such as agro fuels, and resources for other industrial production processes. Simultaneously, increasing oil prices will also impact the increase of agricultural prices by influencing the prices for agricultural input. The support for the use of agro fuel has been presented as partially, although not primarily, motivated by the will to reduce greenhouse gas emissions in the transport sector. But rising oil prices and energy security concerns might be more important drivers.

3. Global food markets will also be confronted with a shrinking surplus production in the US and the EU, partially because of WTO commitments to end export subsidies and partially because more agricultural produce will be used for bio energetic purposes in these countries.

4. Future environmental limitations for agricultural production: There is a decreasing amount of land available for agriculture and grazing. Latest figures estimate that annually more than 0,5 percent of arable land is being lost (WBGU 2008). This is caused by a combination of factors: urbanization and expanded industrial infrastructure, particularly around mega-cities in developing countries, soil erosion, desertification, salinisation, and contamination. Flooding as a consequence of expected increased extreme precipitation events can also contribute to soil degradation. Decreasing precipitation in some regions because of climate change in some regions, vanishing glaciers, and inundations from sea-level rise etc. are expected to reduce water availability and partially the available land for agriculture. Increasing demand for freshwater, inter alia through mega-city growth, also adversely impacts on the availability of this crucial resource.

5. Climate-related volatility on the supply side: Climate change will not only bring long term consequences. The expected increase in intensity and number of extreme weather events may also bring about temporary shortfalls on the supply side. This can be one important factor for the increased volatility of food prices, especially in times of reduced storage capacities. In its recent analysis, the FAO explicitly mentions „weather-related production shortfalls“ as one of the factors that have contributed to the recent increase in food prices (FAO 2008a). In recent years there has been a number of examples where extreme weather events have hit regions that supply large amounts of food commodities to the global market, both in developing and developed countries. For example, in Australia, which had been the second largest grain exporter after the US, a drought in 2006 made grain yields drop from 25 million tonnes to less than 10 million tonnes (Bryant 2008).

In June 2008, tornadoes caused severe flooding in the Midwest of the USA, with the water covering more than 40,000 hectares of farmland including large soy fields. As a result, soy prices experienced another increase (dpa 2008). For methodological reasons, it is never possible to link one single extreme weather event to global climate change. But it can already be shown that anthropogenic greenhouse emissions have now

[9] Own calculation based on caloric consumption estamates.

"loaded" the atmosphere. The likelihood of an increase in number and intensity of extreme weather events has grown (IPPC 2007a). In extreme cases, traditionally exporting regions can become importers.

What are the implications of these trends for those suffering from food insecurity going to be?

Reflecting these structural drivers behind the price increase, it is likely that prices will stay above the level we had during the last decade, even though there is a recent decline in commodity prices from the peak levels in early 2008 (see also CTA 2008). In addition to the mentioned factors, there is a continued rise in fertilizer prices and energy costs, which are major input factors for farmers. All indicators therefore support the assumption that prices will stabilize at a higher niveau in the mid- and long term. A recession would certainly support a short term price reduction.

A recent OECD and FAO study highlighted that while prices should decline from their recent peak, they will remain above the average of the past decade (OECD/FAO 2008). Comparing the 1998-2007 period to the projected price levels for 2008-2017 beef and pork prices may be some 20 percent higher, raw and white sugar around 30 percent, wheat, maize and skimmed-milk powder 40 percent to 60 percent, butter and oilseeds more than 60 percent, and vegetable oil over 80 percent.

The European Commission published an analysis of the recent food crises which supported the conclusion that the rising prices have affected net food importing countries in Africa most severely (see Table 6). According to the EC judgment the higher food prices have translated into greater poverty, malnutrition and increased vulnerability to further external shocks for the world's poorests (EC 2008). At the same time, the EC has the hope that higher prices in the medium or long term will present new income-generating opportunities for farmers also in developing countries, allowing them to better deal with the consequences of climate change. But the common OECD/FAO report is skeptical about that hope: High prices, the OECD is arguing, will benefit commercial producers but not necessarily the bulk of producers in developing countries where many farmers are not linked to markets (see OECD/FAO 2008). Prices are expected to become more volatile in the coming period, partly as the result of speculation, partly due to more intense weather extremes.

The FAO sees two reasons why the urban poor are most exposed to the increase in world food prices.

> *„First, urban populations are more likely to consume staple foods derived from tradable commodities (wheat, rice), while rural populations (particularly in Africa and Latin America) tend to consume more traditional staples, such as roots and tubers. Second, urban populations are less likely to produce a significant share of their own food or produce for sale" (FAO 2008a, 31).*

Price increases could have positive welfare effects for parts of society, including rural smallholders, which are net-sellers in respect to goods that experience price increase. The amount of positive effect depends on the ratio between the price increase of the good sold and the production costs. In this regard, soaring oil prices have a detrimental effect on rural farmers, because energy use plays such an important role in the production and particularly transport of these products to markets. Even worse, in many countries most of the rural poor are not net-sellers. This means that they also face increased expenditures for their food consumption (FAO 2008a, 31f). In some cases, it may be possible to switch to consuming goods which have not faced such price increases. In the long term, price increases may lead to more political attention, increased support, and improved productivity of rural agriculture, with opportunities for higher incomes for the rural poor. However, currently it is more likely that a large number of people are negatively affected.

Price trends might be aggravated by the impact of climate change. It becomes therefore more and more obvious that these particular groups are those most likely affected by rising prices, because the price increase will directly affect the percentage of their income which they

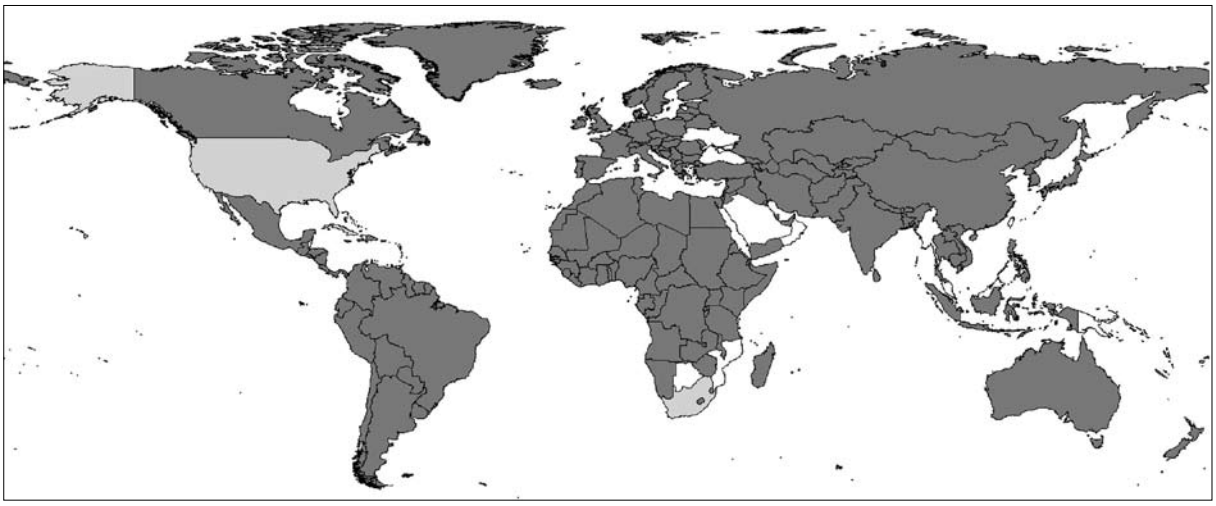
have to spend on food alone. Adequate policies such as social transfers and increased humanitarian help might improve the situation of poor consumers as well as policies to increase market access by remote small holder farmers. However, conclusions for strategic responses vary tremendously and are often partially contradictory. Against the background of these trends and including the impacts of global climate change on food security, conclusions with regard to agricultural development policies and rural development will be discussed in chapter 5.

2.5 Food security compared with other concepts: food sovereignty, right to food

For the purpose of this study, it is important to clarify the relationship between the concept of food security and the human right to adequate food, as both concepts are referred to regularly, and it is important to see both the similarities and differences. Food security has been described above. In essence, it is a concept to analyze and describe the nutritional status of people; they should have sufficient access to food and be healthy enough to avoid malnutrition. The four components of food security (availability, physical access, economic access, utilization) seem comparable to the description of the right to adequate food, but the two concepts differ. Food Security is mainly an analytical tool, and not an agenda for policy action.

The right to adequate food is a human right. It is enshrined in the Universal Declaration of Human Rights, adopted in 1948 by the UN General Assembly (UN 1948). This document serves as a foundation for the legally binding International Covenant on Economic, Social and Cultural Rights (ICESCR), which was adopted by the UN General Assembly in 1966 and entered into force in 1976. As of June 2008, it has been ratified by 158 state Parties (as of June 2008, UN 1966, see Figure 12: Map of Parties to the ICESCR). It is well described by the General Comment No. 12 of the United Nations Committee on Economic, Social and Cultural Rights (see High-Commissioner for Human Rights OHCHR). Moreover, it is politically reconfirmed

Figure 12: Map of Parties to the ICESCR



Parties to the ICESCR: Parties in dark grey; states which have signed but not ratified in light grey, non-parties in white

Source: www.wikipedia.org, based on OHCHR

and strongly supported by all member states of the Food and Agricultural organization in the adoption of the „Voluntary guidelines on the implementation of the right to adequate food in the context of national food security“ in November 2004 by the FAO-Council (FAO 2004). It describes government obligations, and it is therefore an implementation-oriented tool that allows monitoring government action vis-à-vis groups which are particularly food insecure.

Other human rights particularly relevant for climate change effects are the rights to housing, to health, and to water and sanitation. The right to adequate food and housing are part of the right to an adequate standard of living in Art. 11 of the ICESCR. The right to achieve the highest attainable standards of health is recognized in Art. 12 of the same covenant. The right to water is not mentioned specifically in the ICESCR, but is derived from Art. 11, the right to adequate food and Art. 12 the right to health. The content and state obligations linked to the rights to food, housing and health has been developed in the course of the last 10 years, partially by the UN-Committee on Economic, Social and Cultural Rights (CESCR) in the form of general comments, or by the work of UN-special rapporteurs.

Special rapporteurs are thematic experts nominated by the UN-Human Rights Council woh follow one issue for up to six years and publish two thematic and two country reports every year. The have helped develop a detail and precise understanding of the rights to food, housing, health and education (see Eide et al. 2007).

General comments are interpretations or clarifications given by the UN-expert committee that is supervising the implementation of the Covenant. They are not legally binding but interpretation guidelines for judges who use or apply the covenant in court rules related to ESC rights (see Eide et al. 2007). The detailed understanding of the right to water is still under discussion and in 2008 the Human Rights Council selected an independent expert on the right to water and sanitation, who has the mandate to help clarifying the related state obligations. An initial orientation for the use and interpretation of the right to water has given in 2002 by the UN-Committee on Economic, Social and Cultural Rights with the General Comment No. 15 (see Sacher and Windfuhr 2008).

2.6 Content of the right to adequate food

In General Comment No. 12 (GC 12), the Committee on Economic, Social, and Cultural Rights has given its interpretation of the right to adequate food.

> *„The right to adequate food is realized when every man, women and child, alone or in community with others, have physical and economic access at all times to adequate food or means for its procurement“ (Committee on Economic, Social and Cultural Rights 2002).*

The right to adequate food implies the availability of food in quantity and quality which is sufficient to satisfy the dietary needs of individuals. The food has to be free from adverse substances and acceptable within a given culture. Furthermore, the food has to be accessible in ways which are sustainable, which implies that the access and the availability needs to be given long term.

Several components of this definition are of particular importance in properly understanding the content of the right to adequate food. Food must be physically available. Availability implies either a possibility to feed oneself from productive land or the existence of a well-functioning food distribution system that guarantees food is always there. Availability in a region or a village alone does not mean that a person or a household has access to the food. The food needs to be accessible both physically and economically. Sometimes minorities are hindered in getting access to food. Sometimes they do not have the economic means to buy food.

Accessibility of food is only sufficiently guaranteed when individuals or households do not have to sacrifice other essential basic needs in order to get food. Any form of food procurement is therefore only viable when other ESC-rights do not have to be breached. The term

`dietary needs´ refers to more than pure nutrients for physical needs. It refers to those dietary needs which are necessary for physical and mental growth and physical activity.

Another important component is access to adequate health prevention and control of disease. Many children who die from malnutrition do have access to food, but cannot adequately utilize it, because diseases are hindering them.[10] For children, particularly small children and babies, another component is decisive. Somebody must give adequate care so that children will be feed well and regularly. The General Comments defines this as core content of the right to adequate food and the freedom from hunger. This refers to the immediate obligations of governments to guarantee that nobody dies from acute hunger due to man made and natural catastrophes and emergencies. While the content of „freedom from hunger“ has not been well elaborated so far, it reflects the intention of the drafters of the ESCR to make sure that nobody dies from immediate hunger. The full realization of the right to adequate food can only be achieved progressively and will take time, even when many government obligations can be implemented immediately.

The implementation of the right to adequate food is guided by specific government obligations. Food security describes a goal; the right to adequate food obliges governments make a qualitative response to the problem of hunger and malnutrition. A human rights-based monitoring has the specific focus to analyze whether governments are implementing their specific human rights obligations (see Immick 2004). Rights-based monitoring (RBM) starts by using available information and data in a country as identified by food security indicators. Additionally, it tries to measure progress in the implementation of human rights obligations of the country. It measures to what extent government policies constitute an adequate answer to the duties of the government. It analyses whether governments use their respective resources adequately and most reasonably to guarantee the full enjoyment of this right.

A third term gaining prominence within the debates of civil society organisations dealing with issues such as hunger, malnutrition, and rural development is food sovereignty. Food sovereignty is a political concept primarily developed in the context of La Via Campesina, a global small farmers‘ movement. It is increasingly being used by other civil society organisations including the umbrella organization of civil society groups working at the FAO.

The parallel civil society forum to the World Food Summit + 5 conference in June 2002 was held in the name of food sovereignty, providing evidence that this topic is becoming the most relevant civil society concept. In March 2007 Via Campesina coordinated with the umbrella organization of small farmers in West Africa, (Reseau des Organisations Paysannes et des Producteurs Agricoles de l’ Afrique de l’ Quest, ROPPA), and other civil society organisations at an international gathering of civil society in Mali. The outcome was a common statement that describes the ideas behind the concept of food sovereignty quite well (see Nyeleni Declaration 2007). Food sovereignty has been developed as a concept by social movements and farmers organisations to protest the neglect of rural areas and rural development in national and international policies. It highlights the political will of organisations of rural people to have the right to determine their own situation.

- Emphasis is placed on protecting the possibilities of smallholder farmers to continue producing and to earn a decent income from agricultural production.

- Security in accessing productive resources is key for this concept. This includes a secure access to land, water, as well as seeds and breeds.

- The current marginalization of rural communities shall be overcome and their right to food realized.

- International trade shall be reduced to a minimum in order to let local and national markets blossom.

[10] The standard definition of food security covers that aspect because adequate use and utilization of food is a precondition for food security.

■ Traditional plant varieties shall be used, protected and supported. Patents on seeds and breeds should be forbidden.

■ Food sovereignty is not only used as concept for farmers, but also as a concept for the ambitions of fishers, herders and indigenous communities.

Food sovereignty is promoted as a political concept countering the current dominant model of rural development based on a free trade as central parameter. The current model is perceived by social movements as a model of „corporate driven" agriculture that fosters a concentration of power and resources in the hand of a few multinational corporations and land owners. While the use of the term food sovereignty still varies and no standard definition is yet available, the Nyeleni statement offers the first consolidated reference point. In the last chapter, this study will compare its own recommendations with the central elements of the concept of food sovereignty (see chapter 11).

2.7 Standards of governance under the right to food

The right to adequate food sets standards for governance at both national and international levels, according to the International Covenant on Economic, Social and Cultural Rights (ICESCR) and the aforementioned voluntary guidelines. 18 guideline recommendations describe how governments can guarantee the right to adequate food in national or local policies. Guideline 19 refers to international obligations governments have in their own foreign policy, but also to obligations they have when acting in intergovernmental organisations.

The right to food perspective in this study allows for discussing and challenging current forms of governance and to draw conclusions on how to better orient national and international policies to overcome hunger and malnutrition.

Human rights set standards for government policies. The state parties to the ICESCR have the obligation to respect, protect, and fulfill the right to adequate food, particularly for the most vulnerable groups. This results in a number of more specific obligations:

1. The state has to respect the rights of its people. When it comes to the right to food, the state must not take actions that endanger the means of livelihood or access to food for groups or individuals. Examples include forced evictions due to different kinds of projects (e.g. large development or infrastructure projects, like construction of dams, lumbering or oil exploitation etc.). In cases where the possibilities for people to feed themselves are undermined by such activities, these groups must be offered compensation, rehabilitation, or an equal opportunity to feed themselves. The obligation to respect this target often requires states to omit action. The implementation of that obligation is often affordable and can be immediately implemented by all states. At the same time, the obligation to respect requires that states respect equal rights of access to productive resources as well as to social transfer incomes.

2. The state has to protect peoples' access to food against outside third parties. For example, transnational or national corporations or big land owners might threaten the livelihoods of people by engaging in activities without taking into consideration the people living in the area. Such activities might be mining, oil exploitation, industrial fishing etc. Adequate protection means legislation protecting vulnerable groups in society from being deprived of their resources or rights. Governments are obliged to implement existing laws in order to guarantee freedom from hunger through administrative and police measures.

3. The obligation to fulfill requires that the state becomes active in identifying vulnerable groups and designing policies and programs that improve their access to food-producing resources or income. The obligation to fulfill can only be implemented in a step by step manner. Art. 2 of the ICESCR requires that state parties use the „maximum of the available resources" (UN 1966). The non-identification of vulnerable groups or the missing start of progressive realization can be judged as violations of Covenant rights. Furthermore, the obligation

to fulfill states that parties should implement two different types of policy measures:

First, they should enable as many people as possible to take care of themselves. Facilitating covers measures like creating access to productive resources like land, seed, water etc. or to receive other forms of income. For example, this obligation implies that governmental measures fulfill the right to food through agrarian reform, guaranteeing a minimum income, or securing minimum wage provisions.

Second, the obligation to fulfill covers specific measures protecting affected groups who cannot make use of productive opportunities. These populations are comprised of those who are too old, too young, HIV-Aids orphans etc. These groups need the provision of food or money in order to avoid hunger and malnutrition.

The implementation of economic, social, and cultural human rights does not demand impossible efforts from states, as is often suggested by skeptics, but involves feasible objectives. The obligation to respect and protect rights can usually be fulfilled without recourse to extensive financial means. The obligation to fulfill human rights requires the investment of resources. However, Art. 2 of the ICESCR sets realistic standards, which can be met even by poor countries. The article does not demand that all rights are to be immediately implemented, but that the state has to implement the rights progressively and has to use the maximum amount of resources available. This obligation can also be fulfilled by poorer states, as the article only requires the investment of resources available. The use of these resources should, though, focus on and prioritize the poor and discriminated sections of the population.

Other requirements have been described in the literature and are becoming standard interpretations of the application of the obligation to fulfill. Governments have to show that they have taken specific steps vis-à-vis all vulnerable groups. The realization of the rights should be progressive and should be fostered „as expeditiously as possible“. These qualifications were first developed in the Limburg principles from 1987. These principles are the result of a international lawyer conference which discussed the nature of the realisation of ESC-Rights. Published by the ICJ in 1987.

The right to adequate food allows for holding governments accountable with regard to their adaptation policies to climate change. Governments must develop a national strategy for the implementation of the right to adequate food, which should encompass at least the following five elements (see Windfuhr 2001):

1. Governments must assess and identify the most vulnerable groups concerning the right to adequate food and food insecurity or those who are malnourished and hungry. Without proper assessment, governments cannot properly focus their policy attention to these groups.

2. Governments have to make sure that existing legislation addresses the concerns of these groups and that the legislation is not leading to de jure discrimination and violations.

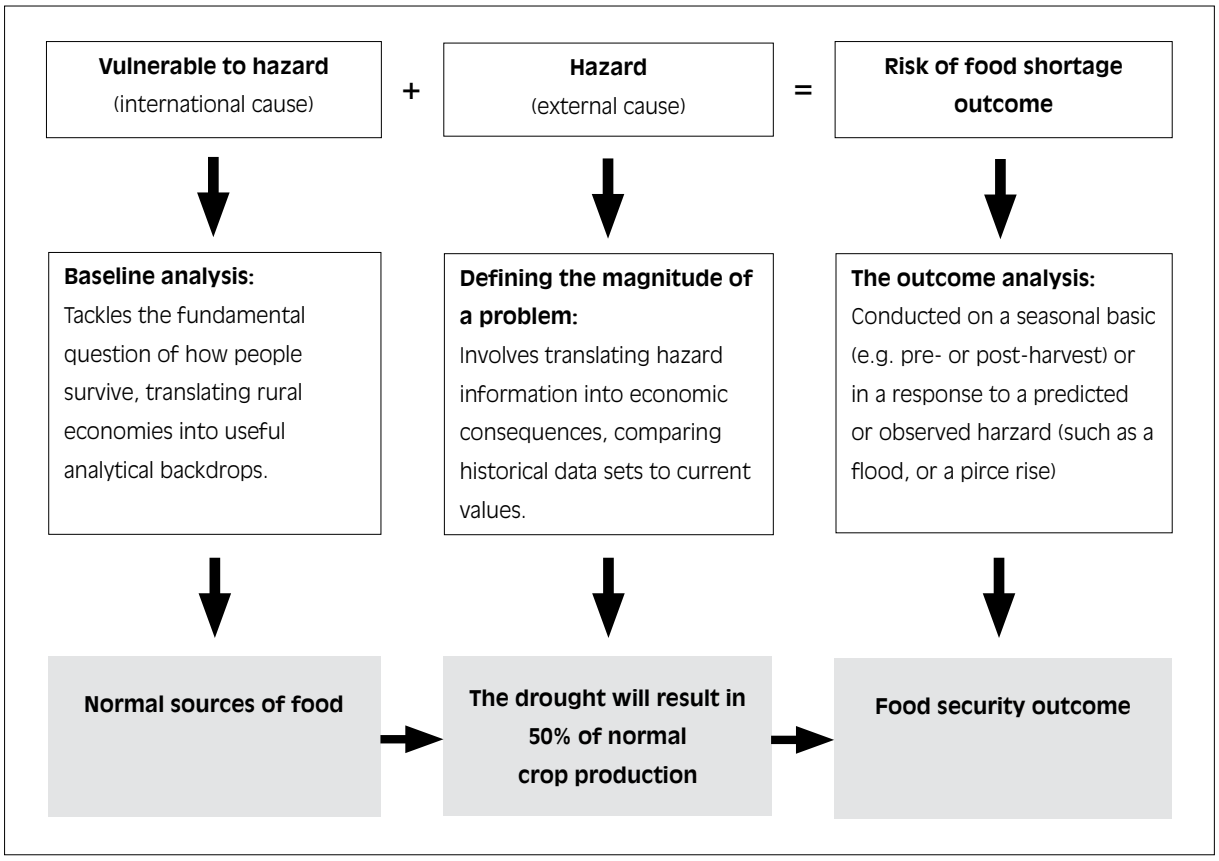
3. Governments have to make sure that their policy response and choice of instruments (de facto) is reasonably focused towards the most vulnerable. Policies should respect and protect existing access to productive resources, income, and food. Governments must prove that they are doing the utmost to implement the right to adequate food and are helping people cope with risks.

4. Governments are obliged to monitor the outcome of their policies.

5. Governments must also allow for accountability mechanisms, including functioning complaint mechanisms and access to recourse procedures.

As described above, the World Food Summit in 1996 established a new secretariat to improve the food insecurity measurement and the identification of vulnerable groups to food insecurity. Since then an interagency working group has developed a detailed methodology on how to identify vulnerable groups for food insecurity. It developed a typology of 54 potentially vulnerable

Figure 13: Analytical framework to assess climate-related risks and food security



Source: Zulu 2003

groups, from both rural and urban livelihood contexts. This typology can be a helpful starting point for government assessments on hunger and malnutrition (FIVIMS 2002).

Governments need to build the skills and methodology to work with such a measurement system, which is so far only used by the UN-Agencies. However, the complexity of the system should not give the impression that it is too complex to monitor vulnerability for food security. In most countries, few groups are vulnerable and need to be monitored in detail. The focus of the more detailed assessment of the specific vulnerable groups depends on the livelihood circumstances in that country.

2.8 Climate change and vulnerabilities for food insecurity

Agriculture, forestry, and fisheries are all sensitive to climatic conditions. Climate change will have direct impacts on these three sectors, including their productivity. In turn, this will affect the income of vulnerable groups that depend on resources and products derived from these sectors. The scale of the direct adverse and positive effects varies with the specific geographical situation. Relatively easy general conclusions can be drawn on the global to regional scale, where it becomes obvious that particularly low-latitude regions will be affected negatively regarding their agricultural yields, water availability etc. Generally speaking, the greater the glo-

Table 7: Determinants of rural household vulnerabilities

External	Internal
A high proportion of households engaged in subsistence or small scale farming or herding on marginal lands	Access to safe water and sanitation
Scarcity of water and other resources	security of water rights
High poverty rates	Land-tenure status
Rapidly growing population	Farm size and soil quality
Poorly diversified income opportunities in the local economy	Number of animals owned
Inadequate health, education and other services	Quantity and quality of household labor supply
Lack of social safety nets	Ownership of farm equipment
Gender inequality	Amount and diversity of household income
Declining local authority	Financial savings
Governance failures	Access to Credit
Violent conflict	Food stores
Competition from market liberalization	Health status of household members
	Gender of household head

Source: Leary et al. 2007

bal temperature increase, the more severe the adverse effects (IPCC 2007b).

However, these macro-level projections are not sufficient to identify the most vulnerable groups within regions or countries. This requires further efforts. Vulnerability assessments on the national level and the community level are crucial for developing adequate responses to food insecurity in face of climate change. The vulnerability-specific information, which primarily looks at the internal constitution of a region or a community with regard to non-climate stressors, is the necessary next step, as was addressed above. It then must be connected to climate-related factors, for example the change in the likeliness of extreme weather events, and precipitation patterns etc. (see chapter 3). This may result in general assessments of vulnerability to climate change, but may also – and that would be appropriate in the context of this study – be translated into sector-specific climate change risk assessment, for example with regard to food security (Figure 13).

It is generally likely that those already suffering from undernourishment and hunger are also among those most at risk from climate change, although there might be exceptions. It then becomes important what vulnerable groups are placed in regions where climate change will have adverse impacts. As in other fields also in the case of food security, certain non-climatic stressors may have a very important influence on adaptive capacity, as has been identified in the case of India (Parry et al. 2007, 71). There is a large overlap between those districts with a high vulnerability to climate change and those that rank highest in terms of import competition associated with economic globalization. Other studies have assessed specific rural vulnerabilities and relevant climate drivers, e.g. in Africa (Leary et al. 2007). Both external factors and internal factors were found to increase the vulnerability of rural households.

So far we see many regions – e.g. in Africa or in Asia – with more changes in the of weather patterns than changes in the average amount of rain fall (FAO 2003a,

361ff). That means that even with insignificant changes of the average precipitation impacts on farmers and their harvests can already be severe. This provides a serious challenge for the timing of sowing and harvesting. Additional problems are generated by a general trend towards more intense rain events, even if this does not effect the average rain fall. It is important to note, that – because of the non-linear and often chaotic behavior of weather – we will have considerable uncertainty in the future about how projected changes will impact the local level. On the other hand, we can expect progress in assessing the likeliness of climatic long term changes for these regions. The possibility to predict the environmental and social impact will remain limited, but governments have to try to be as specific in their assessments as possible.

The IPCC has concluded that the number and intensity of extreme weather events have likely increased (IPCC 2007a). According to data from the reinsurance company MunichRe, the increase in weather-related extreme events has been much more significant than that of non-weather extremes (e.g. earthquakes) since 1980. This fact is another indicator for increased risks from climate change (Munich Re 2007). Additionally, it needs to be analyzed how changes in the frequency and intensity of extreme weather situations will increase the risk of these groups of being hit by an event with eventually disastrous consequences. Non-linear changes in climate change are difficult to estimate in a detailed assessment of changes. Nevertheless, their potential consequences help to indicate which the potential vulnerable groups are.

In the UN-Human Rights context the term "vulnerable groups" is often used in an standardised form, to describe groups that are particulary hit by serveral forms of discrimination such as "women, children, indigenious etc.". This study use the term in a broader form to describe all groups which are vulnerable to food deprivation and undernutrition or which are under threat to become food insecure. This term is similarly used by an interagency working group on assessing food insecurity the Food Insecurity and Vulnerability Information and Mapping System (see FIVIMS/FAO 2003).

The risk arising from potential consequences of climate change for people will not only be determined by changing weather conditions but also to a large extend by the appropriateness of risk management and adaptation policies. It will therefore be decisive for potentially affected persons how well their government and local community develop responses to adapt to already existing and potential future risks or uncertainties. Thus, climate change impacts have to be assessed in a double sense:

(1) First, certain groups at the national or regional level are at risk to be affected by climate change in a similar way. Entire villages might have to expect impacts by changes in rainfall patterns. Governments need to identify the most likely changes (and also more uncertain but high risk exposure) in livelihood situations and start designing an adequate policy response from that perspective.

The number and geographic size of regions at risk is likely expanded, but in some cases it may also shift. New geographic areas, which had not been risk-prone to weather patterns or increasing sea levels, will be affected by new risks in a climate-changed world. At the same time, new vulnerable groups regarding food insecurity are likely to emerge. While some agriculturally-based livelihoods may – mainly in the beginning – benefit from the effects of climate change, others will be undermined. Also, the livelihood status of agricultural workers will change as specific agricultural production patterns regionally shift. Vulnerability is also increasing for other groups such as low-income city dwellers who often face impacts of extreme weather events or variable food prices. Those with few assets and those who lack adequate insurance coverage or access to safety net transfers are likely to become more vulnerable.

(2) Second, from a human rights perspective, looking at the livelihood situation alone is not enough; even when persons belong to a certain livelihood setting and the climate change effects are similar for all households in a village or region, their individual coping capacities vary from household to household. Households have a different factor endowment that takes into account aspects

such as land ownership, access to assets, or labor capacity. Governments might discriminate in their design of adaptation policies towards households headed by women, or families belonging to minorities or other discriminated ethnic groups. In quite a number of regions, especially in Africa, HIV-affected families are particularly vulnerable.

Any assessment of vulnerability must therefore be human rights-based. A rights-based assessment is a process in itself and has to build on human rights principles such as transparency, participation and non-discrimination. It has to be asked whether the people whose situation was assessed were informed about the assessment, if they could participate or contribute to the assessment, and if they can complain in case that their specific concerns and problems were not adequately reflected in the outcome. The human rights based approach guiding the methodology of this study is further explained below (see chapter 2.5, 4 and 5). One value added is that it sharpens any assessment for the needs of particularly poor and marginal groups in society.

The ability of people at risk to cope with the trends and effects of climate change will depend generally on the three following factors, and for each factor key analytical questions can be identified:

1. The coping capacity of each family and community in its given situation: How many assets does the family have? Which income sources are available? Where is the family living and what are the factors determining the livelihood situation etc.?

2. The government response to the challenges: Does the government have the most affected groups identified? Has it started to introduce policies and programs that address their particular vulnerability etc.?

3. The support for governments and local communities provided by the international community, e.g. by the UN climate policy process: Does the international community provide enough support for governments and local communities? Does the support provide incentives for the government and local communities to identify most vulnerable groups and limit their risk? Does the international support reach these groups?

A person or a family is a vulnerable person or family not only due to changing weather conditions, but mainly due to their livelihood situation and their factor endowment. The question whether the vulnerable situation translates into persistence of or to additional hunger or malnutrition is dependent on the form of the government response. A given (insufficient) factor endowment of families is already partially a result of government policy. The challenge for governments to deal adequately with climate change will be therefore a double one: To adequately address vulnerability, as well as – identify the people at risk from additional climate change related threats – acute or long term ones.

In many cases new groups will become vulnerable through sea-level rise, glacier melting, changing weather patterns or other climate related risk factors. Additionally, countries will see new vulnerable groups emerging that may face problems unknown so far to the country.

Adaptation policies to climate change in principle must pass the same rights-based „test“ as normal policies:

- Has the government identified the relevant vulnerable groups?
- Has a proper risk assessment been done?
- Are the policies reasonably focused on those vulnerable groups?
- Are the effects and the impact of policies monitored?
- Do people have the right to complain against policies affecting them, do they have a legal recourse?

Human rights not only ask for an end to violations and for positive outcomes for the most vulnerable groups, but they also set standards related to the political processes leading to results. These processes must be participatory, transparent and non-discriminatory. A rights-

based approach to adaptation policies will help make them better-targeted to those most affected by climate change.

While only states are parties to the Covenant and are thus ultimately accountable for compliance with it, all members of society – individuals, families, local communities, non-governmental organizations, civil society organisations, as well as the private business sector – have responsibilities in the realization of the right to adequate food. The state should provide an environment that facilitates the implementation of these responsibilities.

2.9 International obligations in the right to food debate and under the UNFCCC

The right to adequate food also sets standards for government interventions abroad and at the international level. The International Covenant on Economic, Social and Cultural rights mentioned the obligation to international cooperation and assistance in two articles. In Articel 2 (1) where the general obligations are described and in Artikel 11 (2) in relation to the realization of the right to adequate food.

While it is a new step in international law to talk about such extraterritorial obligations, there is an increasing body of literature that discusses the matter and describes the respective obligations (see Bread for the World, EED and FIAN (ed.); Gibney and Skogly 2007; Skogly 2006; Coonmans and Kaminga 2005). Three of the special rapporteurs on economic, social, and cultural rights have also started to contribute to the clarification of the extraterritorial obligations of states. Two reports on the extraterriorial obliagations related to the right to adequate food has been written by Jean Ziegler (2006 and 2007). The special rapporteur on the right to health, Paul Hunt, has written one report on the obligation to interational cooperation and assistence in the year 2007. International obligations has been clarified by the special rapporteur on adequate housing, Miloon Kothari.

The obligations can be described in parallel to the obligations at the national level. Governments should make sure that their own policies and programs do not harm people abroad and do not contribute to violations (obligation to respect). They should regulate private actors in a way that their action in foreign countries does not lead to violations (obligation to protect). Concerning the obligation to fulfill, one cannot easily translate the obligation from the national level to the international level, because at the national level it is an obligation to use the maximum of available resources. Thus, in the literature the term used is therefore „the obligation to support in fulfillment".

In this context it is also important to have a look at the obligations for governments arising from the United Nations Framework Convention on Climate Change (UNFCCC), which entered into force in 1994 and has been ratified by 192 Parties (for furhter informations see the website of the United Nations Framework Convention on Climate Change UNFCC). In Article 4.1 all Parties have committed to inter alia

- Cooperate in preparing for adaptation to the impacts of climate change; develop and elaborate appropriate and integrated plans for coastal zone management, water resources and agriculture, and for the protection and rehabilitation of areas, particularly in Africa, affected by drought and desertification, as well as floods;

- Take climate change considerations into account, to the extent feasible, in their relevant social, economic and environmental policies and actions;

- Promote and cooperate in scientific, technological, technical, socio-economic and other research;

- Promote and cooperate in the full, open and prompt exchange of relevant scientific, technological, technical, socio-economic and legal information related to the climate system and climate change, and to the economic and social consequences of various response strategies;

- Promote and cooperate in education, training and public awareness related to climate change and encour-

age the widest participation in this process, including that of non-governmental organizations.

It is both remarkable and concerning that these commitments, as well as the whole Convention, only include a recognition that low-lying and other small island countries, countries with low-lying coastal, arid and semi-arid areas or areas liable to floods, countries experiencing drought and desertification, and developing countries with fragile mountainous ecosystems, are particularly vulnerable to the adverse effects of climate change. But it does not include any specific reference to vulnerable groups or parts of the society. Only in education, training and public awareness are NGOs explicitly mentioned. The same holds true for the Bali Action Plan (UNFCCC 2007b). It is a process driven by Parties, and stakeholders below that level are rarely addressed in negotiating texts. At least the guidelines to the preparation of National Adaptation Programs of Action (NAPAs) explicitly state that it shall be guided by the objective of a „participatory process involving stakeholders, particularly local communities" (UNFCCC 2001).[11]

Where commitments under Art. 4.1 relevant to food security and the preservation of the right to food are implemented, the obligations and guidelines previously described with regard to the right to adequate food are applicable. The combination of these two delineates a clear legal foundation for applying these criteria to adaptation policies and programs related to food security and other rights impacted by climate change, particularly the right to water. According to the „obligation to support in fulfillment", industrialized countries have committed themselves to additional obligations in the UNFCCC which are relevant to this debate:

Article 4.3 of the Framework Convention contains a two-fold financial obligation, to (a) „provide new and additional resources to meet the agreed full costs incurred by developing countries" to prepare their initial national communications, and (b) to „meet the agreed full incremental costs of implementing measures" as referred to under Art. 4.1.

In addition, Article 4.4 states that industrialized countries

> *„shall also assist the developing country Parties that are particularly vulnerable to the adverse effects of climate change in meeting costs of adaptation to those adverse effects" (UNFCCC 1992, 8).*

In essence, industrialized countries have agreed to the obligation to support developing countries in fulfilling their commitments under the Convention. However, Article 4.7 of the Convention must be read in close conjunction with this obligation, because it makes the support by developed countries a precondition for the activities undertaken by developing countries:

> *„The extent to which developing country Parties will effectively implement their commitments under the Convention will depend on the effective implementation by developed country Parties of their commitments under the Convention related to financial resources and transfer of technology [...]" (UNFCCC 1992, 8).*

The recently (end of 2007) adopted Bali Action Plan has the objective to lead to an agreement which will enable

> *„the full, effective and sustained implementation of the Convention through long-term cooperative action, now, up to and beyond 2012" (UNFCCC 2007b, 1).*

It is thus based on all principles and commitments that are enshrined in the Convention. While the Bali Action Plan is literally about considering certain elements in the negotiations on the way to a new climate change

[11] LDCs are assisted financially in preparing NAPAs which should identify the most urgent adaptation needs and identify priority projects; in June 2008, 33 LDCs had submitted their NAPAs to the UNFCCC.

Table 8: Global percentage shares of population, income, capacity, cumulative emissions, responsibility and RCI (combined Responsibility and Capability Index) for selected countries and groups of countries

	Percentage share of					
	Global population	Global income	Global capacity	Cumulative emissions 1990-2005	Global responsibility	Global RCI
United States	4.7	20.2	31.8	23.7	37.0	34.3
EU (27)	7.7	21.5	29.0	17.8	23.1	26.6
United Kingdom	0.9	3.3	4.7	2.5	3.6	4.3
Germany	1.3	4.0	5.6	3.8	5.2	5.5
Russia	2.2	2.5	1.5	7.4	4.3	2.3
Brazil	2.9	2.6	2.1	1.3	1.0	1.6
China	20.4	14.7	7.1	13.8	6.6	7.0
India	17.0	6.1	0.4	3.8	0.3	0.3
South Africa	0.7	0.9	0.8	1.6	1.5	1.1
LDCs	8.3	1.4	0.1	0.4	0.0	0.0
All high income	15.6	53.9	78.8	52.7	76.9	78.5
All middle income	47.7	36.6	20.7	41.1	22.8	21.1
All low income	36.7	9.5	0.5	6.2	0.4	0.5

In this calculation, the US would have to bear 34.3 percent of the adaptation costs in developing countries, based on a combined analysis of capacity and responsibility. This analysis includes a „development threshold", which excludes the number of people living below an annual income of USD 9,000 in power purchasing parities (see original source for more details).

Source: Baer et al. 2007, 12

agreement, the elements contained imply certain reiterated or new commitments for developed countries to support developing countries. Without these it is unlikely that developing countries will agree to a (meaningful) post-2012 framework.

New and additional resources shall be provided, including innovative means of funding to assist particularly vulnerable Parties on adaptation, financial and technical support to assist developing countries in determining their financial adaptation needs, and means to incentivize adaptation action (UNFCCC 2007b).

A number of activities are listed where increased international cooperation shall be discussed, including vulnerability and financial needs assessments, risk management and risk sharing concepts (such as insurance) and ways to enable climate-resilient development and to reduce vulnerability (UNFCCC 2007b, 2).

The size and criteria for any additional resources developed countries will have to provide a key issue in the post-2012 negotiations. The Convention's key principle of „common but differentiated responsibilities and respective capabilities" serves as a starting point for determining the „burden sharing" in adaptation financing, but the concrete application is not trivial. Responsibility is usually related to greenhouse gas emissions, and capability mostly refers to an indicator of economic wealth or state of development. Table 8 shows one of the most recent and most sophisticated attempts to calculate the burden.

While the negotiations on a post-2012 agreement are gaining pace, countries are expected to come forward with more concrete proposals describing how adaptation could be fostered in the future. In the negotiations in Bonn in June 2008, some countries introduced ideas based on the Convention's principles. Three notable examples are proposals by Norway, Switzerland and Mexico. The first two presented their ideas explicitly as a means to generate financing for adaptation, while the Mexican proposal of a World Climate Change Fund focused on financing mitigation (see Harmeling and Bals 2008b). In some of these concepts certain developing countries would also have to make limited financial contributions, like in Table 8. While differentiation among developing countries is a touchy issue, the fact is that in more and more developing countries there is a growing consumer class with a growing carbon emission responsibility – more than hundred of million people in China and India. It is interesting to see that, not only Mexico, but more and more developing countries start addressing this perspective more openly.

At the same time, developing countries are also expected to present on how they plan to effectively scale-up adaptation and deliver it to the most vulnerable communities in case they want to receive financial support. Neither the Bonn negotiations nor the submissions made in past months by developing country Parties have added substantially to this particular question (see Harmeling and Bals 2008b). Against this background, a more thorough analysis of how the voluntary FAO guidelines outlined above could serve as a guideline to develop such concepts, e.g. in the context of the future development of „National Adaptation Plans", will be reasonable.

Finally, a crucial issue with regard to developed countries' commitments has to be raised. Assuming the additional resources needed for adaptation in developing countries is generated through a mechanism under a post-2012 framework, this resource flow would reach a significant magnitude in the order of tens of billions Euros. The actual delivery of ODA not only falls short of the developed countries' commitment made to provide 0.7 percent of their GNI, it also lags behind what is estimated to be necessary to reach the Millennium Development Goals. While there are many possible synergies between increasing people's adaptive capacity to climate change and poverty reduction strategies, adaptation requires additional investments. Those that are least able to cope with climate change are those that have contributed almost nothing to the problem. That is why many countries in the recent negotiations in Bonn and other occasions have rightfully called for a definition of additional finance (additional to ODA commitments). Thus, financing mechanisms that deliver resources that are not counted as ODA can be judged as more in line with the principles of the Convention (see Harmeling and Bals 2008b and for more details on adaptation measures see chapter 5).

3 Relevant trends in climate change

The following chapter is primarily based on the results of the IPCC's Fourth Assessment Report (FAR) which was released in the first half of 2007. Most information is taken from the Working Group II of the IPCC on „Impacts, Adaptation and Vulnerability" which was concerned with the relationship between observed climate change and the recently observed changes in the natural and human environment (IPCC 2007b; Parry et al. 2007).

Working Group I, „The Physical Science Basis", considered the information available on observed climate change and projections of future emission pathways and related consequences in terms of temperature increase, sea-level rise etc. (IPCC 2007a). Additional information has been added as new data has become available.

The average global temperature has increased during the 20th century by 0,74°C. The first working group of the FAR concluded that most of the observed increase in globally averaged temperature since the mid of the 20th century is very likely due to the observed increase in anthropogenic greenhouse gas concentrations.

The FAR Working Group II summarized some major trends which show that many natural systems are being affected by climate change, particular processes related to temperature increase (IPCC 2007b):

■ In relation to changes in snow, ice and frozen ground, including permafrost, there is a high confidence that natural systems are affected on all continents. This conclusion includes the enlargement and increase of glacial lakes, the increasing ground instability in permafrost regions, rock avalanches in mountain areas, as well as substantial changes in Arctic and Antarctic ecosystems.

■ Concerning hydrological systems, there is high confidence that many glacier- and snow-fed rivers will experience increased run-off and earlier spring peak discharge. A warming of lakes and rivers in many regions is projected.

■ There is also high confidence that recent warming is strongly affecting terrestrial biological systems, which includes effects such as earlier timing of spring events, leaf-unfolding, bird migration and egg-laying. Satellite data show already earlier greening of vegetation in the spring since the early 1980s, and that this trend is linked to longer thermal growing seasons due to recent warming.

■ Rising water temperature will impact marine and freshwater biological systems as substantial new studies have shown. It will lead to range changes and earlier migrations of fish in rivers, and will contribute to shifts in ranges and changes in algal, plankton and fish abundances in high-latitude oceans and high-altitude lakes.

For some fundamental trends, recent studies indicate that the expected changes might even occur faster than recently anticipated. For example, the increase of the atmospheric CO_2 concentration has been faster during the last years (2000-2006: 3,3%/year; 1990-1999: 1.3% year) (Raupach et al 2007). This development is partly seen as an implication of the fact that the ocean might already be absorbing less CO_2 than expected (perhaps already as a result of global warming) (Canadell et al. 2007). Loss of arctic sea ice seems to be accelerating compared to even the most advanced model projections (Stroeve et al. 2007). Observed temperature increase and sea level rise are at the highest range of IPCC expectations (Rahmstorf et al. 2007).

The research on tipping elements and their thresholds and the impacts that these might have is increasing (see Lenton et al. 2008 for an overview). The severity of impacts of such non-linear processes of climate change is potentially huge, also with regard to food security. Still there is a lot of uncertainty, particularly on the threshold levels for triggering these changes.

Here, we choose a strategy to argue for a precautionary principle based mitigation strategy. It would prevent, with a high likelihood, the big tipping points. The tip-

Table 9: Examples of major projected impacts of climate change

Phenomenon and direction of trend	Likelihood of future trends based on projections for 21st century using SRES scenarios	Agriculture, forestry and ecosystems	Water resources
Over most land areas, warmer and fewer cold days and nights, warmer and more frequent hot days and nights	Virtually certain	Increased yields in colder environments; decreased yields in warmer environments; increased insect outbreaks	Effects on water resources relying on snow melt; effects on some water supply
Warm spells/ heat waves. Frequency increases over most land areas	Very likely	Reduced yields in warmer regions due to heat stress; wildfire danger increase	Increased water demand; water quality problems, e.g., algal blooms
Heavy precipitation-events. Frequency increases over most areas	Very likely	Damage to crops; soil erosion, inability to cultivate land due to water logging of soils	Adverse effects on quality of surface and groundwater; contamination of water supply; water stress may be relieved
Area affected by drought	Likely	Land degradation, lower yields/crop damage and failure; increased livestock deaths; increased risk of wildfire	More widespread water stress
Intense tropical cyclone activity increases	Likely	Damage to crops; wind throw (uprooting) of trees; damage to coral reefs	Power outages cause disruption of public water supply
Increased incidence of extreme high sea-level (excludes tsunamis)	Likely	Salinisation of irrigation water, estuaries and freshwater systems	Decreased freshwater availability due to salt-water intrusion

Source: Parry et al. 2007, 68

ping point which would irreversibly trigger the melting of the Greenland ice shield might already be triggered with a treshold of less than two degrees Celsius. It is unclear whether a meaningful adaptation strategy would be possible in a scenario where the threshold of most tipping points is passed this century. This is further elaborated in chapter 3.4.

The different findings on the impact of climate change on food, fibre, fish and water as well as the necessary adaptation needs from the FAR are presented in chapter 3.5. Obviously regional trends will vary quite substantially because many different factors will interfere (costal regions, continental climate, land-use change etc.). They are described below in chapters 7 to 9 and are subject to continental studies that will accompany the main study.

Besides chapter 3.5, we will summarize the major trends in climate change in chapter 3. These trends are of particular importance for the agricultural sector and for food security: (3.1) increase in variability of weather patterns, (3.2) rising importance of weather extremes, (3.3) moving of climate zones and (3.4) changes to be expected through non-linear changes in climate change (tipping elements).

Table 9 summarizes projected climatic changes and their impact on the sectors most relevant for the food security debate.

3.1 Increasing variability

One of the major trends that will characterize the impact of climate change on food security will be the increase in the variability of weather patterns. Many factors that determine local weather conditions will change in the process of climate change and such changes in the patterns of these weather factors have already become a major source for impact of climate change on agricultural production and food security.

The IPCC predicts with high confidence a greater instability of seasonal weather patterns for all parts of the world. The first indicator to change will be the start and the end of growing seasons. This trend is linked to increasing evidence from observations of a wider range of species, that recent warming is strongly affecting strongly terrestrial biological systems. It leads inter alia to an earlier timing of spring events, including earlier leaf-unfolding, bird migration and egg-laying (Rosenzweig et al. 2007, 1.3). While this can be positive in temperate climates prolonging the growing season it will be negative in those areas where the start of the growing season was historically oriented towards sufficient rainfall. If the growing period is disconnected from the mayor rainfall events, it will become difficult to continue agriculture with the same plants than were traditionally used in a certain region.

Most land used for agriculture is still rain fed. Only 16 percent of land used for agriculture is irrigated, and around 40 percent of the world‘s harvest is produced on this land. In Africa only seven percent of agricultural land is irrigated (FAO 2007). For all non-irrigated land, changes in precipitation patterns will have a huge impact on agricultural production. Rainfall will be influenced by the temperature increase, which will lead also to an increase in the evaporation almost worldwide. Because more water will be in the atmosphere, more precipitation will fall as a result of climate change – but not everywhere. The IPCC concludes increasing precipitation at high latitudes and in the tropics. The south-east monsoon region might benefit and the tropical pacific might get more rainfall (Kundzewicz et al. 2007, 3.3.1). A decrease in precipitation is expected in the sub-tropics such as southern Europe, Northern Africa and northern Sahara.

While temperatures are expected to increase during all seasons of the year worldwide, precipitation may increase only in one season and decrease in another season. Precipitation variability are expected to increase in the future (Trenberth et al. 2003). Studies on expected changes in precipitation extremes in Europe can be summarized by the fact that the intensity of daily precipitation events will increase over the all areas in Europe, even on those where the average is likely to decrease (Christensen and Christensen 2003; Kundzewicz et al. 2006; Giorgi et al. 2004). This means that the number of wet days in Europe is projected to decrease, with longer dry periods in between excluding the winters of western and central Europe. At the same time an increase in days with intense precipitation has been projected across most of Europe, except for the South. However, the IPCC highlights that the projections related to the change in precipitation and other hydrological factors are less secure than the projections related to temperature increase (Kundzewicz et al. 2007, 3.3.1). Climate projections are still not easy to incorporate into hydrological impact studies (Allen and Ingram 2002).

The expected changes in precipitation will be of particular relevance for agricultural production. If the rain does not come at the right moment or on fewer days with more intensity, it might hinder the possibility of farmers in a certain region to produce the products they are used to. Alternative varieties or the shift to other products might help to deal with the situation, but this will require that the affected farm households have the necessary information on the expected changes and the necessary resources or support to shift production.

Freshwater availability will also be affected by changes in the runoff of rivers. With the increasing humidity in the atmosphere it is projected that the annual average

river runoff and water availability will increase by mid century. The increase expected are 10-40 percent in high latitudes and in some wet tropical areas, however, decreases of 10-30 percent may occur in some dry regions in mid-latitudes and in the dry tropics, some of which are already water stressed areas (Kundzewicz et al. 2007, 3.4.1). Since the TAR, over 100 studies have been published on climate change effects on river flows in scientific journals. Most of them are still focused on Europe, North America and Australia. While uncertainties still exist relating to the downscaling from climate change models on catchment scale predictions, a very robust finding from hydrological impact studies is that warming leads to changes in the seasonality of river flows where much winter precipitation falls as snow (Barnett et al. 2005). The IPCC FAR refers to serval studies for all relevant regions, such as European Alps, the Himalayas, western Nothern America, central and eastern Northern America, the entire Russian territory, and Scandinavia and Baltic regions (Kudzewicz et al. 2007, 3.4.1). Temperature increase causes less water to come down as snow, and therefore winter flows will increase and summer flows will decrease. In many cases the peak flow would occur at least a month earlier than today.

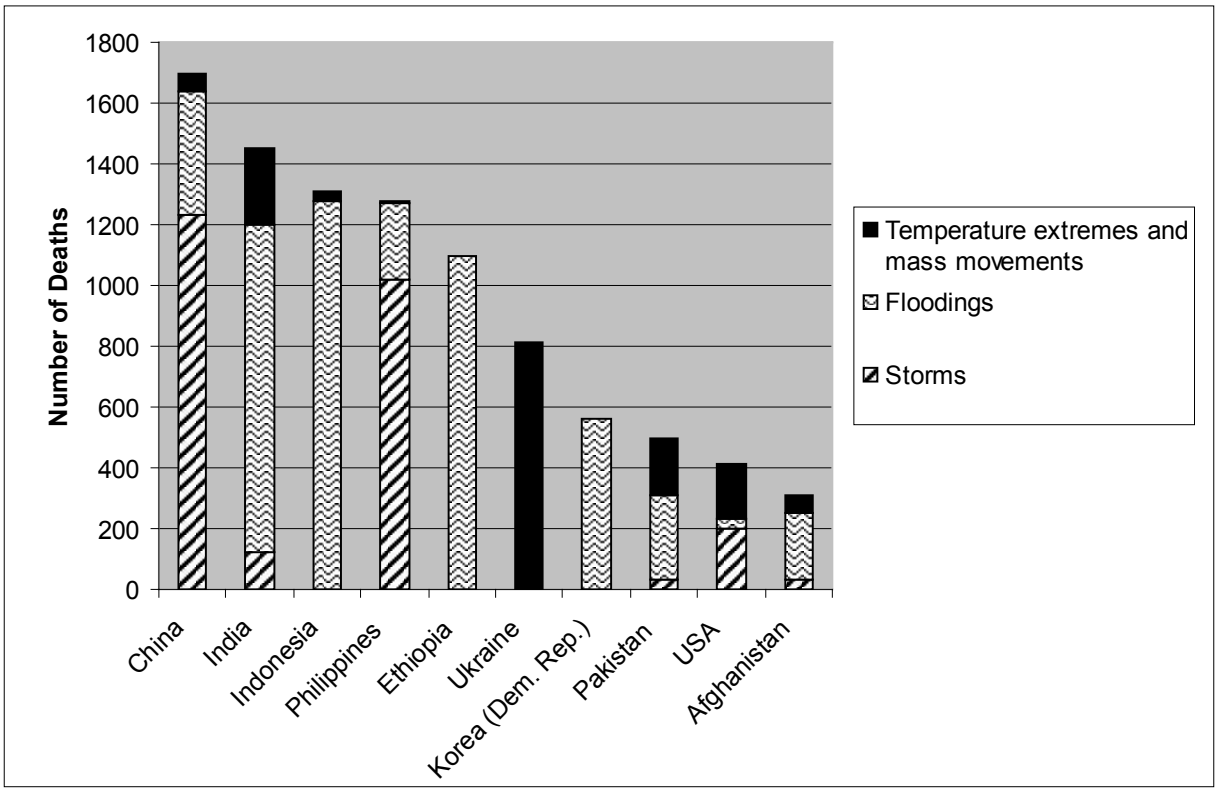
Higher temperature will lead to increased glacier melt. The results from simulations lead to the conclusion that glaciers in the Northern Hemisphere will decrease in size up to 60 percent by 2050 (Schneeberger et al. 2003). Melting glaciers will lead to an increase in river flow in the short term, but the contribution of glacier melt will gradually decrease over the next decades. Less snowfall or earlier melting of snow will increase the seasonality of the river flow, creating higher flow in the peak flow seasons or either lower flows during the low flow season or extended dry periods. One sixth of mankind is living in areas with rivers nurtured by glaciers, particularly in the Himalayas (IPCC 2007b, 11). The melting of these glaciers in the coming decades will change the river flow pattern of all mayor rivers in South and East Asia. This will impact both the access to drinking water and water for personal consumption as well as to irrigation water. The large increase of productivity in agricultural production in Asia that has happened since the ‘80s was basically achieved through a combination of high yielding varieties with the increase of irrigation water and agricultural inputs. The expected changes of river flows in the region will be an important trend for the long term production potential of the region.

3.2 Extreme weather events

Disaster losses from weather-related extreme events have grown much more rapidly than population and economic growth indicators (Kundzewicz et al. 2007, 3.2; Mills 2005). There is now clear evidence for a climate change-related trend in floods during the last decade (Kundzewicz et al. 2007; Schiermeier 2006). What is visible is the observed increase in precipitation intensity and other changes, such as the increase in westerly weather patterns during winter over Europe. This trend leads to very rainy low-pressure systems that often trigger floods. These are the first indicators that climate change might have an impact on rain based floods. So far the number of great inland flood catastrophes has doubled during the years 1996-2005 compared to the ‘50s up until the ‘80s. Economic losses have even increased five fold (Kron and Bertz 2007). However, the dominant factor for the upward trends in economic flood losses are socioeconomic factors, such as increasing population and the increase of settlement in vulnerable areas etc. Floods are currently the most reported natural disaster across the globe. In this connection the World Development Report in 2003 abd 2004 reports about 140 million affected persons per year. In many countries they are the type of extreme weather events that cause the highest number of deaths (Figure 14).

Drought affected areas will likely increase in extent (IPCC 2007a). Several models predict that the proportion of the land surface in extreme drought, will increase globally by the factor of 10 to 30, or from 1-3 percent today to 30 percent by 2090 (Burke et al. 2006). Droughts are first and foremost affecting rainfed agricultural production and the water supply for domestic, industrial and agricultural purposes. However, it also impacts livestock (Table 10). It is already possible to show that some semi-arid and sub-humid regions of the

Figure 14: Deaths attributed to different types of extreme weather events in 2006



Source: based on Harmeling 2007

globe have suffered from more, more intense and multi-annual droughts (e.g. Kundzewicz et al. 2007, 3.2).

The term drought also refers to different factors. A meteorological drought refers to reduced precipitation, a hydrological drought to reduced river flows and reduced water levels in rivers, lakes and groundwater. Agricultural drought means lower soil moisture. With the expected increase in area affected by drought, it is likely that water stress in semi-arid and land in low latitudes as well as in mid-latitude continental interiors in summer will be more widespread (IPCC 2007a).

Processes of land degradation will intensify the negative impact on crop yields up, livestock death and crop failure. Reduced water availability will also lead to water shortages for food and domestic consumption, which in turn will increase the risk of water and food-borne diseases.

Precipitation intensity is projected to increase almost everywhere, but particularly at mid and high latitudes, causing more severe flash floods and urban flooding. An increase of events with heavy precipitation is very likely, and might damage crops and lead to soil erosion (IPCC 2007a). It might increase the risk and/or inability to cultivate land (IPCC 2007b). Heavy precipitation events will simultaneously contribute at the same time to flood risks in the drought-prone areas. The amount and distribution of rainfalls will be important for food security. Only slight changes in the arrival or amount of water will influence certain crop yields dramatically. While the precipitation in the Sahel region has increased during the last decade, there is uncertainty over the future

Table 10: Quantified impacts of selected African droughts on livestock, 1981 to 1999

Date	Location	Mortality and Species
1981-84	Botswana	20% of national herd
1982-84	Niger	62% of national cattle herd
1983-84	Ethiopia (Borana Plateau)	45-90% of calves, 45% of cow, 22% of mature males
1991	Northern Kenya	28% of cattle, 18% of sheep and goats
1991-93	Ethiopia (Borana)	42% of cattle
1993	Namibia	22% of cattle, 41% of goats and sheep
1995-97	Greater Horn of Africa (average of nine pastoral areas)	20% of cattle, 20% of sheep and goats
1995-97	Southern Ethiopia	46% of cattle, 41% of sheep and goats
1998-99	Ethiopia (Borana)	62% of cattle

Source: Easterling et al. 2007, 278

development (Lenton et al. 2008). Some models predict further increase. However, if this going to fall more intensely and extreme precipitation events are going to occur, this may cause damages rather than benefits. It will be one of the regions where rain water harvesting could become one of the most important adaptation techniques. Storm drainage systems need to be adopted to cope with increasing rainfall (Waters et al. 2003). A storm drain, storm sewer (U.S.), stormwater drain (Australia and New Zealand) or surface water system (UK) is designed to drain excess rain and ground water from paved streets, parkings lots, sidewalks, and roofs. Storm drains vary in design from small residential dry wells to large municipal systems.

While it is estimated that up to 20 percent of the world's populations live in river basins that are likely to be affected by increased flood hazards by the 2080s as a result of global warming, river flows in many temperate regions during snow melt spring flood periods is likely to decrease (Kleinen and Petschel-Held 2007). River basins fed by snow-melt water in summer and autumn, when demand is highest, could become areas of temporal or seasonal droughts, particularly when, with rising temperature, precipitation is falling as rain and not as snow (Barnett et al. 2005). Drought problems are projected for regions which depend heavily on glacial melt water for their main dry-season water supply. In the Andes region it will affect rivers fed by small glaciers in Bolivia, Ecuador, and Peru and will be relevant for tens of millions of people during the long dry season (Coudrain et al. 2005). In the Hindu Kush and Himalayas, areas are affected by reduced glacier melt in the long run, on which hundreds of millions of people in China and India live (Barnett et al. 2005).

The projected increase in the frequency of droughts and floods is expected to negatively affect local crop production, especially in subsistence sectors in low latitudes (Easterling et al. 2007, 5.4). More frequent extreme events may lower long-term yields by directly damaging crops at specific developmental stages, such as temperature thresholds during flowering, or by making the timing of field applications more difficult, thus reducing the efficiency of farm inputs (Porter and Semenov 2005). The potential effects of extreme weather on food security and human beings have to be seen in regional or local perspectives. When marginalized farmers start to plant crops on steep hills, strong rains can easily destroy their harvest. When people settle in areas often flooded by extreme weather conditions it will have an effect. Other examples could be given: These effects

from weather extremes have to be strongly judged in connection with land use patterns and settlement patterns. Both (the climate change effects and the land use patterns) have changed rapidly during the last decade and this fact increases the risks.

Droughts will also have a huge impact on livestock kept on grassland and pastoralism, as it is summarized in Easterling et al. (2007). Warming up to 2°C is suggested to have positive impacts on pasture and livestock productivity in humid temperate regions. Negative impacts are projected in arid and semiarid regions, even under this very positive scenario, while only a few studies exist on the impact for tropical grasslands and rangelands. Thermal stress will contribute to reducing productivity and is potentially life-threatening to livestock. Higher temperatures might put an end to the diary production of certain modern breeds (Friesians) in the tropics (King et al. 2005). As shown in the chapter above, many of the world's rangelands are affected by ENSO events, increasing the risk of severe vegetation degeneration.

Other weather extremes that are analyzed in the IPCC report are tropical cyclones and heat waves. It is likely that the intensity of tropical cyclones and the severity of their impacts will increase, which is also due to the rise in sea-level (see chapters 3.4 and 3.5). This will increase the risk of total failure of crops in a certain region. Trees may be uprooted, damaging the income families accrue from using the trees and reducing future protection of coastal areas. More intense tropical cyclones can also damage coral reefs, which are inter alia of very high importance for the re-growing of fish stocks (IPCC 2007b). Latest findings also show that tropical cyclones might reach areas that were never before hit by cyclones, so that the risk areas for damages at coastal zones are increasing. This was the case in 2004 when for the first time ever a hurricane formed off the Brazilian coast (Swiss Re 2004). More intense tropical cyclones would also cause severe economic consequences for the affected regions and households. For example, in 2004 hurricanes hit the Cayman Islands and caused economic losses that amounted to more than double the Gross Domestic Product of that year (Anemüller et al. 2006). Beside the loss of property the likelihood of cyclones alone will change land prices and the possibility to secure property with private insurances.

It is also very likely that the frequency of heat waves will increase across most continents (IPCC 2007a). Heat waves can have a huge impact on the agricultural sector. The European heat wave in 2003 is a good example that can prove this connection. In the summer of 2003 Europe experienced a heat wave, with reaching 6°C above the long term means and precipitation deficits up to 300 mm (Trenberth et al. 2007). Maize yields in Italy dropped by 36 percent for the Po valley. For France, the corn grain crop was reduced by 30 percent compared to 2002 and the fruit harvest by 25 percent (Easterling et al. 2007, 5.2.2). Heat waves will contribute to reduced yields in warmer regions due to the heat stress for crops and can add to already existing water stress. The increase of the danger of forest fire and will directly affect the health of many people. The European heat wave in 2003 was a disastrous example of the possible health impacts, more than 30,000 people died across Europe, making this heat wave the most severe European natural catastrophe for centuries (Munich Re 2007). However, it is likely that better preparation for heat waves in hospitals, nursing homes etc. will limit the impacts in the future. In terms of the connection to climate change, studies found out the anthropogenic greenhouse gas emissions already have substantially increased the likelihood of such kind of extremes across central Europe. By 2050 such heat waves could become a usual phenomenon (Stott et al. 2004).

The increase in heat waves goes hand in hand with the trends of warmer and fewer cold days and nights and with warmer and more frequent hot days and nights. Together these tendencies will increase the heat stress for crops. While the second trend can be positive to yields in colder environments, yields will be reduced in warmer environments (IPCC 2007b).

In sum: The likelihood of weather extremes is increasing both in frequency and intensity over all continents. Regional variation will be huge; different geographical conditions at specific locations will co-determine how disaster prone a certain area will be. One of the con-

clusions of the FAR of the IPCC is that the projected changes in the

> *„frequency and severity of extreme climate events will have more serious consequences for food and forestry products, and for food insecurity, than will changes in projected means of temperature and precipitation" (Easterling et al. 2007, 299).*

Modeling studies suggest that the increasing frequency of crop loss due to extreme weather events may eliminate positive effects of moderate temperature increase (Easterling et al. 2007, 5.4.1).

For all of the extreme events, there are quite a number of climatic and non-climatic drivers influencing the impact, all of which have to be taken into account. The impact of different types of flooding (flash floods, river floods, urban floods etc.) is heavily influenced by non-climatic drivers such as the human encroachment into flood plains or the lack of flood response plans. Drought impacts depend on factors such as changes in land use patterns or land cover and water demand and use. Excessive water withdrawals by urban cities or intensified agriculture are just two examples that might aggravate the impact of a drought (Kundzewicz et al. 2007).

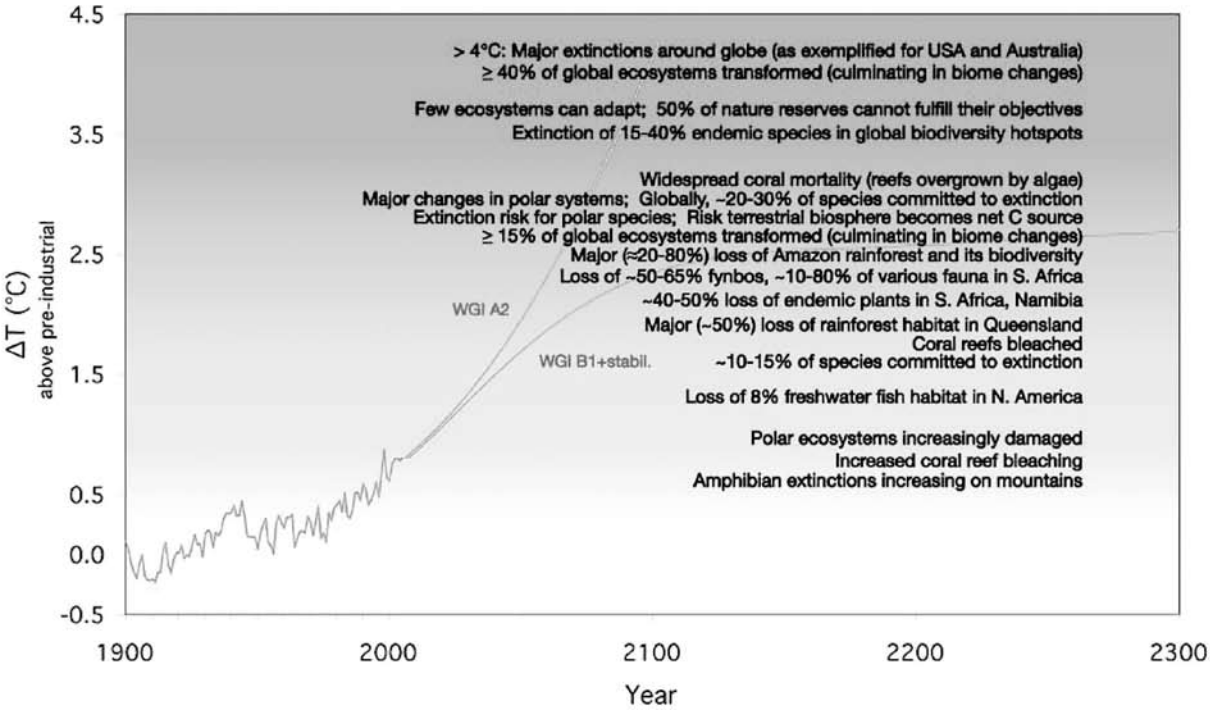
3.3 Moving of climate zones and other ecosystem impacts of climate change

The expected global increase in temperature will have an impact on many ecosystems and will require change and adaptation. Since healthy ecosystems are a key provider of services relevant to food security, this notion will impact food prospects. The IPCC FAR concludes that there is very high confidence that recent warming is already strongly affecting all terrestrial biological systems, which will include earlier timing of spring events, and pole ward and upward shift in ranges of plant and animal species (IPCC 2007b). In this subchapter we will summarize the main changes that are expected in ecosystems and that are relevant for food security. Other changes might also indirectly impact food security in the long run but they are not discussed here in detail. This is particularly relevant for health related effects, such as changes in insects affecting human health and wiht that also individual food securtiy circumstances. Increasing temperature above 2.5°C, projections suggest major changes in ecosystem structure and function, species´ ecological interactions and species´ geographic ranges, with predominantly negative consequences for biodiversity, and ecosystems goods and services (IPCC 2007b). Plants and crops will need to adjust to the global temperature increase. In chapter 3.5 we will look into the changes that can be expected for crop yields of major stable crops. Rice, wheat and maize have a limit in temperature increase, beyond which grain yields are damaged. In tropical regions the limit is 1.5 to 3° C, in temperate climate it is 4.5 to 5° C above. Further warming in either regions exceeds adaptive capacity (Easterling et al. 2007). In this chapter we will focus on the overall changes needed for plants, trees, and pluriannual crops.

Non-anthropogenic climate change has also forced species to migrate in a palaoclimatic perspective. At the beginning of each cold period in the climate history many trees, crops, and other species had to move away from the poles or downwards into warmer valleys. Conversely, at the beginning of every warmer period plants and species started to move up towards the poles and uphill (Rosenzweig et al. 2007, 1.3; Confalonieri et al. 2007, 8.2; Field et al. 2007, 14.2). A similar process is expected to happen with current anthropogenic climate change. The IPCC estimates that already at a temperature increase of 2°C above 1980-1999 levels will force around 20 percent of the world's eco-systems will have to move (IPCC 2007b). Due to the fact that entire systems can hardly migrate, the dominance of certain lead varieties will change. The current observed trend is about a 6 km per year move towards the poles (Fischlin et al. 2007).

There is a limit to the speed with which crops can move over longer distances in order to grow there. Unmitigated anthropogenic climate change will be faster than all processes of warming or cooling during human history, and it will be too fast for many species

Figure 15: Projected impacts of climate change on ecosystems



Source: Fischlin et al. 2007

to move. Moreover, such moves were historically possible because nature had untapped space in which to migrate. It was not interrupted by cities or other major forms of land use, which now hinder such moves. In part climate change will lead to the use of crops which might not have been cropped in a certain country or region before. However most studies do not believe that this potential is substantial enough to offset other losses in food production through climate change.

Ecosystems will react to external forcing in a non linear manner. Most initial changes in ecosystems seem to dampen the impact, but amplify it if thresholds in magnitude or rate of change are surpassed (Fischlin et al. 2007, 4.4.1). The temperature increase is projected to lead to a huge loss in the number of species present, and therefore the potential of biodiversity.

Approximately 20 to 30 percent of plant and animal species assessed so far are likely to be at an increased risk of extinction if global average temperature exceeds a 2 to 3°C increase as compared to pre-industrial level (Fischlin et al. 2007, 4.4.10 and 4.4.11). This scenario requires very substantive mitigation efforts. Current conservation practices are poorly equipped to deal with the expected changes. An increase in temperature of 2 to 3°C over pre-industrial levels will already put more terrestrial, maritime and freshwater species at the risk of extinction than in the recent geological past, inter alia because of the speed of the change.

Coral reefs are the habitat for about a quarter of all marine species. These reefs contribute to food security particularly in that they supply protein to subsistence fishers. They will be influenced by climate change by increasing surface water temperature and the acidification of the oceans. These changes are projected to result in greater vulnerability to thermal stress, to which most species have a very low adaptive capacity. Increases in sea surface temperature of about 1 to 3 °C are projected

to result in more frequent coral bleaching events and widespread mortality (see also Figure 15).

In addition to the effects of temperature increase, extreme weather events may also damage or even destroy important ecosystem components. The relevant IPCC chapter lists a number of examples of how extreme events can cause mortality of species, contribute to determining which species are present in ecosystems, and how droughts and heat waves have both short-term and long-term implications for vegetation (Fischlin et al. 2007).

Climate change becomes a forceful external driver that will influence long-term food security at the global level. It will endanger sustainability of natural processes and their services to human beings in the long run. Beyond the threshold of 2 to 3°C temperature increase above pre-industrial levels, the IPCC projects

> *„substantial changes in the structure and functioning of terrestrial, marine and other aquatic ecosystems" (Fischlin et al. 2007, 213).*

Ecosystems do have adaptive capacity but there seem to be thresholds which are likely to induce non-linear consequences and feedback processes. Also, the pace of change is particularly important. That is a key reason why, in addition to limiting global warming to below 2°C above pre-industrial levels, the German Advisory Council for Global Environmental Change has also introduced a climate guard rail of no more than 0.2°C increase per decade (WBGU 2003).

However, it is important to underline that many ecosystems are under immense stress from non-climatic human drivers, such as deforestation, urbanization and unsustainable use of resources etc. Climate change adds to these stresses. Thus, the IPCC concluded that

> *„the resilience of many ecosystems is likely to be exceeded this century by an unprecedented combination of climate change, associated disturbances (e.g., flooding, drought, wildfire, insects, ocean acidification), and other global change drivers (e.g., land use change, pollution, over-exploitation of resources)" (IPCC 2007b).*

3.4 Tipping elements – large-scale risks in the earth system

Trespassing of certain threshold values regarding the rise of global temperature could cause abrupt and irreversible changes in the earth system. Not only is this a lesson learned from the earth's history, but it is increasingly being investigated by climate change scientists.

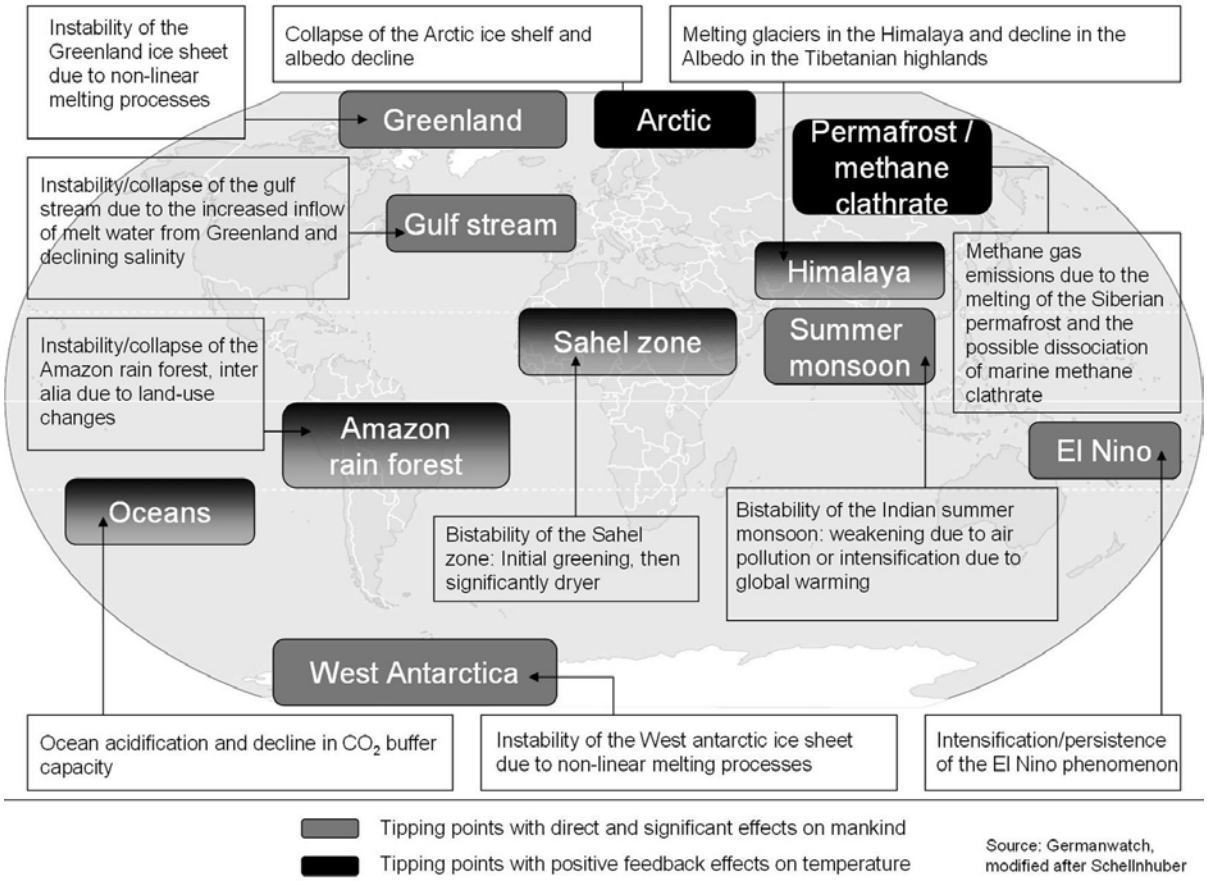
The relation between global climate and the earth system is a complex one, particularly due to the fact that climate and non climate drivers interplay with one another. Additionally non-linear processes include several feedback loops and these loops are very difficult to predict. The history of the earth shows that non-linear processes have happened quite often, particularly in the Holocene epoch. Ice shields have suddenly melted, ocean streams have frequently abruptly stalled and monsoons have unexpectedly collapsed.

Often small disruptions are sufficient to entail fundamental changes. Simulations based on the knowledge of abrupt climate change in the past and the scientific school of analyzing highly complex processes which was established in the 1970s support the finding that our climate and the earth system might react to the increasing temperature due to the anthropogenic climate change with changes of enormous magnitude.

Avoiding dangerous climate change, in accordance with Article 2 of the United Nations Framework Convention on Climate Change (UNFCCC see chapter 1), requires a better scientific understanding regarding the levels of temperature increase and atmospheric greenhouse gas concentrations at which large-scale dangerous impacts are projected to occur with a certain likeliness. Major progress has already been made in this regard (Lenton et al. 2008).

Two approaches have been developed to define the challenge of „avoiding dangerous climate change". One

Figure 16: Map of selected tipping elements and their consequences



Source: Germanwatch, based on Schellnhuber

is based on assessments from the bottom and includes the calculations of the impacts of climate change based on linear trends in ecosystems, agriculture etc. The other is a top-down approach that attempts to avoid more substantive changes than those during the still ongoing interglacial.

One of the first approaches to calculate a threshold for avoiding dangerous climate change came in the early 90s from the United Nations Advisory Group on Greenhouse Gases (AGGG). The AGGG was the pre-IPCC scientific advisory group in the UN. They started to systematically screen scientific articles on climate change and studied historic processes of climate change.

The AGGG developed two central indicators. The first was a 1°C increase in temperature over pre-industrial levels; a higher increase was expected to lead to a fast, unpredictable, and non-linear reaction and damage to ecosystems. At the same time the 2°C limit was introduced as a ceiling to avoid risks of severe impact on ecosystems which could be aggravated by non-linear feedback loops. The 2°C limit was later confirmed by the Scientific Council of the German government on Global Environmental Change (WBGU). The WBGU also made a top-down assessment defining a ceiling above which the risk of dramatic changes in ecosystems was seen (WBGU 1995). In 2003, the WBGU confirmed that limit again in a bottom-up study, which concluded that

the expected losses of species and ecosystems would be unacceptably high if temperature should pass the ceiling of 2°C (WBGU 2003). In addition, the WBGU urged limiting global warming to less than 0.2°C per decade.

The 2°C limit is now guideline for policies. In March 2007 the EU decided to orient their climate and energy policies toward this limit (EU 2007). It has now become one of the key negotiation issues for a shared vision for long-term cooperative action under the UNFCCC. Norway, Iceland, Bangladesh, Chile, South Africa and the Alliance of Small Island States (AOSIS) join the EU in explicitly supporting a 2°C (or even lower) limit.

A key reason for this new political backing is the increasing though still incomplete scientific understanding of the so-called tipping elements in the climate system (see Lenton et al. 2008). Connected to the tipping elements are tipping points, thresholds of temperature increase (or other changing factors) beyond which the likeliness of large-scale impacts is significantly increased through initiating non-linear and irreversible (at least in human dimensions) changes in the climate system. Or, how Lenton et al. (2008) explain this concept:

- Tipping element: A component of the Earth system, at least sub-continental in scale (~1000 km), that can be switched – under certain circumstances – into a qualitatively different state by a small perturbation.

- Tipping point: The corresponding critical point – in forcing and a feature of the system – at which the future state of the system is qualitatively altered.

John Schellnhuber from the Potsdam Institute for Climate Impact Research (PIK) developed the first map of possible tipping points, Germanwatch developed this map further (Figure 16). In some cases exceeding certain temperature thresholds could entail dangerous positive feedback effects (black), in other tipping elements there could be enormous direct consequences for human life – usually for many millions of people (grey). In other cases both reactions could occur in parallel (grey-black). For this analysis it is important to look at policy-relevant tipping points. Thus, Lenton et al. focus their report

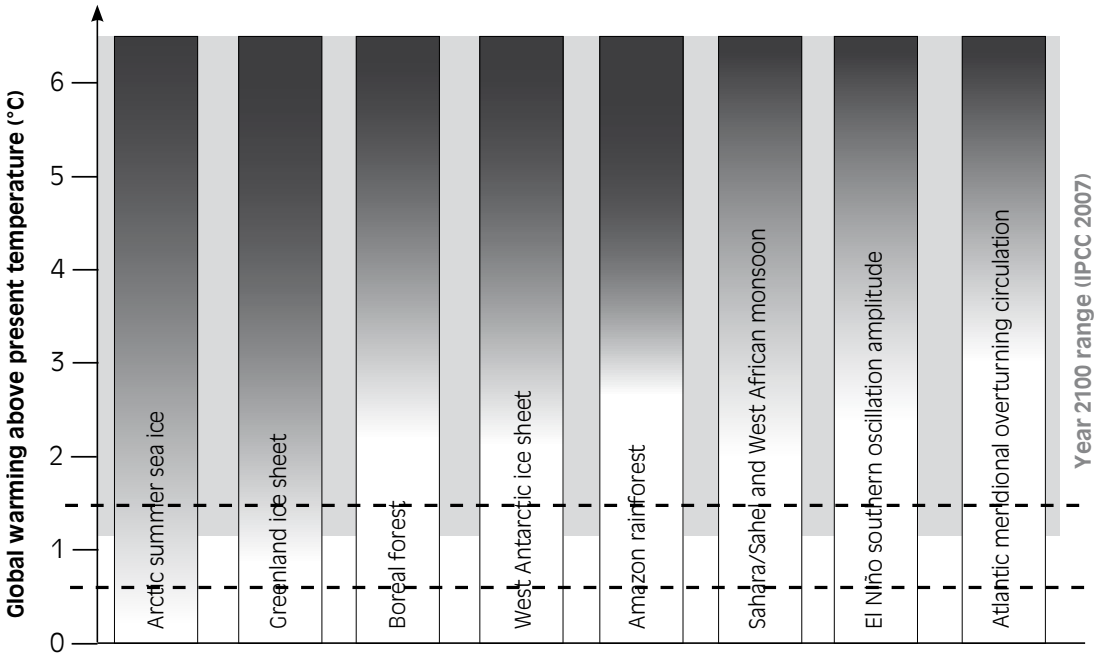
> *„on the consequences of decisions enacted within this century that trigger a qualitative change within this century, and we exclude tipping elements whose fate is decided after 2100".*

Figure 17 shows the estimated temperature for selected tipping elements. All of these points lie within the range of the IPCC emission scenarios for this century and thus could be triggered if no substantial emission reductions are going to be achieved. It shows that even below a 2°C temperature increase the Arctic Sea Ice is probably getting lost and that melting processes in Greenland may be irreversibly induced.

Many aspects of these highly complex processes are not yet fully understood. The models that are used by climate scientists to analyze and project the tipping processes are not yet advanced enough to illustrate these dynamic processes with their multiple feedback loops. Additionally there is inherent uncertainty in these non linear processes. In some of these systems minimal fluctuations at decisive points can induce very different outcomes. Therefore, the anticipated developments are not deterministic predictions but rather well-justified scenarios. On a scale of 0 to 100 Hans Joachim Schellnhuber, president of the Potsdam Institute of Climate Impact Research, estimates the reliability of the simulation results for many of the feedback processes ranges „maybe at 30 to 50, for other only at 10" (Schellnhuber 2007).

Latest observations and new publications show that Greenland and the West-Antarctic already lose much more ice than expected in the IPCC FAR report (Germanwatch 2007; Lenton et al. 2008). This observation has particular relevance for global sea-level rise. These processes are also a good example of how important it is to take a closer look at scientific development since the IPCC presented the FAR in 2007. In the Fourth Assessment Report, the IPCC estimated the future sea-level rise to be between 18 and 59 cm compared to present levels (IPCC 2007a). The TAR report from 2001 resulted in a projected increase of up to 88 cm. While this may create the impression that sea-level rise has lost pace, this change is due to a number of methodological

Figure 17: Selected tipping elements and its temperature thresholds (above 1980-1999 levels)



Shading indicates uncertain thresholds. For each threshold, the transition from white to light grey indicates a lower bound on its proximity, and the transition from grey to black signifies an upper bound. The degree of uncertainty is represented by the spread of the color transition. Dotted lines were added by the authors; the upper line indicates the 2°C limit (above pre-industrial levels), and the lower line shows the temperature increase that can no longer be avoided due to the inertia in the climate system, even if all emissions were stopped by now.

Source: based on Lenton and Schellnhuber 2007; IPCC 2007c

reasons (see Germanwatch 2007). The main reason is that certain processes have been excluded in the recent scenarios because the scientific assessment of these is still in its early stage. The Greenland melting process is partially being driven by the loss of Arctic Sea Ice, which in itself does not lead to higher sea-levels (because the ice is already swimming in the ocean), but leads to a faster temperature increase in the North Atlantic Ocean and in turn further accelerates melting processes. Due to these processes, sea-level rise is now expected to rise by between 0.5 and 1.4 meters by the end of the century (Rahmstorf 2007). Passing the tipping point in Greenland would likely trigger a melting process which could take centuries (in Greenland) but would be irreversible with devastating consequences. The Greenland ice shield alone contains between 4 to 6 meter of sea-level rise. This process could be triggered at a temperature increase of around 1 to 2°C above 1980 to 1999 levels, which is equivalent to 1.5 to 2.5° C above pre-industrial levels. The Arctic sea ice loss tipping point is estimated at 0.5 to 2°C above 1980 to 1999 levels (Lenton et al. 2008).

A recent paper by a group of scientists around James Hansen, which looked in more detail into some of the earth system's feedback, concluded that even at an increase of 1.7°C above pre-industrial levels processes triggered could result in a dangerous or even catastrophic climate change, in particular because of the melting process in Greenland (Hansen et al. 2008).

Fast sea-level rises are nothing new, but a known phenomenon from the past. About 20.000 years before today the temperature was 4 to 7°C lower than today and the sea-level was 120 meter lower at that time (Rahmsdorf 2007, 193). Around 3 Million years ago, the temperature was 2 to 3°C higher and the sea-level was around 25 to 35 meter higher than today. The examples show that substantive temperature related changes are possible. The historic oscillation of sea-level changes was influenced by a variety of factors and no simple equation between temperature increase and size of sea-level rise can be made, but the trends are clear. Around 20 percent of the world population lives in coastal areas not more than 30 km from the coast line. A World Bank study in 2007 estimated that with a sea-level rise of 1 meter about 56 million people in 84 investigated developing countries would be directly affected through permanent inundation (Dasgupta et al. 2007, 10).

Some of the most fertile lands on earth are in low-lying coastal zones. Table 11 shows that even at a sea-level rise of 1 meter many countries would be severely affected in different regards. The situation will be very difficult particularly for several of the small island states (Tuvalu, Kiribati etc.), which have not been included in the analysis shown in Table 11.

It must also be mentioned that this analysis only looked at the impacts of the inundated area, but there are additional impacts like increased storm surge, erosion and other coastal hazards, saltwater intrusion into rivers in delta areas etc. These will threaten vital infrastructure, settlements and facilities that support the livelihood people living along the coast.

There are some tipping points which entail a bi- or multistability, that means there are different directions

Table 11: Ten countries most affected by a 1 meter sea-level rise

Rank	Population	GDP	Urban areas	Wetlands
1	Vietnam (10.79)	Vietnam (10.21)	Vietnam (10.74)	Vietnam (28.67)
2	Egypt, Arab Rep. of (9.28)	Mauritania (9.35)	Guyana (10.02)	Jamaica (28.16)
3	Mauritania (7.95)	Egypt, Arab Rep. of (6.44)	French Guiana (7.76)	Belize (27.76)
4	Suriname (7.00)	Suriname (6.35)	Mauritania (7.50)	Qatar (21.75)
5	Guyana (6.30)	Benin (5.64)	Egypt, Arab Rep. of (5.52)	The Bahamas (17.75)
6	French Guiana (5.42)	The Bahamas (4.74)	Libya (5.39)	Libya (15.83)
7	Tunisia (4.89)	Guyana (4.64)	United Arab Emmirates (4.80)	Uruguay (15.14)
8	United Arab Emmirates (4.59)	French Guiana (3,02)	Tunisia (4.50)	Mexico (14,85)
9	The Bahamas (4.56)	Tunisia (2.93)	Suriname (4.20)	Benin (13.78)
10	Benin (3.93)	Ecuador (2.66)	The Bahamas (3.99)	Taiwan, China (11.70)

Source: based on Dasgupta et al. 2007

in which the system can tip. This particular holds for the Indian and the West African monsoon or the El Niño phenomenon (see Lenton et al. 2008, for more details). If global warming is limited to below 2°C above pre-industrial levels, then there is a relatively high probability that most of these tipping points will not be passed. Hence, there is no reason for anyone to pretend that there is an exact forecast of the future with regard to these non-linear, extremely complex processes. „We are conducting a disastrous experiment whose outcome we are just about to see", summarizes theoretical physicist David Gross, who won the Nobel Prize in 2004 for his contribution to quark research.

> *„We do not have the appropriate instruments to anticipate the impacts of these drastic changes that we are talking about. The only serious climate experiment that we can conduct is the experiment that is done by emitting greenhouse gases. Only when we actually experience these devastating non-linear effects we will truly know where this is leading" (Germanwatch 2007, 14).*

The risk of extensive discontinuities is a category of particularly drastic dangers induced by the continuing increase of global temperature. However, as has been shown before, there are other important risk categories, and significant impacts from a rise in global mean temperature by more than 1.5 to 2.5°C compared to pre-industrial levels have to be expected, independent of the tipping elements.

3.5 Effects on food production, agriculture and water, forest and fishing resources

This chapter sums up research results related to the impact of climate change on food production, agriculture, water, forestry and fishing resources. It is important to note that most of the scenarios referred to do not take into account the consequences of the potential non linear effects which were discussed in the previous chapter. Where possible, impacts resulting from the tipping of the described large-scale risks on food security issues are indicated. The summary of these findings will allow us to better understand the impact of climate change on future food availability on a global and regional scale – if major disasters can be prevented. In general it is important to note that currently around 40 percent of the Earth's land surface is utilized as cropland and pasture (Fowley et al. 2005). Natural forests cover another 30 percent of the land surface. Just 5 percent of the natural forest areas are provide 35 percent of global round wood. In developing countries, nearly 70 percent of people live in rural areas, where agriculture is the largest supporter of livelihoods and income (FAO 2003b).

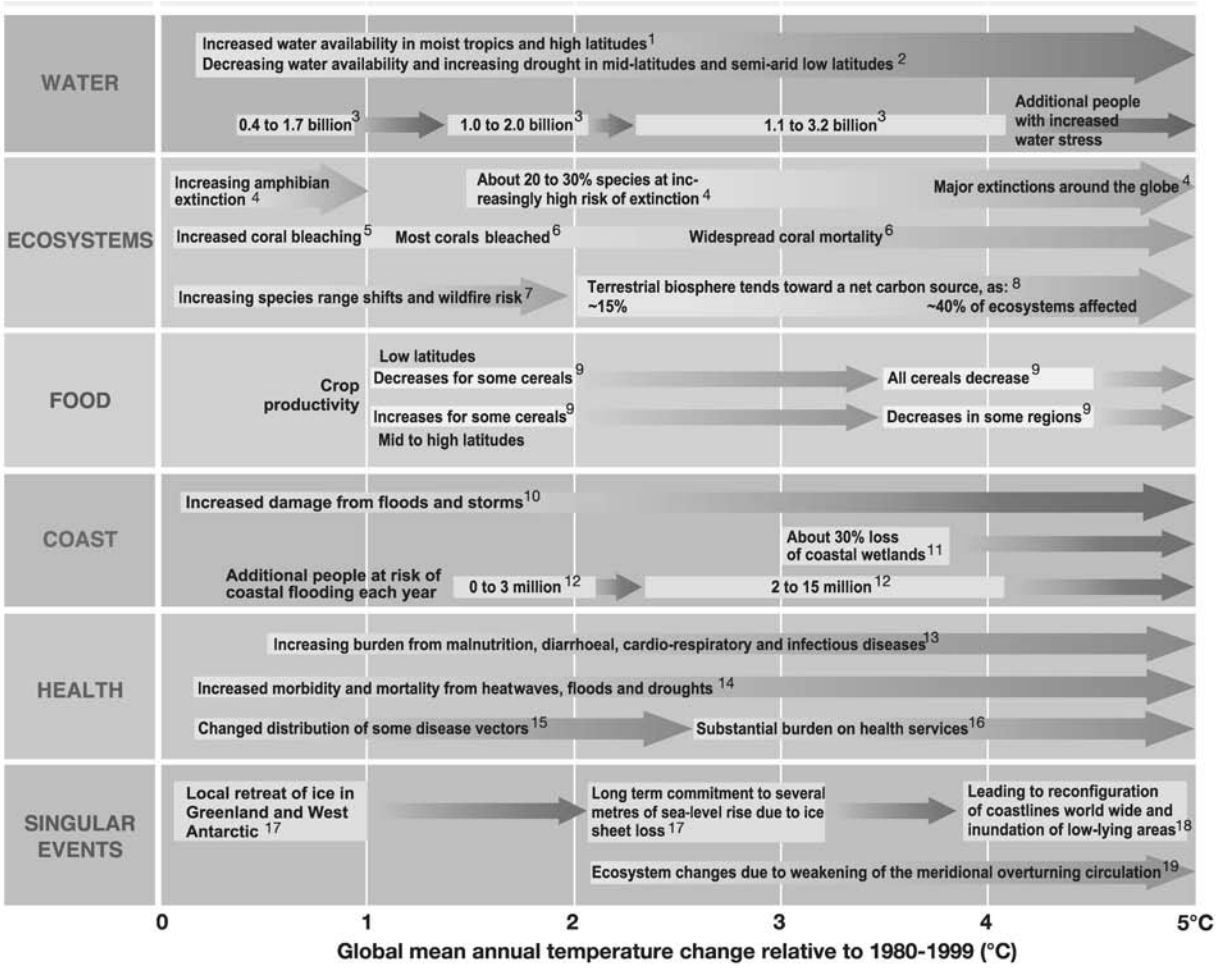
The Third Assessment Report (TAR) systematized 2001 the ways on how climate change and variability might impact on food, fibre, and forest around the world. The elevated level of CO_2 will have effects on plant growth and yield. Higher temperatures, altered precipitation, and transpiration regimes will be of high importance, as will be the increased frequency of extreme events, and modified weed, pest and pathogen pressure. These findings are supported by most studies that were published since then.

3.5.1 Effects on food production and agriculture

Results from different models are summarized in the IPCC FAR. Figure 18 shows the impacts relevant to food production and agriculture in different sectors. In mid- to high latitude regions, moderate and medium local increases in temperature (1 to 3°C)[12], along with associated carbon dioxide increases and rainfall changes, can have certain beneficial impacts on crop yields. In low latitudes, however, even moderate temperature increases (1 to 2°C) are likely to have negative yield im-

[12] If not indicated otherwise, following figures refer to an increase above the 1980-1999 average; to compare with pre-industrial levels, 0.5° C have to be added

Figure 18: Sectoral impacts of climate change at different levels of temperature increase



The 19 footnotes refer to the 19 chapters of the IPCC Working Group II report from 2007. See Parry et al. 2007

Source: Parry et al. 2007, 66

pacts for major cereals. If temperatures increase above these levels, the impact will be negative for crop yields in all regions (Easterling et al. 2007, 5.2). In summary, the FAR estimates that temperature increases from 1 to 3°C will have a net positive impact on the potential for food production, but that this effect will become negative above this range of warming.

The effects of elevated CO_2 on plant growth and yields were reviewed extensively in the TAR. Plant response to elevated CO_2 alone, without climate change, is positive. But recent studies also confirm that these effects depend on a variety of other influencing factors: species, growth stage, management regime, and water and nitrogen application (Ainsworth and Long 2005). Nevertheless, on average, across several species, and under unstressed conditions, the effect of an increase of atmospheric CO_2 concentrations at 550 ppm CO_2 would lead to an increase in crop yields between 10 and 20 percent. The IPCC reports a common understanding between plant physiologists and modelers that the effects of elevated CO_2, measured in experimental

settings and implemented in models, may overestimate actual field- and farm-level responses. This fact is due to many limiting factors like pests, weeds, competition for resources, soil, water, and air quality, etc. (Easterling et al. 2007). IPCC judges that the interplay of these factors are neither well understood at large scales, nor well implemented in leading models.

Many recent studies confirm that temperature and precipitation changes in future decades will modify, and often limit, the direct CO_2 effects on plants. Higher temperatures during the flowering season may lower positive CO_2 effects by reducing grain number, size, and quality. Increasing temperatures may also indirectly reduce CO_2 effects by increasing water demand. Rain-fed wheat shows increases in yields up to 0.8°C at 450 ppm CO_2, but declining yields with temperatures above 1.5°C. It would be possible to counterbalance these negative effects with additional irrigation (Xiao et al. 2005). This is an illustration for a trend described by IPCC. For most crops there will be a yield-damaging climate threshold. Below a certain increase, yields will increase, yet should the temperature climb beyond this threshold, the effect would be negative.

At the same time, it is important to link changes in temperature development to other vectors that will change due to climate change. The climate impact on crops may significantly depend on the precipitation scenario considered. Given the fact that more than 80 percent of total agricultural land and almost 100 percent of pasture land is rain-fed, the future of precipitation changes will be the most influential for the direction and magnitude of the overall impact of climate change. Ecosystem functions are changed substantially by changes in precipitation and in evaporation-precipitation ratios.

This effect will be of extreme importance for smallholder agriculture, which is very much dependent on rain-fed agriculture. They often miss out on the resources needed for irrigation agriculture.

Beyond the consequences from estimated changes in mean temperature or other mean variables alone, increasing climate variability will additionally add to the negative impact of climate change. This is even more relevant for weather extremes.

The IPCC concludes with high confidence that the projected changes in the frequency and severity of extreme climate events will have more serious consequences for food and forestry production, and for food security, than will changes in projected means of temperature and precipitation.[13] This relates to the increased frequency of crop loss due to extreme events, such as droughts or heavy precipitation (Easterling et al. 2007, 5.8.1).

More frequent extreme events may lower long-term yields by directly damaging crops at specific developmental stages, such as temperature thresholds during flowering. Crops do have threshold responses to their climatic environment, which affect their growth, development, and yield. It might be yield-damaging, if unusual weather appears during short window of time for the formation of reproductive organs, such as seeds or fruits. Unpredictable weather extremes will also make it more difficult to time field application. Smallholder farmers living off of rain-fed agriculture with low adaptation capacities will be those most affected.

Other important factors for food production and agriculture are the impact of weed and insect pests, diseases on plants, and animal health. Results from the TAR have already shown that climate change will have an impact on weeds, insects, and diseases, and this concept has been reaffirmed since then. The expected increases in temperature and precipitation can change plant damage from pests. For example, recent warming trends in the U.S. and Canada have led to earlier spring activities of insects and to the proliferation of some species, such as the mountain beetle (Crozier and Dwyer 2006). Additionally, an increase in weather extremes may promote plant disease and pest outbreak.

[13] IPCC notes that even the importance of climate variability is recognized, most studies contiunue to include only effects of changes in mean variables (Easterling et al. 2007, 5.4.1.3).

Land available to agriculture will be affected through climate change. The reduction of precipitation in certain areas (see below) will have the consequence that larger areas are no longer suitable for agriculture. Many crops will be affected and will no longer be able to be planted in certain regions (e.g. coffee regions in Kenya and Uganda are supposed to shrink). No exact data can be added to this claim, because, as it was previously mentioned, many other non-climate drivers interfere as well.

Adaptation policies will also have an influential effect on the availability of water in certain regions in the future. If water-harvesting and irrigation systems are developed and become more efficient, the total net effect will be very different from the „no response" scenario.

Recent and future land use changes and associated landscape fragmentation are very likely to impede species' migration and impair their natural adaptation via geographical range shift (Fischlin et al. 2007, 4.1.2, 4.2.2, 4.4.10). This might produce important income changes for affected families. It remains to be seen if national adaptation policies will support affected families or if only bigger producers will be supported in order to maintain their level of irrigation.

3.5.2 Effects on forests

Forests are ecosystems with a dense tree canopy, covering 30 percent of Earth's surface worldwide. In other words, forests amount to around 4 billion ha. They cover 42 percent of the surface in the tropics, 25 percent in temperate areas, and 33 percent in the boreal zone (Sabine et al. 2004; Fischlin et al. 2007, 4.4.5). Forests require relatively favorable environmental conditions, and are among the most productive terrestrial ecosystems. Therefore, they are attractive for both climate change mitigation, but also for agricultural usage. The current high rate of deforestation and degradation in tropical and subtropical regions is responsible for about 17 percent of anthropogenic greenhouse gas emissions (Barker et al. 2007, 5). Forests are the biggest storage of terrestrial ecosystems carbon stocks. The most recent estimate is that forests sequester an equivalent of 220 percent of atmosphere carbon (Sabine et al. 2004, Figure 4.1).

The FAO estimates that 3.4 billion m^3 of wood were removed in 2004, and around 60 percent of this wood was used as industrial round-wood (FAO 2005b). Only 4 percent of forest areas are managed by intensive forest plantations (FAO 2005b); but these limited forest areas supply about 35 percent of global round-wood. Intensive forest plantations are increasing rapidly, and their share in global round-wood production is expected to increase to 44 percent by 2020 (FAO 2000). In addition to commercial timber goods, forests provide a huge number of non-timber forest products, most of which are important for subsistence livelihoods (Shvidenko et al. 2005). Forests also provide important environmental services as described by the IPCC (Fischlin et al. 2007, 4.4.5).

Modeling studies that examine the impact of climate change on forests estimate an increase in global timber production (Fischlin et al. 2007, 4.4.5). Forests will benefit from the fertilizing effect of increased CO_2 concentrations in the atmosphere. Higher growth rates and location gains[14] are predicted, particularly when the positive effects of elevated CO_2 concentrations are taken into consideration. Although global timber productivity is likely to increase, regional production will face large variability, similar to the trends discussed for crops. In drought prone areas the effects will be different from boreal areas where productivity might be increasing due to higher temperatures and elevated CO_2 concentration.

Since the IPCC's Third Assessment Report, new studies have suggested that the CO_2 fertilizer effect may be overestimated in models. It was shown that the fertilizer effect is particularly strong in young trees, but that older trees hardly grow faster (Korner et al. 2005). Additionally, the fertilizer-enhanced growth period

[14] This covers the expected poleward shift of most productive species due to climate change (Fischlin et al. 2007, 4.4.5).

might be limited by competition, disturbances, nutrient limitations, or other factors (Fischlin et al. 2007, 4.5.4.1). There are several other factors that are not or not properly included in existing models. Examples include fire, insects, and extreme events. Warmer temperatures have already enhanced the opportunities for insects to spread across the landscape (Crozier and Dwyer 2006). There is evidence of both regional increase and regional decrease of fire activities, with some reasons linked to climate change. Climate change might influence ignition sources, drought periods, and other risks in the forest industry. Pulp and paper production are particularly affected. For many forest types, pest and disease outbreaks are a major source of concern.

The IPCC's Fourth Assessment Report has collected information on the effects of extreme climate events on commercial forestry. It is region-specific and includes reduced access to forestland, increased costs for road and facility maintenance, and direct damage to trees by wind, snow, frost, or ice. Among the indirect damages are wildfires, insect outbreaks, and recently, thaws on logging rates (Easterling et al. 2007, 5.4.5.2).

Interaction between different disturbances is very important and can increase feedback loops. For example, severe drought increases mortality and is often seen in combination with insect and pathogen damage and wildfires. Such positive feedback between deforestation, forest fragmentation, wildfire, and increased frequency of droughts appears to exist in the Amazon basin, so that a warmer and dryer climate may trigger massive deforestation (Laurance et al. 2004; Nepstad et al. 2004). This drought can be influenced by more severe magnitudes of the El Niño Southern Oscillation (ENSO). This phenomena causes higher temperatures in the Atlantic subtropics, e.g. in the Caribbean region, and leads to a decrease in precipitation over the Amazon. At the same time, the rate of deforestation in this area is increasing. The IPCC concludes that very few current models can simulate these effects (Easterling et al. 2007, 5.4.5.2).

Land use change and the net global loss in forest cover had slowed since the TAR (FAO 2001; Easterling et al. 2007, 4.4.5). However, deforestation rates are still high in some tropical and sub-tropical regions, particularly in Southeast Asia and the Amazon. And in recent months we have seen a dramatic change in the positive trend in the Amazon region. After falling for three consecutive years, deforestation in the Brazilian Amazon jumped during the final five months of 2007. While the Brazilian government had previously taken credit for the decline in deforestation, the recent rise in logging confirms suspicions that commodity prices – not policy measures – are the primary determinant of forest clearing. Grain and cattle prices have surged in recent months, boosting development pressure on the Amazon – increasingly the agricultural heartland of Brazil (Butler 2008).

Degradation rates are also increasing in some northern regions such as Siberia due to unsustainable logging practices (Lepers et al. 2005). While uncertainties about deforestation rates are considerably high, analyses show a continuous trend in pressure from deforestation and degradation on forests in critical areas for biodiversity (Duraiappah et al. 2005). Contrarily, in most industrialized countries, forests are expected to increase. While general land use change will dominate impacts in certain regions, climate change will also exacerbate biodiversity risks, e.g. in tropical montane cloud forests (Fischlin et al. 2007, 4.4.7).

The socio-economic impact of climate change on forests will be dominated by the relocation of forest economic activities through a shift in production preferences (e.g. towards bio fuels). The most important socio-economic effects will be linked to income opportunities for forest-based communities. Although these communities are likely to have a modest impact on global wood production, they may be especially vulnerable because of their limited ability as rural, resource-dependent communities to respond to risk in a proactive manner (Davidson, et al. 2003; Lawrence 2003).

Non-timber forest products (NTFP) are an equally important source of income for the livelihood of rural communities (Easterling et al. 2007, 5.4.5.3). NTFP cover fuel, forest food, medical plants, and other collected goods. The FAO estimates that in many rural communities of sub-Saharan Africa, NTFP may supply over 50

percent of farmers' cash incomes and provide for the health needs for over 80 percent of the population (FAO 2004a).

This is a similar result to concerns from the impact of food production and agriculture. While the net effect on global productivity might be modest – which itself is not a sufficient claim as models do not take into consideration all effects of climate change and non climate drivers – it is obvious that poor rural communities are the most affected. They will lose income which is often gained without secure property rights. It will be very difficult to get any compensation for these types of income. Such communities and people will have the greatest difficulties in getting attention in adaptation policies.

3.5.3 Effects on fisheries

Fish, crustaceans, and mollusks can be either captured or grown in aquaculture. Although the capturing of fish has decreased every year by 1 percent since 1979, aquaculture production has increased by 59 percent. Still, capture production generates twice as much as aquaculture production. However, FAO data estimate that aquaculture production will reach the size of capture production by 2030. World fishing resources are already overused or depleted in many regions of the oceans, and aquaculture will become increasingly important. Around 2.6 billion people receive an important part of their protein supply from fish (FAO 2008).

The IPCC compares aquaculture with animal husbandry because they share similar vulnerabilities and adaptation needs to climate change. These similarities include ownership issues in access and use of land and water, the control of inputs, diseases, and predators (Easterling et al. 2007, 5.4). Aquaculture is also dependent on captured fish, because fish often needed as a food source for the aquacultures.

The principle conclusions from the TAR concerning aquaculture and fisheries remain valid and are confirmed with the FAR. The negative impacts of climate change on aquaculture and freshwater fishing include stress from increased temperature, oxygen demand, and increasing acidity. Other factors mentioned are the uncertainty of future water supplies from river flows for fish farms, the increase in extreme weather events, the increased frequency of diseases, the expected sea-level rise, and the conflict of interest with coastal defense needs. Positive impacts are seen in increased growth rates, an increased length of growing seasons due to increasing ocean temperature, and range expansion for fish species and access to new areas of the oceans due to the decrease in ice cover (Easterling et al. 2007, 5.4.6).

The current rate of overfishing is huge (www.overfishing.org). Overfishing is an important non-climate driver that undermines the long-term availability of fishing resources, and thus negatively impacts food security. Nevertheless, it is interesting to study the specific impact climate change might have on fishing resources. The following impacts are likely to occur at an increase in temperature of more than 2 to 3°C above pre-industrial levels (Fischlin et al. 2007, 4.4).

One general trend resulting from an increase in CO_2 concentration in the atmosphere will be an increase in ocean acidification. This phenomenon will

> *„impair a wide range of planktonic and shallow benthic marine organisms that use aragonite to make their shells or skeletons, such as corals and marine snails (pteropods), with significant impacts particularly in the Southern Ocean, where cold-water corals are likely to show large reductions in geographical range this century" (Fischlin et al. 2007, 213).*

Ocean acidification can become a profound source of change in the long-term productivity of oceans. The acidification will hinder all species that require aragonite to build their body from shells as well as coral reefs (Fischlin et al. 2007, 213). The IPCC calculates that the pH-figures of the oceans are decreasing by 0.14 to 0.35. It is possible that by 2065 few regions will be left where species that build their bodies with aragonite can live. Consequently, the whole system of food chains in the ocean will be affected, and fish production will be adversely impacted (WBGU 2006).

Some studies estimate that fish growth can increase due to higher temperatures; however, other studies show that temperature increases in the wrong season could negatively affect fish populations and risks incurred on the upper end of these populations‘ thermal tolerance.

A direct effect of temperature increase is the rapid pole ward shift of species in regions where the temperature change is rapid. Local extinctions are occurring at the edges of current ranges. Not only acidification, also climatic change will affect the food chain for fish. Research in the Pacific and Atlantic suggests that nutrient supply for fisheries is declining due to reductions in the Meridional Overturning Circulation (Easterling et al. 2007, 5.4.6.2).

This has resulted in a reduction of primary production with regional variability (Lehodey et al. 2003).The IPCC concludes that the aggregate level the effects of changes in primary production due to climate change related impact of the food chain are unknown, even when some regional sutdies are available.

Another problem will be the pole ward spread of pathogens, particularly through temperature increases in winter. Regional climate variability, such as the so-called El Niño events (ENSO) in the South Pacific, can have major economic impacts on fishing communities in their respective regions. El Niño is a climatic anomaly frequently ocurring in the south pacific between Southeast Asia and South America.

Through complex ocean-atmosphere interlinkages, El Niño leads to the warming of the Humboldt stream off the South American East Coast which negatively impacts on the fishing productivity, because the warmer water contains realtively less nutrients. El Niño ususally leads to extreme precipitation events in that region and droughts in the West Pacific. Negative effects of higher temperatures are expected for inland lakes. The decline in fish catches in Lake Tanganyika since the late 1970s has been related to climate-induced increases in the vertical stability of the water column, resulting in a reduced availability of nutrients (O´Reilly et al. 2004; Easterling et al. 2007, 5.4.6.2).

3.5.4 Effects on pasture and livestock production

Grasslands and rangelands cover large areas all over the world, and more than 200 million people still make their living from pasture and livestock production (FAO 2007). Grasslands are the dominant vegetation type of areas with low rainfall, such as steppes in Central Asia and prairies in Northern America, but they can also be found in regions with higher rainfall. Rangelands can be found on all continents, mainly in regions where temperature and moisture restrictions limit other vegetation types. Pasture and livestock production systems range from extensive pastoral systems to intensive systems based on forage and grain animal feed, where animals are kept indoors.

In general, studies expect climate change to positively impact pasture and livestock in humid temperate regions. The elevation of CO_2 will influence the combination of species growing on grassland and rangelands. The future development of grasslands will also depend on management factors such as grazing and non climate drivers like fertilizer supply. Experiments support the possibility of rapid changes in species composition and diversity due to climate change (Easterling 2007, 5.4.3.1). The IPCC concludes that global extrapolations are still unclear. Experiments in the Mediterranean have shown that plant diversity decreases with elevated CO_2 and nitrogen desposition, and increases with elevated precipitation, but showed no significant effects from warming (Zavaleta et al. 2003). Changes in the forage quality are also quite likely, because elevated CO_2 will lead to a possible reduction in crude protein. Thermal stress is likely to reduce productivity and conception rates. In some parts of the world, drier and hotter periods can potentially become life-threatening for livestock, as has it been the case in the past 20 years (see chapter 3.2, Table 10).

The most decisive factors for grasslands and rangelands will be the effects caused by weather extremes and changing weather variability. These impacts will be far greater than effects associated with the average changes in climatic conditions. This finding is very similar to the

finding for the impact on agricultural production in general (Easterling et al. 2007, 5.4.3.1). Non-preparedness to extreme weather events often results in losses of livestock. Many rangelands might be affected by potentially intensified ENSO conditions (see in chapter 3.1).

In dry regions, reduced precipitation can lead to severe vegetation degeneration, which in turn contributes to desertification, soil erosion, and the possible loss of pastoral areas. Pastoralists, who live in Africa and Asia at the fringe of the big deserts and in the savannas and mountainous regions, are among the most vulnerable groups related to climate change. Droughts and decreased water availability can be directly life-threatening for the livestock and the pastoralists. Recent research shows declines in rainfall in some major grassland and rangeland areas, particularly in South America, South and North Africa, Western Asia, Australia, and Southern Europe (IPCC 2007b). Increased variability of rainfall may create more severe soil moisture limitation and will have an important impact on productivity (Luscher et al. 2005).

The general impacts described here need to be analyzed in terms of their respective socio-economic consequences. The impact of climate change on livestock keepers and pastoralists will vary greatly from country to country, and therefore need to be studied in a decentralized manner. Livestock production between prairies in the U.S. and pastoralists in many arid and semiarid regions can hardly be compared. The most negative impacts will be seen for producers in arid and semiarid regions.

3.5.5 Effects on water resources

Changes in the availability of water will be an essential factor influencing food security effects of climate change. But water is not only relevant for food production and processing; it itself is an important good, needed for survival and almost all human activities. Access to water for domestic consumption is regarded as a universal human right. At the end of 2002, the UN-Committee for Economic, Social and Cultural Rights (CESCR) adopted the General Comment No. 15 to the International Covenant on Economic, Social and Cultural Human Rights (ICESCR) concerning the right to water. The General Comment confirmed the fundamental human right to water and showed it interrelatedness for the realisation of any other human right (CESCR 2002). Improved water management is seen in many circumstances as an essential element for the long term availability of water to people. Unmanaged water systems are likely to be most vulnerable to climate change.

The impact of climate change on freshwater will be huge.[15] Climate change will change precipitation patterns and increase the variability of precipitation. The risks of flooding and droughts will increase in many areas (Kundzewicz et al. 2007, 3.3.1). Climate change will also affect river flow in many regions of the world.

> *„In a warmer world, less winter precipitation falls as snow and the melting of winter snow occurs earlier in spring. Even without any changes in precipitation intensity, both of these effects lead to a shift in peak river runoff to winter and early spring, away from summer and autumn when demand is highest. Where storage capacities are not sufficient, much of the winter runoff will immediately be lost to the oceans. With more than one-sixth of the Earth's population relying on glaciers and seasonal snow packs for their water supply, the consequences of these hydrological changes for future water availability – predicted with high confidence and already diagnosed in some regions – are likely to be severe" (Kundzewicz et al. 2007, 3.3.1, quoting Barnett et al. 2005).*

The expected sea-level rise will extend the salinisation of groundwater and estuaries, resulting in a decrease of freshwater available for humans, agriculture, and ecosystems in coastal areas (Kundzewicz et al. 2007, 3.4.2).

[15] The findings will be summarized here. Most trends have already been described in more detail in chapter 3.1 and 3.2.

Semi-arid and arid regions are particularly exposed to the impact of climate change on freshwater. Efforts to offset declining surface water due to increases in variability will be hampered by the fact that groundwater recharge will also decrease in already water-stressed regions. The number of people living in water-stressed countries, defined as those using more than 20 percent of their available resources, is expected to increase substantially over the next decades – irrespective of climate change. Population increase, the sharp increase of water demand from growing mega-cities, and the overuse of water resources for irrigation projects etc. are some of the driving forces for increased water demand (Neubert et al. 2008). Particularly in the next few decades, population and other non-climate pressures are likely to be more important than the effects of climate change, although some regions may already be badly affected by climate change consequences during this period (Kundzewicz et al. 2007, 3.2). In the longer term, however, climate change becomes much more important.

Adverse effects of climate change on freshwater systems might aggravate the impact of other water stress factors such as population growth, changing economic activity (both for irrigation agriculture but also for increasing industrialization), land use changes, and urbanization etc. Exacerbating factors such as the link between land degradation, climate change, and water availability are generally unaccounted for in the global assessments.

One landmark study on the risk of climate change was produced by Parry et al. (2001). This study estimated the additional millions at risk for different temperature levels and time horizons:

One of the major factors relevant for the future water situation in Asia is the increased water demand from mega-cities in India and China. It is not clear whether or to what extent additional water resource options will be available for these cities. This uncertainty may have broad implications for environmental flows of water in major rivers of China, India, and Tibet. It would change all water calculations for these regions if the mega-cities of India and China should seek large-scale diversion and impoundments of flows in the region.

Water management systems used currently are very likely to be inadequate to deal with the negative impacts from climate change on water supply reliability, flood risks, health etc. Water-related management has to be build around the fact that the increase in climate-related variability is respected. That will make adaptation to climate change easier.

Drastic changes in the monsoon regime in both Asia and West-Africa are possible or even expected. Because of the bistability of these systems and a complex interplay of different drivers (mainly albedo change and climate change), it is highly probable that we will see non linear changes in these regimes, but it is not clear in which direction, – stronger, weaker, or even a total collapse of e.g. the Indian monsoon (Lenton et al. 2007).

Changes in the amount and variability of rainfall, as well as melting glaciers will have major impacts on water availability, agriculture, and food security. Around 70 percent of all water consumed worldwide is used in agriculture. The increase in global productivity of agriculture since the late 1970s was only possible because of the increase in irrigation areas.

Besides this global perspective, it will be the regional or local changes that will determine the impact on particularly poor people. Potential changes in the precipitation regime in rain-fed agricultural areas will require drastic adaptation measures. Changes in river runoff will have similar impacts on many forms of agriculture.

3.5.6 Effects on health and nutrition

Only in recent years have there been more studies on possible health effects of global warming. Also IPCC has given health issues substantive scope and space. Climate change will induce many health-related effects; some examples include the health impacts that more intense heat waves and weather extremes will cause.

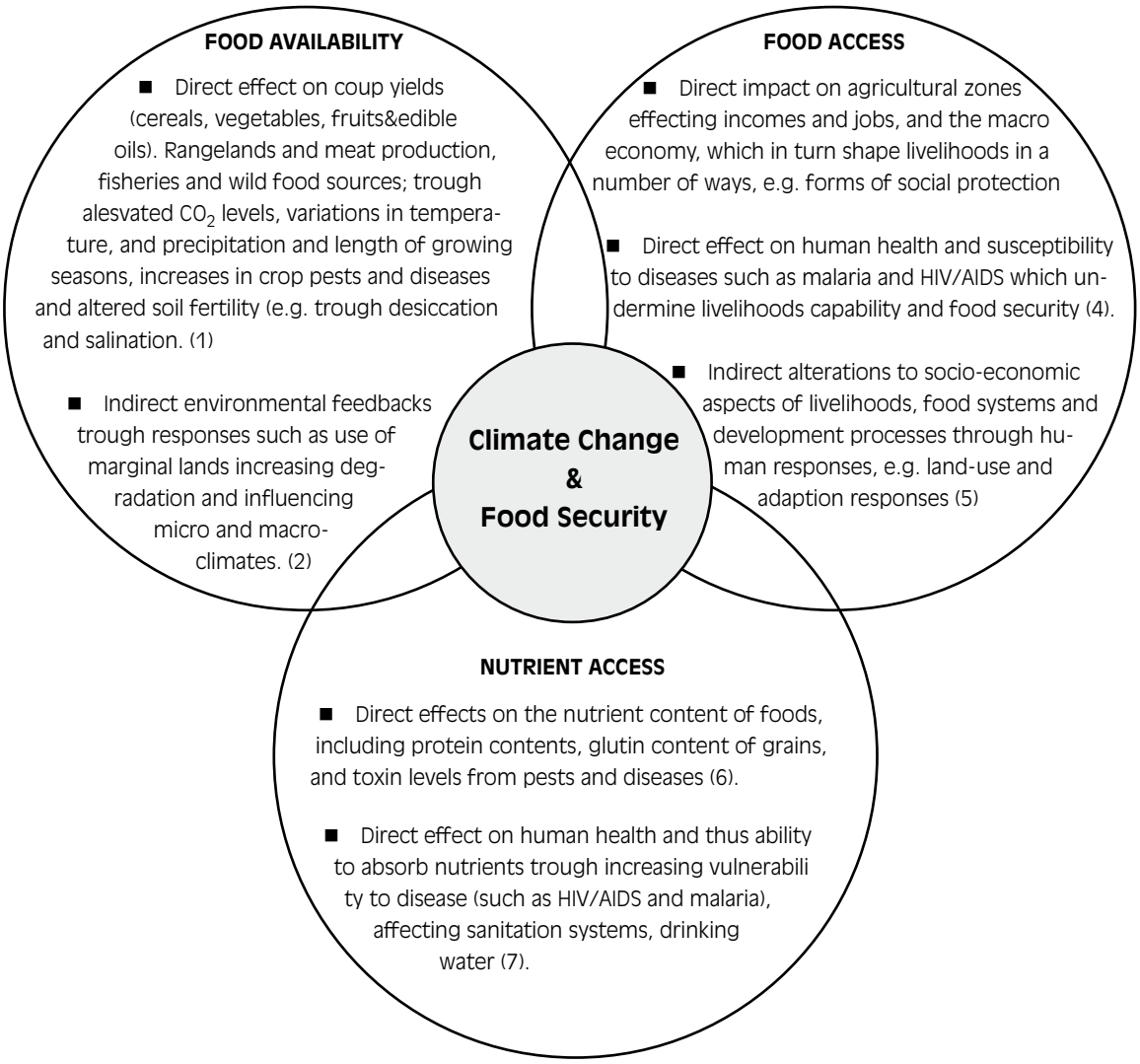
As an example: In 2003, at least 30.000 people died during the summer heat wave in Europe (Munich Re 2007b). Climate change also could increase the prevalence of certain diseases such as malaria, cholera, and

dysentery. The spread of diseases, such as malaria and diarrhea, will affect labor availability for agriculture as well as non-farm economic activities.

Also, the aggravation of malnutrition and infectious diseases can move upwards into areas of higher altitudes and higher geographical regions. For example, temperature increase is likely to shift the altitude limit for malaria upwards, spreading malaria risk to new areas, e.g. in the mountains of the East African highlands (IPCC 2007b). Access to clean water might be the biggest climate-related health risk. At the same time, the availability and quality of water is very influential in the prevalence of diarrhea and thus the utilization of food.

Climate-related health risks will be not being discussed here in detail, but they can be extremely important in determining or influencing the food situation.

Figure 19: Climate change and food security



Source: based on Boko et al. 2007, 455

3.5.7 Effects on food insecurity

All four dimensions of food security, namely food availability (production and trade), stability of food supplies, access to food, and food utilization (FAO 2003a) will likely be affected by climate change. Figure 19 summarizes how the impacts of climate change previously described influence the state of three dimensions of food security. Other influencing factors are the social economic impacts and changes in trade flows, stocks, and food aid policy.

The impact concerning food availability will be mixed and vary regionally (FAO 2005b). A reduction in the production potential of tropical developing countries, many of which are already faced with poor land and water resources and serious food insecurity, is quite likely. At a global level, the production potential is expected to increase if average temperature increase is limited to 1 to 3°C. The higher the temperature increases, the more the production potential will decrease (IPCC 2007b). Food insecurity will be further affected by loss of cultivated land and nursery areas for fisheries (FAO 2003a). Access to food and stability of that supply will be hit by changes of increased frequency and intensity of extreme weather events such as flooding and droughts. Food access might be impacted through economic problems and direct health-effects of climate change; health problems can be related to reduced access to clean water, flooding, or inundation due to drought, sea-level rise, or increased precipitation. Increasing exposure to vector-borne (e.g. malaria) or water-borne (e.g. cholera) diseases (Easterling et al. 2007, 5.6.5). This might be one of the factors, which limits the capacities of affected people to utilize the food consumed.

A number of studies have attempted to quantify the impacts of climate change on food security at regional and global scales (e.g. Fischer et al. 2002, 2005; Parry et al. 2004, 2005; Tubielo and Fischer 2006). These studies are based on complex modeling frameworks that integrate outputs from General Circulation Models (GCM) with climate science, agro-ecological zone data, and/or dynamic crop models as well as socio-economic models. They are all – in the judgment of the IPCC FAR – still highly uncertain. One reason is that they focus mainly on food availability; they do not cover reactions by affected communities in stabilizing food supplies, and they are based on a limited number of crop models. Given the complexity of factors analyzed and the dependence on reactions of affected communities, governments, and the international community, these studies are highly uncertain, but they help to understand the dimension of the problem and the complex net of influencing factors.

Some findings on the overall development of climate change with regard to food security are summarized in the IPCC report (Easterling et al. 2007, 5.6.5, Table 12).

1. The number of people at an additional risk for hunger primarily depends on the development of socio-economic indicators, and poverty reduction progress is projected to lead to a decline in the number of people at risk by the 2080s. Climate change in most scenarios reduces the decline of people at risk. For this trend the IPCC FAR has found medium confidence, i. e. 5 from 10 articles go into this direction. Parry et al. (2004, 2005) estimate reductions by more than 75 percent by 2080, which would be 560-700 million less hungry than the 820 million in developing countries by FAO estimates today. By contrast, in an A2 scenario, the number of hungry will decrease slightly until 2080 because of the larger population projections as compared to other SRES scenarios.

2. The role of the CO_2 fertilizer effect significantly influences the results of some scenarios. Excluding this uncertain effect leads to significantly higher numbers of people at risk in A2, with up to 100 percent more people at risk compared to non-climate change scenario. However, this varies with the different scenarios.

All projections show that the realization of the MDG 1 (reducing the percentage of the hungry by half) will not be met until 2020 or 2030.

At this time in the debate, it needs to be asked whether these assumptions are too optimistic. No reduction in

Background to IPCC scenarios

The scenarios of future climate change are part of the IPCC reports. Working with different scenarios takes into account that we are not dealing with deterministic systems. Emission trends and climatic reactions can differ - we do not know the future. In order to develop a common and standardized method, the IPCC developed a Special Report on Emission Scenarios (SRES) in 2000 in which different scenario-families are defined (IPCC 2000).

The SRES scenarios are based on different assumptions of how the future will look and which trends are possible concerning population development, economic development, consumption patterns, and political framework conditions. All models developed by the IPCC describe possible trend descriptions/storylines without an explicit climate change policy. The models do not make a prediction or prognosis of the most likely development to happen. They are model families/storylines whose function is to calculate different development scenarios and compare their impact. The four scenario families used in IPCC literature can briefly be summarized in the following way:

The A family is more economically oriented. The A1 family is oriented toward rapid economic growth combined with a globalized setting in which regions cooperate strongly toward cultural and social integration. The rate of world population is declining after the middle of the 21st century. Per capita income disparities are likely to be reduced. The A1 family has three different sub-scenarios, depending on the dominant technology framework used. A1f is based on the continuous use of fossil intensive technologies, A1T is built on non-fossil technologies, and A1B on a mix of fossil and non fossil technologies. The A2 family is also oriented towards economic growth but is less influenced by globalised factors. Regions keep their local identities, fertility is hardly declining, and world population is steadily growing. No dominant pattern for technology choices can be observed.

The B family is more ecologically oriented. B1 is a scenario family based on a more globalized scenario with intense cooperation. The same development of the world population is assumed as in the A1 family. Under 1, there will be a fast move toward a service and information-oriented economy, which goes hand in hand with a decrease in material, energy intensity, and the introduction of clean and resource efficient technology. It is a path where global solutions for an economic, social, and environmentally sound development are desired.

Like A2, B2 is much more regionally-oriented. The world is searching for local solutions for the economic, social, and environmentally-sound development based on regional economic development trends. World population is increasing, but less strongly than in A2. Economic growth is reduced compared to B1, and less rapid and more diverse technological changes are assumed as compared to the B1 and A1 storylines. While all of the scenario techniques have methodological limits as described above, they nevertheless help to identify trends and allow comparison of emissions from the different scenario paths. More details to the different scenarios of SRES can be found in the study IPCC 2000. The IPCC report is shortly introducing the Emission Scenarios in the Summary for Policymakers (IPCC 2007b).

the number of hungry has been achieved since 1996 despite significant economic growth (FAO 2007). In reality, hunger today is much more persistent than was estimated in 1996. The IPCC estimations are particularly optimistic given the fact that the IPCC report also concludes with high confidence that smallholder and subsistence farmers, pastoralists, and artisanal fisher folk will suffer from complex impacts of climate change. These groups, whose adaptive capacity is constrained, will experience negative effects on yields of low-latitude crops combined with a high vulnerability to extreme events. As shown above in chapter 2, these groups currently make up 80 percent of the hungry. If their situation changes and they become negatively affected, the

Table 12: Impacts of climate change and socio-economic development paths on the number of people at risk for hunger in developing countries

	2020		2050		2080	
	Millions at risk		Millions at risk		Millions at risk	
Reference	AEZ-BLS	DS SAT-BLS	AEZ-BLS	DS SAT-BLS	AEZ-BLS	DS SAT-BLS
A1	663	663	208	208	108	108
A2	782	782	721	721	768	768
B1	749	749	239	240	91	90
B2	630	630	348	348	233	233
Climate change	AEZ-BLS	DS SAT-BLS	AEZ-BLS	DS SAT-BLS	AEZ-BLS	DS SAT-BLS
A1	666	667	219	210	136	136
A2	777	805	730	722	885	742
B1	739	771	242	242	99	102
B2	640	660	336	358	244	221
Climate change, no CO_2	AEZ-BLS	DS SAT-BLS	AEZ-BLS	DS SAT-BLS	AEZ-BLS	DS SAT-BLS
A1	NA	726	NA	308	NA	370
A2	794	845	788	933	950	1320
B1	NA	792	NA	275	NA	125
B2	652	685	356	415	257	384

Data from Parry et al. 2004 ; Tubiello et al. 2007: The first set of rows in the table depicts reference projections under SRES scenarios and no climate change. The second set (CC) includes climate change impacts, based on Hadley HadCM3 model output, including positive effects of elevated CO_2 on crops. The third (CC, no CO_2) includes climate change, but assumes no effects of elevated CO_2. Projections from 2020 to 2080 are given for two crop-modeling systems: on the left, AEZ (Fischer et al. 2005); on the right, DSSAT (Parry et al. 2004), each coupled to the same economic and food trade model, BLS (Fischer et al. 2002 2005). The models are calibrated to give 824 million undernourished in 2000, according to FAO data.

Source: Easterling et al. 2007, 299

estimations from most of the models are all extremely positive and unrealistic. In the longer term, there will be additional negative impacts from other climate-related processes. Such processes include snow-pack decrease (especially in the Indo-Gangetic Plain), sea-level rise, and the effects of the spread in prevalence of human diseases affecting agricultural labor (Easterling et al. 2007, 5.4.7).

Therefore, most models used above to calculate the outcome of climate change on food security are extremely optimistic, because it will be the current groups of people affected by hunger that will be hurt most. Additionally, all of these models do not take into account non-linear climate effects and most of them not even the increased intensity and number of weather effects. The potential loss of the summer monsoon in central and south Asia would have major repercussions on hunger figures.

Another robust trend is that sub-Saharan Africa is likely to surpass Asia as the most food-insecure region. In 2080, sub-Saharan Africa may account for 40 to 50 percent of all undernourished people compared to 24 percent today (Easterling et al. 2007).

Estimates of persons additionally affected by hunger and food insecurity should therefore be used with utmost care. The following figures from the IPCC and other relevant literature (Schellnhuber et al. 2006) refers to the potential additional number of people at the risk of hunger. The actual number of hungry people will depend on how much hunger can be reduced in the coming decades. A warming of around 1°C as compared to preindustrial times produces relatively small damage when measured from the point of increased risk of hunger and/or undernourishment over the next century (around 10 million more at risk). In this temperature range, nearly all developed countries are projected to benefit, while many tropical developing countries are estimated to experience small but significant crop yield growth declines. A warming of 1°C to 2°C compared to preindustrial times could triple the number of people at risk for hunger by the 2080s, particularly hunger related to weather extremes and the increasing variability of climate patterns.

The risk of damage begins to increase significantly with warming between 2 and 3°C above preindustrial times. While developed countries may still benefit within this temperature range, literature indicates that production in this range is finely balanced between the effects of increased temperature and changes in precipitation. ‚Drier' models show losses in North America, Russia, and Eastern Europe, whereas ‚wetter' models show increases. One study shows rapidly rising hunger risks associated with a 2.5°C warming. 45 to 55 million extra people are put at risk for hunger by the 2080s from this level of warming, and this number rises to 65 to 75 million for a 3°C warming (Easterling et al. 2007). Another study shows that a very large number of people, 3.3 to 5.5 billion, may be living in countries or regions expected to experience large losses in crop production potential at 3°C warming. For a 3 to 4°C warming, one study estimates the additional number at risk of hunger is in the range 80 to 125 million, depending on the climate model used. In Australia, a warming on the order of 4°C is likely to put entire regions out of production, with lesser levels of warming causing substantial declines in the west and the south (all figure studies mentioned in the para are taken from Easterling et al. 2007).

Countries and groups of countries are hit differently. Many studies indicate that developing countries as a whole are likely to lose in comparison to the developed nations. India, for example, is projected to experience significant losses with large areas of current cropland losing significant productivity. At all levels of warming, a large group of poor, highly vulnerable developing countries is expected to suffer increasing food deficits. It is anticipated that this will lead to higher levels of food insecurity and hunger in these countries. They will need support to cope with and finance the necessary adaptation measures. Developed countries will not be immune to large effects of climate change on their agricultural sectors.

3.6 Most affected: rural livelihoods – subsistence and smallholder agriculture

The impact of climate change will be particularly substantial to smallholder and subsistence agriculture. Their livelihood systems, particularly in low latitudes, will be greatly affected by climate change. The farming system will be affected by the previously described changes in temperature, elevation of CO_2, and precipitation on yields of both food and cash crops. The productivity of livestock and fisheries systems will be affected, as well as the potential income from collecting activities in forests. All of these income sources will be affected by changes in the mean conditions and the increase in frequency and intensity of extreme events.

Other physical impacts of climate change important to smallholder farmers are the decreasing water supply through the reduced flow of rivers which feed irrigation systems, the effects of sea-level rise on coastal areas, the increase of intensity of tropical storms, and changes in other environmental conditions (e.g. more forest fires).

The impact of climate change on subsistence and smallholder agriculture, pastoralism, and artisanal fisheries was not discussed in the Third Assessment report of the IPCC; however, the FAR is taking up the issue. It is not mentioned systematically, but chapters 3 and particularly chapter 5 also cover the impact on these groups

in short subchapters (Easterling et al. 2007, 5.4.7). The specific impact must be examined in the context of many different changes and impacts on many different factors at regional and local levels. The FAR is also summarizing a number of new case studies which look more specifically into the impact of climate change on smallholder livelihood systems. Some studies look more into the effects of adaptation policies on smallholders (Thomas et al. 2005), while others study the impact of climate change on crops for smallholder agriculture (Adejuwon 2006) or on ecosystems for smallholders (Lasco and Boer 2006).

The coping capacity of smallholder farmers depends on a variety of factors. One important factor is their geographical situation. Some regions will be hit harder than others. That fact might even change from region to region in a smaller scale. The farming system will be influenced, because some crops might lose a lot, and others might do fine with certain changes in the region. Another important factor is the available family assets that can be used to react to the situation. Some examples include the skills and labor capacity of a family and other income sources such as remittances.

In general, it is not easy to show direct causal links between climate change and specific family situations, because livelihood systems are typically complex and include a number of interfering factors. For example, many smallholder livelihoods are comprised of a variety of income sources like the use of wild resources from forests, remittances, and other non agricultural income strategies. These livelihoods can also involve systems requiring several crop and livestock species. Government support can also play a role, but as of now, many smallholder farmers are marginalized in national and international agricultural policies. Therefore, support is often unavailable or insufficient.

Effective adaptation policies should start here and support coping and adaptation strategies for poorer groups in rural and urban environments. Coping strategies are characterized by changes in the relative importance between different income opportunities and will vary with factors influencing the income situation of families. Adaptation can be better managed if good government support and response is developed and implemented.

Part II

Response capacity to climate change – nationally and internationally

4 Response capacity in developing countries

Responding to climate change is already and will continue to be a challenge for all countries worldwide. The size of the impact will vary from country to country and particularly depend on each area's specific adaptive capacities. For some countries, the changes will be extremely difficult to manage, and for others it looks like it will be easier to cope with the expected scale of the problem.

Industrialized countries will have many more resources to deal adequately with the challenge of adaptation. They have research institutions that can study the expected changes on micro- and meso-levels, which is a precondition for the design of effective adaptation policies. They have well functioning administrative structures in all parts of their countries, and they have the financial resources which allow the development of complex and potentially costly adaptation policies. While these resources are available in principle, the reality will look much more complex and difficult. Often exact information on the local effects of climate change is missing or is not available in enough detail. Some solutions might lead to conflict, for example if people need to be resettled in order to improve adaptation infrastructure such as dams etc. One can expect many debates on questions of: Who is responsible to finance and implement what type of adaptation policies, what is the responsibility of the government, what needs to be financed by affected cities or families themselves etc. Depending on emission scenarios, the magnitude of the impacts from climate change might be so substantial that adaptation will require deep and profound changes in the way certain policies have been implemented during the last decades. Communal water supply might become a major problem in southern Europe when water becomes more scare. Melting permafrost might destroy access to certain parts of northern Europe for months during the year because certain routes will no longer be available for transport.

The situation in many developing countries looks very different. On one hand most developing countries have capacity limitations making adaptation more difficult. On the other hand there are some oil exporting countries, or countries like Singapore and China, where financial resources are not the problem. Limitations include both human capacity and financial resources. In most countries, there is a lack of scientists and university institutes which can generate reliable scenarios for the expected impact of climate change. Financial resources will be extremely tight in many developing countries, in contrast to the expected size of the problem. Non-functioning infrastructure, insufficient administrative capacities, and missing political will are factors that will influence the development of adaptation policies in many countries. The mobilization of financial support is increasingly becoming an international issue both at the level of UN climate negotiations and in development organisations and banks.

Financial support will be needed because the expected costs for adaptation measures in developing countries will be substantial. There is the obligation, both in legal and ethical terms, of the countries who have contributed most to the problem to assist those that are most affected.

Adaptation to climate change will require simultaneous changes in several policy areas. Therefore, success will depend on both coordinated action between differ-

ent ministries and also coordination between different governance levels (national, regional, and local). The UNFCCC summarizes the output from several workshops and meetings carried out under the Nairobi Work Program on Impacts, Adaptation, and Vulnerability as follows:[16] The most effective adaptation approaches for developing countries are those addressing a range of environmental stresses and factors (UNFCCC 2007c, 29). Strategies and programs need to be linked with coordinated efforts aimed at poverty alleviation, enhancing food security and water availability, combating land degradation, and reducing the loss of biological diversity and ecosystems services.

Many developing countries face difficulties integrating climate change concerns into national policies. Key barriers include issues around information, institutions, inclusion, incentives and international finance (IDS 2007). This is aggravated by the fact that those countries which will be hit hardest and that are required to radically change policies are often particularly poor countries. Adequate adaptation policies will entail adjustments and changes at all policy levels – from the household and community level to the national and international levels. Communities must build their resilience, including adopting appropriate technologies and using traditional knowledge. They need to adapt and diversify their livelihood strategies to cope with current and future climate stress. The selection of required adaptation measures will depend on the local and national circumstances. Local coping strategies need to be used and encouraged together with governmental responses at all levels.

Developing countries will be additionally confronted with the problem that not only governments, but also most affected households or communities will have very limited coping capacities and resources to adapt to the changing circumstances. This fact means that the government‘s role in adaptation might be bigger than in industrialized countries.

Chapter 4 will summarize the dimension of the adaptation problem for developing countries. It will study and analyze the response capacity and limitations different actors have at the national level. It will look first into the overall dimension of the problem, and then will address the climate information available at national levels. The following sub-chapter will discuss the response capacity at the national level, regional level, and household level. After that, the relevance of insurance mechanisms as a means to support and incentivize adaptation will be addressed. Chapters 5 and 6 will study the response capacities available at the international level and look into the currently available instruments for financing adaptation measures and the potential needs. They will also discuss how adaptation to climate change in the agricultural sector can be linked with policy choices to mitigate the climate impact of agriculture.

4.1 Dimensions of the problem

4.1.1 Adaptation

The dimension of the problems linked to adaptation to climate change will be huge for developing countries. The IPCC report shows that poorer countries will be relatively more affected by the impact of climate change. Their limited capacities to react are one important reason for this particular affectedness. Adaptation policies cover a variety of interventions[17] from the ability to estimate changing weather conditions, particularly extreme weather events, and establish early warning systems, to

[16] The Conference of the Parties in 2004 (COP10) requested the UNFCCC secretariat organize three regional workshops in Africa, Asia, and Latin America, as well as one expert meeting for small island developing states (SIDS) to discuss adaptation priorities. The seminars took place in 2006 and 2007 and a synthesis report summarizes the identified adaptation needs and concerns, particularly those across all regions (UNFCCC 2007c).

[17] A detailed overview of adaptation measures for key vulnerable sectors are shown below in Chapter 4.3.

infrastructural investments in methods and techniques of disaster management like dams or other mechanisms of flood control. They cover the change in the use of agricultural crops, varieties, irrigation, and land use techniques to support affected families in order to cope with various needs. These needs could cover the cost of other forms of damage to the house or land of the family, or even the necessity to migrate. According to the IPCC,

> *„adaptation practices refer to actual adjustments, or changes in decision environments, which might ultimately enhance resilience or reduce vulnerability to observed or expected changes in climate" (Adger et al. 2007, 720).*

A large number of planned and unplanned adaptation options exist, which can be differentiated along several dimensions (see Adger et al. 2007, 720):

- by spatial scale: local, regional, national,
- by sector: water resources, agriculture, tourism, public health, etc;
- by type of action: physical, technological, investment, regulatory, market;
- by actor: national or local government, international donor, private sector, non-governmental organization (NGOs), local communities, and individuals;
- by climate zone: dry land; floodplains, mountains, Arctic, etc.;
- by baseline income/development level of the systems in which they are implemented: Least Developed Countries, middle income countries, and developed countries;

Table 13: A typology of adaptive responses: examples from food production and food security

Response	Proactive	Reactive	Inaction
International	Guidelines for national adaptation strategies Development of new crops	Measures of food aid	No actions to initiate changes are being taken
National	Grain storage Agricultural policy to alter crops and farming practices	Changes in taxes and dispenses to increase food imports and emergency aid	Small infrastructure investments which only would profit local population are not undertaken
Local	Investments in rainwater harvesting, irrigation and protection from flooding Implementation of seed banks Local coordination	Mutual support	Migration as a response option is ignored
Individual	Diversification of income sources Investments in education Changes in agricultural practices	Migration	Accepting individual increased vulnerability and reduced well-being

Source: based on Adger et al. 2006

- by an identification of most vulnerable groups: small holder farmers, fisher folk etc;
- or by a combination of these and other categories.

Another approach is to differentiate between proactive, reactive, and inactive responses as Table 13 shows.

Analytically, the IPCC further differentiates between two categories of adaptations:

> *„autonomous adaptation, which is the ongoing implementation of existing knowledge and technology in response to the changes in climate experienced, and planned adaptation, which is the increase in adaptive capacity by mobilizing institutions and policies to establish or strengthen conditions favorable for effective adaptation and investment in new technologies and infrastructure" (Easterling et al. 2007, 294).*

The IPCC uses this differentiation of adaptation measures in Chapter 5 on „Food, fibre and forest products", because in agricultural context farmers were always adapting to changing weather conditions. There is a certain amount of autonomous adaptation capacities among local communities and within ecosystems. The advantages of this IPCC differentiation are that it looks into the coping strategies and capacities which are available locally to adjust to the changing circumstances without any government interference. This perspective helps to identify, on the other hand, the need for planned interventions, because the available coping capacities might be very limited. The issue of coping capacities will be taken up in chapter 4.

One way of grouping adaptation options is to identify whether they are sectoral, cross-sectoral, or multi-sectoral (UNFCCC 2008). This differentiation is particularly helpful for identifying responsibilities within governments. The standard form for the design of adaptation measures will be sectoral. Sectoral adaptation measures look at actions of individual sectors affected by climate change, such as agriculture, coastal zones, or for fresh water-related effects. Adaptation policies in one sector will be built around existing sector policies, emphasizing the importance of including long term climate change consideration into the sectoral planning.

Multi-sectoral adaptation options relate to the managements of livelihood systems or natural resources which span sectors, for example, the integrated management of water or river basins. Multi-sectoral adaptation policies will be essential for national adaptation strategies, but will require a much higher institutional capacity to deal with the necessary complexities. Cross-sectoral measures are measures that need parallel and coordinated development in several sectors. Examples could include the development of systematic observations and monitoring systems for the effect of climate change or the development of an effective science and research network at the national level dealing with problems such as forecasting and early warning.

In conclusion, while some priority actions need to be implemented urgently to adapt to the short-term consequences of climate change, adaptation must be viewed as a long-term challenge for societies. „Mainstreaming", or the integration of adaptation into sectoral and other policies and programs at different levels of decision making, will be necessary. It requires a prominent role for the reduction of vulnerability to climate change.

In addition to sectoral responses, ecosystem management plans that allow multi-sectoral approaches that deal with whole livelihood systems are also needed. At the same time, adaptation policies must address negative effects for the most vulnerable groups in order to avoid hardship for these groups most affected by climate change. Tompkins and Hultman (2007) argue that

> *„the best approach to reducing vulnerability must be at the heart of any adaptation strategy and adaptation policy".*

The identification of vulnerable groups has to be achieved in a rights-based form, by identifying which groups within a society will be threatened by the main consequences from climate change. In their opinion adaptation must also include

Table 14: Synergies between the MDGs and climate interventions

Goal	Impacts of climate variability	Role of climate interventions	Outcomes: climate sensitive development planning
Goal 1: **Eradicate extreme poverty and hunger**	Extreme climatic events trigger acute hunger from loss of agricultural production, cause loss of infrastructure. Climatic uncertainty is a disincentive to investment, intensification, technology adoption, fertilizer use, and high value agricultural enterprises. The poor are trapped in a downward, vicious cycle of increasing poverty and asset loss, because they never recover from climate shocks.	Short-term risk reduction Climate-based food insecurity early warning increases lead-time, aids targeting of relief efforts Risk reduction in longer term planning Climate information (monitoring and prediction) empowers poor farmers to better manage risk, and to exploit opportunity in favorable years. Climate information provides opportunity to spread risk through social insurance schemes that provide a safety net for the poor during climatic shocks. Prediction of hydro-climatic extremes helps societies prepare and mitigate disasters, reducing losses in infrastructure and productive activities	Short-term risk reduction Local capacity built to respond rapidly to disaster, crisis and pre-crisis conditions. Fewer public resources spent on disaster rehabilitation and relief and on reconstruction; more public resources available for positive development progress. Risk reduction in longer term planning Small-holder agricultural practice is resilient to climate variability. Stronger economic growth due to resilient irrigation, land use, cropping and trade policies. Generates macroeconomic and investment strategies that minimize recessive impacts.
Goal 4: **Reduce child mortality**	Poor sanitation from both water shortages and flooding contribute to morbidity and mortality from diarrheal diseases. Malaria (whose endemicity and epidemicity are impacted by climate) during pregnancy is associated with lower birth weight, increased infant mortality.	Climate monitoring and forecasts help identify high risk areas prone to water contamination based on water shortages or flooding. Climate forecasts can prompt malaria early warning, increasing lead-time for mobilization and distribution of resources to remote areas.	Plan for water storage and delivery implementation, investment, design and maintenance. Develop national and regional capacities to plan for, anticipate and react to epidemics. Understand long term implications of climate change on disease distribution and socio-economic vulnerability.

Goal	Impacts of climate variability	Role of climate interventions	Outcomes: climate sensitive development planning
Goal 5: **Improve maternal health**	Climate variability impacts on food production and nutrition; affects pregnant women and the development of embryo and fetus. Pregnant women are more likely to contract and die of malaria.	Climate-based food insecurity early warning increases lead-time for organizing interventions. Climate prediction provides advance information for activating relevant aid and raising awareness on the ground (e.g., maternal education programs).	Develop resilience in food production, storage, and markets by taking into account comprehensive climate sensitive socioeconomic data. Develop understanding of dynamic health distribution, socioeconomic impacts, capacity and resource needs in the face of changing climate conditions. Develop understanding of climate impacts on health distribution.
Goal 6: **Combat HIV/Aids, malaria and other diseases**	Climate variability influences endemicity and epidemicity of malaria and other infectious diseases transmitted by insects. Climate variability impacts on food production and nutrition; affects susceptibility to HIV/AIDS, malaria, and other diseases.	Climate monitoring supports targeting high-risk areas. Climate-based early warning increases lead-time of epidemic detection, prevention, and control of climate sensitive diseases, e.g., malaria early warning can facilitate activation of funds for preventive measures and medicines and their distribution to remote areas.	Combined understanding of climate history, climate impacts and affected socioeconomic factors to be used in prioritizing, designing, implementing and maintaining health care investments. Develop and maintain communication and response networks that use the best applied climate information.
Goal 7: **Ensure environmental sustainability**	Climate variability constraints both quality and quantity of water supply. Resource management regimes fail because they ignore the impact of climate variability, e.g. for water or pastures. Resource degradation is blamed on people who are actually responding to climatic variations.	Water reservoirs can be managed more effectively for multiple purposes under both scarcity and surplus, using reliable climate forecasts. Managing rangelands based on understanding of climate human-livestock interactions enhances sustained productivity.	Long term sustainability and/or impact mitigation through adaptation to climate change policies, designs and applications. Biodiversity conservation to take into account climate variability and change. Improved designs of water infrastructure systems, using climate information, mitigate adverse environmental consequences of extreme climatic events.

Source: Germanwatch based on Columbia University 2006

„correcting maladaptations – for instance, by no longer providing flood insurance in ways that encourage risky development in flood zones."

4.1.2 Response capacity

The first problem in designing adequate adaptation policies is that response strategies are needed – often in parallel – in all of these areas. The responses, particularly the overall integration of adaptation, have to involve many different governmental institutions at the central, regional, and local level. Government decisions about new housing areas, financing crop research, and infrastructural investments in flood control or water storage have to consider the potential impacts of climate change. Dealing with the long term perspective and with the necessary multi-sectoral or cross-sectoral complexities requires sufficient institutional capacities in the different institutions involved, from research institutions to line ministries to city or district administrations.

Moreover, many of the decisions require priority setting. What are the measures that need to be financed first? What types of investments in infrastructure are given priority? Because many issues are of high relevance for affected people, priority setting will be difficult. The National Adaptation Programs of Action (NAPA) have been useful in initiating priority identification and creating methodologies (see e.g. Harmeling, Burck, and Bals 2007). But there is a high risk that setting priorities in the management of climate change impacts will overlook or marginalize those groups who have not been in the centre of national policies. They might be marginalized again if their situation is not prioritized in the allocation of resources. Poor groups in society who are already marginalized might get the least attention in the formulation of national adaptation strategies.

Countries will be confronted with conflicts over the use of financial and other resources available to deal with the consequences of climate change. Discussions on how to best use these resources will occur. Will the resources be spent in rural areas or cities? Which sector will get more attention in national adaptation policies? Are specific groups able to obtain a larger share of the resources available? What role will powerful groups with vested interest play in the national policy setting? These questions need to be answered. They are just some examples of the potential conflict that could be caused in the context of resource allocation. A human rights-based approach will help to identify the first priorities by giving criteria for the setting of priorities, as we will see later in chapter 4.6 and chapter 10.

The formulation of adaptation policies require many administrative skills and long term planning processes based on scientific evidence and advice. One problem which is particularly important in developing countries is that disaggregated research on the impact of climate change at the local level is still only rudimentarily available. Such knowledge gaps in climate data go hand in hand with poor or, at times, non-existent social data on land ownership, land cadastres, and population censuses etc. This can lead to a situation where certain groups are not properly registered and will be overlooked in the design of adaptation policies.

It will not be an easy task to mobilize the necessary political will for these types of necessary substantive changes. Adaptation policies might require supporting certain groups that have not been in the focus of national policies or which have been marginalized in national policies until now. They might change the flow and distribution of public resources in countries, between different regions or ethnic groups etc.

Moreover, adaptation policies need to have a long term focus, which might be missing in national policies based on four or five year election cycles. Many developing countries, particularly those involved in resources extraction, are more oriented towards short term gains and policy goals. Shifting policy towards long term sustainable management of resources will be a challenge. Poverty might also be a reason why affected communities or households will not be able to finance the necessary long term adjustments needed.

However, relying on short or medium term solutions might even aggravate the effects of climate change. When farmers are without the money and the skills to

change agricultural techniques toward reduced water consumption, they might start overusing the still existing water reserves even faster than before. That is another reason why the development of adaptive responses has to be linked with actual development priorities as much as possible. Adaptation means safeguarding developmental work rather than just dealing with an environmental challenge. In that sense, it is very important that as many climate-related interventions as possible contribute to development goals, such as the MDGs (Table 14).

Problems will also occur because many decisions on adaptation policies need to be taken in a situation of uncertainty. Still, much data is missing in most parts of the world on the local impact of climate change. But even with the best available data, uncertainty will be part of the picture. The variability of the weather is likely to increase. The chaotic behavior and feedbacks of many parts of the weather and earth system prevent exact regional forecasts. And the insecurity surrounding emission trends, international support activities, and regional economic developments all add to the overall uncertainty. Countries can react to this uncertainty by increasing their scientific and risk management capacities. Exchange of experiences with other governments and institutions will be a key challenge in order to use scarce resources as effectively as possible.

A number of countries that will be affected by climate change are currently in difficult governance situations. There are countries involved in ongoing civil wars, such as Sudan or Chad. Some of these struggles are particularly protracted because they are loaded with ethnic or religious conflicts. Some countries are in a situation where several armed groups operate; these various groups include private armed groups, such as war lords, private security groups protecting extractive industries, or paramilitary groups. Adaptation policies are difficult to design and implement in these types of situations, because no rule of law and no ordinary administrative capacities are available. But even these countries are not totally neglecting the issue. Chad and Sudan both have developed National Adaptation Programs of Action (NAPAs).

Other forms of weak governance relate to countries with wide-spread corruption and inefficient government institutions. Such situations will make it very difficult to develop a long term response towards a realistic adaptation policy to climate change. Again, these are situations where it must be examined how the international community can effectively support affected groups and persons to respond to the situation.

4.2 Climate information and climate science

Adaptation policies will need to start with good knowledge about the impact of climate change on different sectors, actors, and regions in a country. Without sufficient information and services to collect or to use available data, it will be difficult to design an adequate policy response.

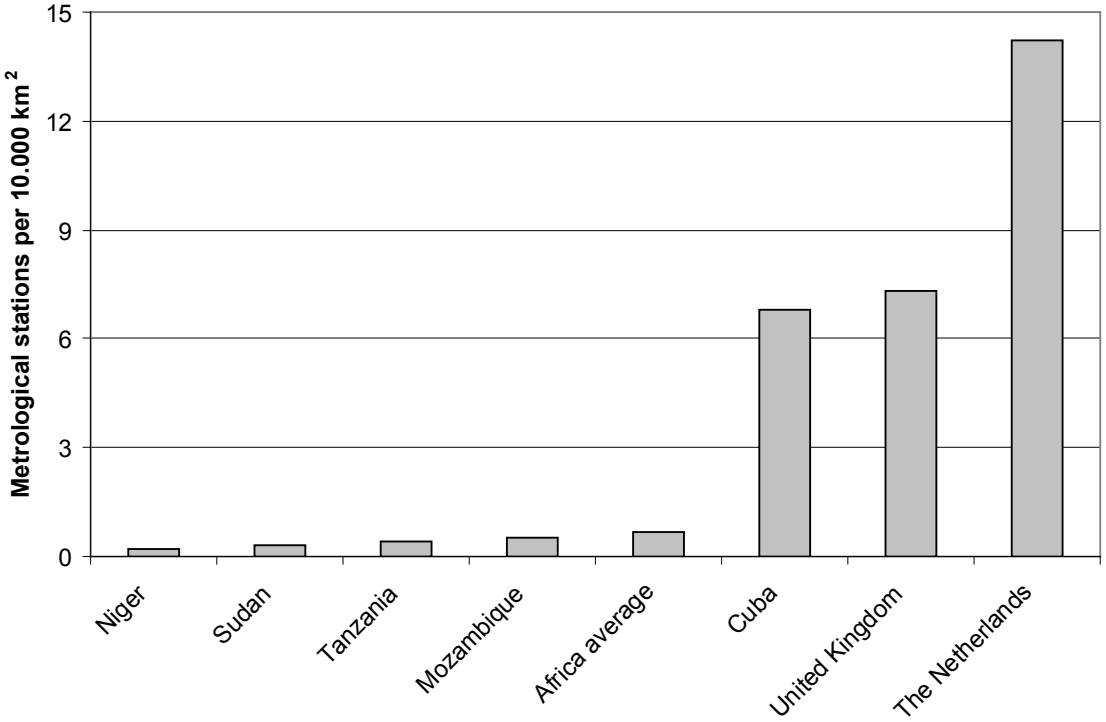
While research on impacts at national or even sub-national levels has started in many countries, data coverage in other regions is still very low. The situation is well summarized by a study from the Earth Policy Institute at Colombia University:

> *„Over relatively long timescales (i.e. 30 years or more) and larger spatial scales (i.e. hemispheric or global), today's climate change models broadly agree, both with each other and with physical theory about what is likely to happen in aggregate, at least with regards to anthropogenic climate change. At shorter timescales and on local and regional scales, there is considerable disagreement among the models, making it difficult to reach conclusion" (Hellmuth et al. 2007, 8).*

This sentiment is particularly true for poorer countries where adequate models to calculate the regional impact are least developed. Regarding the already observed changes,

> *„there is, however, a notable lack of geographical balance in data and literature on observed*

Figure 20: Africa's climate information gap



Source: based on UNDP 2007, 173

> *changes, with marked scarcity in developing countries" (IPCC 2007b).*

This statement is important even though progress has been made since the Third Assessment Report (see also Figure 20).

The gap in climate information and climate science is still huge. They lack national research capacities as well as computing capacity in order to do the necessary calculations. Many developing countries, particularly the poorer ones, lack data on all relevant levels, including historical meteorological data, and well-functioning meteorological monitoring systems specifically for the analysis of particular weather events like heavy rainfalls leading to floods, or drought periods.

The missing data basis and limited research capacities are leading to a situation where all forms of climate-related forecasts are limited. This starts with predictions of atmospheric conditions, which makes even the normal weather forecast more difficult. Data on sea temperature could help to scale up climate information to seasonal forecasts. Seasonal forecasts are the most useful planning data for agricultural activities.

For longer term strategic planning in rural development policies pre-estimations over a time span of 10 to 30 years (decadal variability) are relevant. Getting better data for seasonal and decadal variability, and making these applicable to farmers' daily lives, will be of utmost importance for the adequate design of adaptation policies.

Fortunately, the situation is slowly improving in several developing countries, because of more international data becoming locally available, satellite data supplementing ground observations, and an increasing cli-

mate modeling capacity (Hellmuth et al. 2007, 5). But there is still concern that not all internationally available data – including that from stakeholders such as global reinsurers – is regionally accessible.

For countries to better understand their local climate and thus be able to predict local implications of climate change, they must have adequate operational national systematic observing networks, and they must invest into these networks. The networks should have access to data available from other global and regional networks, be it in the hands of the United Nations such as the data from the World Meterological Organization (WMO) or data collected by private companies such as Munich Re and Swiss Re, the biggest reinsurance companies in the world. For example, the WMO has initiated Regional Climate Outlook inter alia in the Greater Horn of Africa, Southern and West Africa, Asia, and Southern and Central America.

Still, many developing countries do not have access to such information and scientific services. Access to such data will allow inputs for local climate models and a specific adaptation plan to be provided. Monitoring trends of sea surface temperature and sea-level are essential to assessing their impacts on the increased intensity of tropical cyclones and storm surge. Monitoring weather data will help to predict extreme events which are influencing precipitation in different regions and leading to floods and droughts, such as the phenomenon of El Niño.

In addition to the access to data, it is important that countries have sufficient human resources to use the weather and climate information available and to help maintain a minimum recommended density of weather stations. These services need to be financed nationally, but developing countries must also have the opportunity to finance information flow and an adequate scientific infrastructure with financial flows from international adaptation funds.

Article 5 of the UNFCCC obligates the international community to support and further develop climate research and systematic observation systems (UNFCCC 1992). The workshops organized by UNFCCC on adaptation needs of developing countries highlighted the need for international support in collecting necessary information and having access to existing data sources (UNFCCC 2008e).

The UNFCCC workshops also concluded that climate data is not the only thing needed to effectively assess the vulnerability and adaptation needs to climate change in developing countries.

> *„Equally important, and very much lacking at present, is the need for accurate socio-economic data“ (UNFCCC 2008e, 5).*

Without a poverty sensitive assessment, it will be impossible to get an adequate overview about the vulnerability of households and communities in a given region or country. Countries therefore need to develop sufficient assessment capacities in order to do a proper risk and vulnerability assessment. While international support is useful, countries will need to urgently build up such assessment capacities domestically in order to guarantee an adequate policy response.

Secondly, it is important for governments to guarantee that climate information available at national or regional levels is distributed to those groups in civil society which support or represent vulnerable groups. Still today, many farming communities and rural areas do not have access to existing agricultural extension services or to the meteorological data available in the country (UNFCCC 2008e).

Many decisions taken in the „autonomous adaptation“ by farmers, fisher folk, or pastoralists will be of better quality when they have access to such information in an applicable manner. This will influence decisions such as when to start planting, and what type of seed varieties are to be used etc. Even for existing early warning systems, the last mile – from a development perspective, this is the last mile –, which cannot be bridged with technologies, is the biggest hurdle. It is important to find out how disaster assistance can be further optimized in this regard.

4.3 Climate-related insurance approaches[18]

Insurance instruments that provide financial security against droughts, floods, typhoons, and other weather extremes have emerged as an opportunity for developing countries to reduce poverty and adapt to climate change. This issue has increasingly gained importance in the UNFCCC negotiations, e.g. in the Bali Action Plan. This opportunity is due to a number of recent innovations: Greatly increased computer capacity is making it possible to model and price low-probability risks; index-based insurance contracts are providing a low-cost alternative to traditional indemnity-based insurance; and novel mechanisms for transferring catastrophe risks to the global financial markets are opening new windows for reinsurance arrangements. Emerging financial risk management opportunities for the developing world, although not at all the only solution for adapting to increasing climate risks, can play a critical role in reducing economic and human losses from weather extremes, and in providing necessary security for investments necessary to escape poverty.

While insurance can be valuable in reducing the long-term effects of climate disasters on poverty and development, it is important to recognize that insurance instruments, particularly if not supported by donors, cannot be a panacea for adapting to climate change. There are many reasons for this, including:

- Insurance is generally not appropriate for very slow-onset climate impacts, such as sea-level rise and desertification, which are considered uninsurable. Other instruments are needed in this case.

- Without government or donor support, private insurance is not easily affordable by governments, households, and firms in highly exposed and vulnerable countries. Here the opportunity costs of private risk-financing instruments can be prohibitively high in terms of meeting other human needs.

- Many developing countries lack an insurance tradition and market, which will take time to develop.

- Perhaps most importantly, insurance must be considered within an overall risk-management and adaptation strategy. The two top priorities are avoiding dangerous climate change and preventing human and economic losses.

The benefits of insurance must be viewed together with the costs, keeping in mind the urgent need for other types of adaptation and also poverty reduction measures. Insurance benefits those in the risk pool by spreading their losses temporally and geographically, and assures timely liquidity for the recovery and reconstruction process (which can, itself, save lives and livelihoods).

There are also significant transaction and other costs to providing insurance, and over the long run insured clients can often expect to pay more than their anticipated losses. This is especially the case for insuring catastrophes. Unlike other types of insurance (e.g., life or health), catastrophes affect whole regions or countries at the same time (co-variant risk). The insurer‘s cost of backup capital, diversification, or reinsurance to cover co-variant claims can raise the premium far above the „actuarial fair price“ or the client‘s expected losses.

So what is the rationale for governments, households, and farms to insure? The textbook rationale for insurance is based on the concept of „risk aversion“, which simply means that risk-averse persons prefer less consumption, if it is steady, to higher consumption, if it is highly irregular or even subject to catastrophic shortfalls. Even risk-averse agents, however, should not purchase insurance if they have lower-cost alternatives for providing post-disaster security. These may include accumulated assets/savings, post-disaster borrowing, kinship arrangements, and government/donor support. These alternatives appear to work reasonably well for low-loss events, but are often unreliable and inadequate for catastrophic events (Cohen and Sebstad 2003), in

[18] This chapter builds on Linneroth-Bayer, Mechler and Bals 2008 (forthcoming)

which case households may be forced to sell productive assets at very low prices; post-disaster inflation may greatly reduce the value of savings; money lenders may exploit their clients; entire families, even if geographically diverse, may be affected by large disasters; and donor assistance rarely covers more than a small percentage of losses (Mechler et al. 2006). In other words, insurance can have significant advantages over informal security arrangements, especially for the very high consequence events.

Likewise, if governments do not have the necessary infusion of capital after a disaster to rebuild critical infrastructure and assist households and businesses with their recovery, the indirect costs can greatly exceed the direct losses from the disaster. Such delays can lead to secondary economic and social effects, such as deterioration in trade, budget imbalances, and increased incidence of poverty.

An often overlooked but highly significant rationale for investing in insurance is the security it provides for taking on productive but risky investments. Due to high uninsured risk exposure, households and farmers may adopt low-risk, low-return strategies (e.g., placing relatives in low-paid but secure employment or adopting low-yield drought-resistant seeds). This reduces the likelihood that they can accumulate the assets needed to escape poverty through savings and investment.

Banks in developing countries are often reluctant to offer credit to clients at high risk of default due to natural disasters. By making clients more creditworthy, insurance can enable investments that increase their productivity (sometimes more than the cost of the insurance). Thus, agents do not need to be risk averse to receive net benefits from insurance.

The same can be said for the case of governments of highly exposed countries. If governments insure their public infrastructure, this may lead to greater foreign investment in their country. Some observers claim that the security offered by insurance has enabled industrialized countries to take risks, and thus increase productivity, far above the costs of insurance.

In sum, insurance is not appropriate in all contexts and will generally increase, not decrease, the expected financial cost of disasters to the clients. In cases where agents (households, farms and governments) have lower cost alternatives to providing post-disaster liquidity after disasters, insurance may not be advisable. In many contexts, however, these alternatives are ineffective (especially for large catastrophes), in which case agents should weigh the benefits of insurance with the costs. These benefits include, first and foremost, security against the wholesale loss of assets, livelihoods and even lives in the post-disaster period. Insurance not only provides the liquidity to smooth disaster shocks, but by enabling productive investments has the added benefit of helping high-risk agents escape disaster-induced poverty traps.

Novel and imaginative programs are demonstrating their potential to pool economic losses and smooth incomes of the poor facing weather variability and climate extremes, as well as transfer risks to the global capital markets. These schemes provide insurance to (1) farmers, property owners and small businesses (micro scale), (2) to donor agencies charged with providing disaster relief (mesa scale), as well as to (3) governments by transferring their risks to the global capital markets (macro scale). A few examples serve to illustrate:

- In Malawi, smallholder farmers can purchase affordable index-based drought insurance, where, unlike traditional claims-based insurance, indemnity is on an index of rainfall measured at a local weather station. By making farmers more creditworthy, this pilot loan/insurance scheme enables farmers to purchase hybrid seeds, and thus greatly increase their productivity (Suarez, Linnerooth-Bayer and Mechler 2007).

- Similarly, herders in Mongolia can purchase an index-based insurance policy to protect them against livestock loss due to extreme winter weather or dzuds. A recent pilot program combines self-insurance, market-based insurance, and social insurance. Herders retain small losses that do not affect the viability of their business (self-insurance), while larger losses are transferred to the private insurance industry (market-based insur-

ance) and only the final layer of catastrophic losses is borne by the government with backing from the World Bank (social insurance) (Skees, Barnett and Murphy 2008, 151ff.).

■ The World Bank has also absorbed layers of Turkey's earthquake risk to enable an affordable nation-wide insurance program. This is the first time that the international development community has provided pro-active risk-financing support to a developing country (Gurenko, Lester and Mahul 2006).

Similarly, at the mesa scale:

■ The World Food Program issued a novel parametric weather derivative or catastrophe bond to assure sufficient funds to the Ethiopian government to protect the livelihoods of Ethiopia's vulnerable populations, who are at risk to severe and catastrophic drought (investors purchase a bond that pays an above-market interest rate if rainfall exceeds a specified level, but which pays part of the principal to the Ethiopian government if rainfall is below this level). This insurance instrument holds large promise for supporting institutions that have traditionally provided humanitarian assistance (Hess 2006).

And at the macro level:

■ The Mexican government is the first to issue a catastrophe bond to partly insure its catastrophe fund and thus reduce its risk of large fiscal deficits following disasters. This bond makes it possible to transfer sovereign risk directly to the world's capital markets (Cardenas, Hochrainer, Mechler, Pflug, Linnerooth-Bayer 2007, 40ff.).

■ The Caribbean island states have recently formed the world's first multi-country catastrophe insurance pool to provide governments with immediate liquidity in the aftermath of hurricanes or earthquakes. There is a largely untapped potential for pooling uncorrelated risks of country governments ill prepared to respond to disasters with their own means (Ghesquiere, Mahul, Forni, Gartley 2006).

At a recent expert workshop on Insurance Instruments for Adaptation to Climate Risks[19] in Laxenburg, Austria, these risk-pooling and risk-transfer programs were examined by those most familiar with them. Participants agreed that, for the most part, they directly or indirectly target the most vulnerable, and while first experience is promising, it is too early to assess their sustainability. Importantly, without exception these (mainly) public-private systems have received technical and/or financial support from international development and donor organizations, making them a viable alternative to post-event aid.

As experts discussed in Laxenburg, experience is too short to determine if internationally backed public/private systems are viable in the long haul, but as pioneering „test balloons" (and some are beyond the testing phase) they may radically change the way development organizations provide disaster aid and support adaptation to climate change: Binding contracts instead of aid, criteria-based instead of camera-based – it is often critisised that aid goes primarily to regions where TV cameras are present – payments, and obligations to compensate instead of engaging in goodwill activities are three such examples. Despite the promise of these new initiatives, insurance still reaches only a small fraction of vulnerable communities and governments; for instance, over 40 percent of farmers in the developing world face weather-related threats to their livelihood (World Bank 2005), and yet those benefiting directly from micro-insurance systems number in the thousands. Weather risk destabilizes households and countries and creates food insecurity. In the Southern African Development Community (SADC), as a case in point, floods, cyclones, and droughts have been a major cause

[19] An expert workshop, Insurance Instruments for Adaptation to Climate Risks, organized jointly by the International Institute for Applied Systems Analysis (IIASA), Munich Re, the German Agency for Technical Cooperation (GTZ) and the World Bank, and as part of the activities of the Munich Climate Insurance Initiative (MCII), took place at IIASA in Laxenburg, Austria, on Sept. 24-25 2007.

of hunger affecting more than 30 million persons since 2000. Governments and donors react to these shocks rather than pro-actively managing the risks. These emergency reactions have been criticized for being ad hoc, sometimes untimely and destabilizing local food markets (Hess and Syroka 2005a).

Similarly, many highly exposed developing country governments do not have the means to finance the recovery costs of catastrophic disasters and could greatly benefit from transactions, like those in Ethiopia and Mexico. Least-developed countries can hardly afford the technical analyses and other start-up costs for insurance systems. Scaling up will prove costly, especially since disaster risks, unlike health or accident, affect whole regions at the same time and thus require spatial diversification, reinsurance and/or large capital reserves. Thus, it is very important that risk management mechanisms including insurance will play a role in the UNFCCC negotiations. As part of the Bali Action Plan, one workshop will be held during the COP 2008 in Poznan. Switzerland only recently proposed a global carbon tax to generate financing for adaptation, with insurance being identified as one of the key purposes to be supported (Germanwatch 2008). It will also be important to highlight the role of the most vulnerable in this specific debate.

4.4 Response capacity at the national level

The first actor responsible in dealing with the impact of climate change is the government. Given the IPCC differentiation of adaptation introduced above, the government has a key role to play to identify where and which planned adaptation interventions are necessary to increase climate resilience. Often multi- and cross-sectoral approaches will be the most promising to improve the adaptive capacity of the agricultural system or to help to adjust to specific adaptation needs.

Planned adaptation consists, therefore, of deliberate actions undertaken to reduce the adverse consequences of climate change. While a broad range of adaptation measures exists, the role of the governments is essential for these deliberate actions. The first reason is that governments are duty bound by international human rights standards to respect, protect, and fulfill all human rights. The right to adequate food, the right to housing, the right to health, to water etc. are all recognized rights in the International Covenant on Economic, Social, and Cultural Rights (see chapter 2). Governments are obliged to guarantee that no violations are happening and that the government is using the maximum amount of available resources to implement theses rights. The second reason is that most of the measures required for successful adaptation are measures that need to be implemented with the support of national governments, including the creation of regulatory frameworks that incentivize adaptation in the private sector. International help and support cannot replace governments – it is the opposite. Without a functioning government, adaptation policies will not work and cannot be implemented properly, at least not on a longer time scale and with wider geographic coverage. Governments cannot be circumvented by international resources. The better a government response to climate change, the more likely it is that the adaptation options chosen are well selected and strategically chosen.

4.4.1 Financial resources needed

Many studies estimate that autonomous adaptation would be a comparably low cost implementation strategy because it can lead to high benefit-cost ratios. Studies conclude, for example, that adjustments in land use techniques at the farm level, which are assumed to cost very little, can generate significant benefits in terms of offsetting damages (OECD 2008a; Adger et al. 2007). The same is estimated for other behavioral adaptations, such as enhanced water use efficiency. While the examples pinpoint some low cost adjustments, they already show how difficult such assessments are, because their starting point is that farmers have the skills and opportunities to change certain patterns of production easily, including sufficient information on climate data. Extremely marginalized smallholder farmers might need much more support to apply such „low cost“ adaptation. This scenario is often the case when these farmers are extremely poor or part of women-headed households

with less then one hectare, which is not rare in Africa and Asia.

As it has been mentioned before, the FAO and the IPCC highlight that particular care has to be given to the situation of smallholder and subsistence agriculture, and on related livelihoods such as pastoralism and artisanal fishing, because they have the least coping capacities. When they are negatively hit by the impact of climate change, the number of hungry people will increase. The FAO is demanding a conceptual framework to harness the growing understanding of the biological processes involved with climate change impacts on crops and livestock production as they relate to the specific features of these livelihoods (FAO 2008b). According to the IPCC, such a framework should recognize the complexity and high location specificity of these problems, incorporate „non-climate stressors" in rural livelihoods and their contribution to vulnerability, and recognize that climate change impact on smallholder livelihoods is manifold and scale dependent (Easterling et al. 2007).

Nevertheless, while many low-cost strategies for adaptation exist, it becomes more and more clear that adaptation is an economic challenge, particularly for those countries that are highly vulnerable and economically weak. Adapting to climate change requires investing in sustainable natural resources and ecosystem management (e.g. integrated river basin management for the provision of freshwater or the conservation of wetlands for flood protection) as well as significant extra investments such as building new dikes to protect coasts from sea-level rise, supporting local communities to prepare for weather-related disasters, or setting up seed banks to ensure food production after disasters have occurred. This extra challenge emerges at a time where the commitments of developed countries to increase their Official Development Assistance (ODA) are far from being met.

The spending of adaptation finance should focus not only on supporting national governments to make necessary infrastructural investments, but as mentioned earlier, on building poor people's resilience to climate change. However, there is a risk of fungibility with existing Official Development Assistance (ODA) and, while mainstreaming climate change in ODA is important, in general, adaptation financing should be additional and should pay for additional measurably initiatives, due to its compensatory nature.

Although there is still a lot of uncertainty about the future costs both in developed and developing countries, the scale of financing needed is not inconsiderable. Recent studies undertaken by the UNFCCC secretariat, UNDP, or Oxfam suggest that adaptation costs will amount to several tens of billion of dollars per annum (see box page 114). No doubt that adaptation is in most cases cost-effective in the longer term, since it seeks to minimize the damages from climate change in the future. However, initially large investments have to be made. According to the UNFCCC, private sources of funding can be expected to cover a portion of the adaptation costs in developing countries. However,

> *„public resources will be needed to implement policies or regulations to encourage the investment of private resources in adaptation measures especially in developing countries. Public domestic resources will also be needed to cover adaptation costs related to climate change impacts on public infrastructure" (UNFCCC 2007a, 17).*

It also becomes clear that support measures from adaptation funds, e.g. on the UNFCCC level, should also cover the option to support human and institutional capacity development. If that money is not taken from adaptation funds themselves, it could at least become one of the key tasks for bi- and multilateral development aid to help building up the necessary government capacities to act.

The share of public responsibilities will probably be much higher where generally investments in the private sector are limited, such in many Least Developed Countries. Also, where Official Development Assistance (ODA) provides a significant share of national budgets, this instrument may become a key channel to progress towards mainstreaming adaptation.

Different adaptation „cost factors“

a) What are the adaptation costs in international development co-operation (in ODA)?

b) What are the costs for „climate-proofing“ of other (non-ODA) existing infrastructure?

c) How many new investments are necessary because of climate change (e.g. dams, dykes etc.)?

d) What are the adaptation costs on community level (community based adaptation, capacity building by NGOs etc.)?

e) What are the incremental costs to adapt poverty reduction strategies to climate change?

Estimates of annual adaptation costs and the factors included in developing countries:

- Oxfam 2007: at least 50 billion USD (cost factors a-d)
- UNDP 2007: 86 billion USD by 2015 (a, b, e)
- UNFCCC 2007: 28-67 billion USD by 2030 (a-c)
- World Bank 2006: 9 to 40 billion USD (a).

Taken from Harmeling and Bals 2008: differentiation by the authors, deduced from the different cost estimates.

These figures give an initial idea of the expected costs for adaptation but have already received some criticism. In a recent study on the economic aspects of adaptation, the OECD rejects the findings of the few existing studies with cost estimations.

> *„While potentially relevant for the international discussion on adaptation and its financing, existing global multi-sectoral estimates face serious limitations. The quality of data and the assumption are not reliable enough“ (OECD 2008a, 12).*

The discussion shows that adaptation will be a huge challenge for poorer countries. It is still open as to how many low cost alternatives exist, and it becomes clearer that smallholder livelihoods also need particular government attention. While it might still be low cost, it will require good human and institutional capacities to do it properly, which in turn also requires investments.

4.4.2 Assessment of adaptation policies

The IPCC looked also into existing experiences with adaptation policies, practices, and constraints (Adger et al. 2007). Many societies have a long record in adapting to the impact of weather and climate through a range of practices such as crop diversification, irrigation, water management, disaster risk management, insurances etc. The IPCC highlights that, while much can be learned from historic experiences,

> *„climate change novel risks often outside the range of experiences, such as impacts related to drought, heat waves, accelerated glacier retreat and hurricane intensity” (Adger et al. 2007, 17.2.1).*

Many observers do have hope that adaptation to climate change is „nothing new under the sun“ (GTZ 2007, 5), because in a historical perspective, changing climate conditions are not new phenomena.

Obviously many activities considered as adaptation to climate change are not new, such as risk management, coastal management, and spatial planning. Some observers, therefore, conclude that what is needed to cope with the impact of climate change is an exchange of experiences.

> *„In some regions, the repercussions of climate change will be unknown phenomena to these regions, while the same events may be well known in other regions. These latter regions will have developed experiences and traditions to cope with these conditions. It is essential that we learn from such regions and their historic experience – this is an important part of*

adaptation and does not need to be invented: Ii is already there and ‚just' needs to be applied" (GTZ 2007, 5).

While it is true that many technical solutions are available and better practices might be found in other parts of the world, it is the size, speed, and dimension of the problem that will make the search for the best adaptation policy so difficult. How do we set priorities? Who should we support first? These will be decisive questions. Moreover, adaptation measures and policies are not only technical by nature; they might lead to changes in entire livelihoods, thus altering the living conditions of bigger parts of the population. One example is that coffee can no longer be grown in Uganda at certain temperature increases, because coffee needs to be grown in higher (unavailable) altitudes (Simonett 1989).

A large portion of smallholder farmers would lose an important part of their income. Additionally, when adaptation policies are integrated into national politics, the institutional capacity of the government and its political will to help those most who are most affected will matter. In many countries this will require to overcome historic forms of marginalization and discrimination faced by those who are already hungry and malnourished.

The IPCC notes that adaptation policies are seldom undertaken in response to climate change alone. Many measures that might help to tackle the impact of climate change are taken in order to deal with current climate variability, in particular extreme weather events. Often, planned adaptation measures are not undertaken as stand alone measures, but embedded within broader sectoral initiatives such as water resource planning, coastal defense and disaster management planning (Adger et al. 2007, 17.2.2). The adaptation perspective needs therefore to be mainstreamed in all relevant national policies, for agricultural development, water management and housing, just to mention some.

The IPCC is also concerned with the fact that adaptive capacities are unevenly distributed across and within societies. There are individuals and groups within all societies that have insufficient capacities to adapt to climate change and that are disproportionally hit. Women-headed households in subsistence farming are one such group (Adger et al. 2007, 17.3.2 and 17.3.3). The capacity to adapt is a dynamic one; it will be influenced by a variety of factors such as economic development, natural resources, social networks, and security of entitlements that poorer segments of the society have. The availability of sufficient institutional capacities and governance as well as human resources and technologies are also important.

„Multiple stresses related to HIV/AIDS, land degradation, trends in economic globalization, and violent conflict affect exposure to climate risks and the capacity to adapt. For example, farming communities in India are exposed to impacts of import competition and lower prices in addition to climate risks; marine ecosystems overexploited by globalized fisheries have been shown to be less resilient to climate variability and change" (Adger et al. 2007, 719).

Adaptation is not and will not be an easy task. The IPCC has very high confidence that there are significant barriers to implementing adaptation measures (Adger et al. 2007, 17.4.2). These include both the inability of natural systems to adapt at the rate and magnitude of climate change, as well as technological, financial, behavioral, social, and cultural constraints within societies. Additionally, there are still significant knowledge gaps on the one hand as well as valuable experiences on the other hand. Good organization is necessary so that available knowledge will reach those most affected by climate change. Even in countries that have a huge capacity to finance and implement adequate adaptation policies, it does not mean that adaptive policies automatically will reduce vulnerability. The IPCC uses the heat wave in Europe to illustrate the point:

„(...) despite a high capacity to adapt to heat stress through relatively inexpensive adaptations, residents in urban areas in some part of the world, including European cities, continue to experience high levels of mortality" (Adger et al. 2007, 719).

To conclude: While technical expertise might be available – and, to a large extent, it is an issue of knowledge management to know what answers can be supplied to a given problem – the politics of adaptation and the management of necessary changes will be the real challenges in the development of adaptation policies. Increasing the accountability of government institutions and policymakers towards those affected by climate change will therefore be a decisive step for the processes of development of national adaptation policies. The authors of the study propose a human rights-based strategy for adaption policies as a key tool to increase accountability towards the most vulnerable groups. More details to a human right based strategy will be given in chapter 10.

4.4.3 Adaptation measures

Key to effective adaptation policies will be a functioning national setting in which different actors cooperate and try to work together in order to achieve better outcomes through cooperation. Adaptation policies will entail adjustments and changes at all levels – from the community level to national and international levels. Communities can increase their resilience, including searching for and developing the most appropriate technologies. They can partially draw on their own „traditional" knowledge, but they can also learn from the experience of communities in other places who have acted successfully in similar situations. They might diversify their livelihood strategies in order to cope with the expected future climate stress and the expected extreme weather events. Or they might insure themselves. Local coping strategies will only be successful if they are developed in synergy with government action at the local and international level. At all levels, ministries, governments, as well as institutions and non-governmental organisation have to work together and integrate the climate change perspective in their planning and budget work. If only some of the actors mentioned are aware and willing to act according to the adaptation needs identified, but the others opt out, the result will probably be sub-optimal.

There are many adaptation measures that can be applied, and literature is increasing in presenting many options available to deal with one problem. The IPCC has in each chapter of the report from Working Group 2 a subchapter discussing the opportunities and techniques for adaptation in that sector: in chapter 5 „Food, fibre and forest products", in chapter 3 „Freshwater resources and their management" and in chapter 4 „Ecosystems, their properties, goods and services". Most of the recommendations for the systematization of adaptation measures use a sectoral approach. The following overview (Table 15) from the UNFCCC lists adaptation measures for different vulnerable sectors. It differentiates between reactive and anticipatory adaptation measures.

The typology used by the FAO follows an ecosystemic structure. The FAO framework study on climate change and food security from 2008 uses, based on this structure, three steps:

- analysis of the nature of risks in each ecosystem (Nature of risk),
- definition of vulnerable groups affected by these risks (Livelihood groups at risk),
- possible adaptation approaches for each of the vulnerable groups (Adaptation responses).

Since this appears to be a very useful and practical approach, the full tables for 10 ecosystems are displayed here.

Independent from the typology used to systematize the available instruments and technologies used to adapt to climate change, it is important to recall from above that adaptation is not only a technical issue. Adaptation policies need to be integrated into a national strategy that focuses on particular vulnerable groups and that tries to involve all actors significantly affected.

Adaptation to climate change must also occur through the prevention and removal of mal-adaptive practices – e.g. incentives to live in risk-prone areas –, as has been outlined before. A policy test is needed to make sure that they do not contradict adaptation needs. Examples include badly managed irrigation systems, the removal

Table 15: Adaptation measures in key vulnerable sectors highlighted in national communications of developing countries

Vulnerable sectors	Reactive adaptation	Anticipatory adaptation
Water resources	Protection of groundwater resources Improved management and maintenance of existing water supply systems Protection of water catchment areas Improved water supply Groundwater and rainwater harvesting and desalination	Better use of recycled water Conservation of water catchment areas Improved system of water management Water policy reform including pricing and irrigation policies Development of flood controls and drought monitoring
Agriculture and food security	Erosion control Dam construction for irrigation Changes in fertilizer use and application Introduction of new crops Soil fertility maintenance Changes in planting and harvesting times Switch to different cultivars Educational and outreach programs on conservation and management of soil and water	Development of tolerant/ resistant crops (to drought,salt, insect/pests) Research and development Soil-water management Diversification and intensification of food and plantation crops Policy measures, tax incentives/ subsidies, free market Development of early warning systems
Human health	Public health management reform Improved housing and living conditions Improved emergency response	Development of early warning system Better and/or improved disease/vector surveillance and monitoring Improvement of environmental quality Changes in urban and housing design
Terrestrial ecosystems	Improvement of management systems including control of deforestation, reforestation and afforestation Promoting agro forestry to improve forest goods and services Development/improvement of national forest fire management plans Improvement of carbon storage in forests	Creation of parks/reserves, protected areas and biodiversity corridors Identification/development of species resistant to climate change Better assessment of the vulnerability of ecosystems Monitoring of species Development and maintenance of seed banks Including socioeconomic factors in management policy

Vulnerable sectors	Reactive adaptation	Anticipatory adaptation
Coastal zones and marine ecosystems	Protection of economic infrastructure Public awareness to enhance protection of coastal and marine ecosystems Building sea walls and beach reinforcement-Improvement of carbon storage in forests Protection and conservation of coral reefs, mangroves, sea grass and littoral vegetation	Integrated coastal zone management Better coastal planning and zoning Development of legislation for coastal protection Research and monitoring of coasts and coastal ecosystems

Source: based on UNFCCC 2008a, 31

of laws that protect particular vulnerable groups and their access to productive resources for the building of infrastructure, and practices that lead to the destruction of mangroves etc.

The key focus of all adaptation policies should be improving the situation of particularly vulnerable groups. The following set of principles and criteria should be applied for all adaptation policies:

- they should be based on human rights standards and principles (e.g. transparency and non-discrimination);

- they should focus on vulnerable groups and people and show that they are using the maximum amount of available resources to improve their situation;

- they should guarantee existing access to productive resources and avoid mal-adaptation;

- they should be build around meaningful participation of all affected groups;

- they should include the right to complain, including complaint and recourse procedures and

- they should be „customer-oriented“, meaning that appropriate climate services should be developed for the groups affected by climate change. That must include effective communication between stakeholder groups, user friendly support tools, full stakeholder participation in all steps of adaptation policies, capacity building at all levels of government, and integrated climate research whose results are communicated to all stakeholders. Community-based adaptation strategies often show the best results. Political will is a central precondition for designing adaptation policies in a result-oriented manner. Political will is best fostered by freedom of expression and a proactive role of media and the guarantee of freedom of association for civil society groups.

4.5 Response capacity to problems at the local and household level

Developing countries have very different national circumstances. The specific impact of climate change on a country depends on climatic conditions as well as its geographical, social, cultural, economic, and political situation. As a result, countries require a diversity of adaptation measures very much depending on these specific circumstances. However, there are cross-cutting issues which apply to multiple countries and regions. The same sectors are affected by climate change, albeit to differing degrees, such as agriculture, water resources, human health, terrestrial ecosystems, biodiversity, costal zones etc. The capacity of governments to act locally and to correctly assess who is going to be affected and in what ways also differs.

Adaptation policy will only work if it functions locally, because otherwise it is very likely that the instruments

Table 16: Examples of adaptation responses according to different ecosystems

Nature of risk	Livelihood groups at risk	Adaptation responses
Dry land ecosystem		
EXTREME Drought Flood GRADUAL Changes in rainfall patterns	Low-income groups in drought- and flood-prone areas with poor distribution infrastructure and limited access to emergency response Producers of crops that may not be sustainable under changing temperature and rainfall regimes Poor livestock keepers where changes in rainfall patterns will affect forage availability and quality	Improved crop, grassland and livestock management Promotion of cropping systems increasing soil organic matter and water infiltration capacity (no-tillage systems)Research and dissemination of crop varieties and breeds adapted to changing climatic conditions Community grain storage for food distribution Weather-related insurance
Coastal and island ecosystem		
EXTREME Heavy rains,high winds, storm surges, floods GRADUAL Saltwater intrusions, sea-level rise	Fishing communities that depend heavily on coral reefs for protection from natural disasters and flood Fishers whose infrastructure essential for fishing activities, e.g. port and landing facilities, storage facilities, fish ponds and processing areas, become submerged or damaged Farmers whose land becomes submerged or damaged by the rise in sea-level or saltwater intrusions	Coastal defenses: Hard-groynes, revetments, embankments Soft-mangroves, coral reefs, wetland conservation Emergency shelters on high ground, with stocks of food, water and medicine Relocation of settlements, roads and other infrastructure Integrated coastal zone management Desalination plants Weather-related insurance Relocation where a rise of sea-level is inevitable
EXTREME Flood Landslide	People indirectly dependent on mountain ecosystem services Producers of crops that may not be sustainable under changing temperature and rainfall regimes	Integrated watershed management approaches Adjusted silvicultural practices Research and dissemination of crop varieties and breeds adapted to changing climatic conditions
EXTREME Heat and cold waves, high winds, storm surges, floods GRADUAL Sea-level rise	Elderly people and others susceptible to temperature extremes Low-to-medium-income groups who may lose homes, stored food, personal possessions and means of obtaining livelihoods	Emergency shelters Adaptive infrastructure investments Innovative insurance instruments

Nature of risk	Livelihood groups at risk	Adaptation responses
EXTREME More anomalies, in both failures and bonanzas, among multiple species Drastic shift in the areas where small, migrating fish are found GRADUAL Changes in ocean currents, rise in average sea temperatureSharpening of various gradient structures, Increased discharge of freshwater into oceansRatchet-like Eutrophication (increase in chemicalnutrients and loss of oxygen in ocean waters), severe reductions in water quality and in fish and other animal populations.	Fishers/aqua farmers who sufferdiminishing catches from shifts in fishdistribution and aquatic ecosystem productivity	Shift from dynamic to static fishingtechnologies that are less wasteful ofremaining fish stocks Occupational training to facilitate searchfor new livelihood opportunities
Inland water and floodplain system		
EXTREME High winds, heavy rains, floods GRADUAL Changing water levels	Low-income groups in drought- and flood-prone areas with poor food distribution infrastructure and limited access to emergency response	Changes to dam and infrastructure specifications Storm- and flood-resilient building codes Improved river defenses Watershed management, including zero-tillage farming systems Restricting development in high-risk (floods, mudslides) zones Weather-related insurance
Forest ecosystem		
EXTREME Heavy rains, high winds, floods, droughts, wildfires GRADUAL Sea-level rise, forest dieback, pests and disease	Low-income, forest-dependent people People indirectly dependent on forest ecosystem services	Integrated forest pest managementsystems Integrated forest fire managementsystems Integrated watershed managementapproaches Adjusted silvicultural practices Forest conservation Promotion of small-scale forest-based enterprises for local income diversification
Cultivated ecosystem		
EXTREME High winds, floods, droughts GRADUAL Changing temperature and rainfall regimes	Producers of tree crops that aresusceptible to wind damage Producers of crops that may not be sustainable under changing temperatureand rainfall regimes	Introduction of cropping systems that donot move and expose soil Introduction of integrated agro forestrysystems Research and dissemination of cropvarieties and breeds adapted tochanging climatic conditions

Source: FAO 2008b, 56

Table 17: Examples of adaptation options by poverty category

Poverty Category / Type of Adaption	Chronic Poor		Transient Poor	
	Always Poor	**Usually Poor**	**Cyclical Poor**	**Occassionally Poor**
Autonomous adaption	• Conflict, crime, sex work • Selling of last assets	• Intra-community transfer/charity • Sending children to work	• Seasonal migration • Working multiple jobs, longer hours	• Diversify livelihoods • Investment in social capital/assets
Market-based adaption		• Promote micro-finance, micro-insurance • Cattle insurance	• Weather-indexed insurance • Promote mirco-finance, micro-insurance	• Promote mirco-finance, micro-insurance • Selling assets
Public policy driven adaption	• Assisted migration • Cash tranfers	• Community re-stocking schemes • Subsidised seed banks	• Ecosystem rehabilitation • Improved climate information (seasonal forecasting)	• Social insurance programmes (health, crop, employment) • Irrigation schemes/urban service provision

Source: IDS 2007, 4

will not be precise enough to reach out to those who are locally affected. In all countries, a detailed analysis of the impact of climate change is a pre-condition to deal adequately with it. Assessing the impacts of and vulnerability to climate change and subsequently working out participative adaptation strategies reflecting the needs of the affected people require good quality information. This information has to include local climate data as much as possible, such as temperature, rainfall, and the frequency of extreme events.

The risk of households hit by the effects of climate change will depend on several circumstances. Vulnerable groups need to be distinguished by the different livelihood risks they face. Additionally, the coping capacities of each family need to be taken into consideration. It will vary from family to family; those families with savings, or where enough labor capacity is available might have a better chance of autonomously coping with climate risks than those who are heavily affected by HIV/AIDS or who are headed by marginalized women. Younger and better skilled people might find it easier to adapt to changing circumstances because historically they are more open to planting other crops. Often, younger people have better educations which might provide them with additional useful capacities.

In most cases, the effects of climate change will vary within regions and even among households, although there may be generalized trends on the national level. This fact leaves households with different coping capacities. Therefore, developing a vulnerability mapping of households potentially affected by climate change is an indispensable starting point for each country. This action allows countries to develop adaptation strategies that target the most vulnerable.

Overall, there is little doubt that poverty is a key factor limiting the adaptive capacities of people and why poor people often constitute the most vulnerable groups.

Table 18: Policy options for the design of local adaptation policies

Type of measures	Examples
Adopting physical adaptive measures	Excavation, re-excavation of canals, miniponds, irrigation, storage facilities for retaining rain water
Adjusting existing agricultural practices	Adjustment of cropping patterns, selection of drought-tolerant crop varieties; better storage of seeds and food; dry seedbeds, or adopting alternative, cash crops such as mango and jujube
Adjusting socio-economic activities	Livelihood diversification, market facilitation, small-scale cottage industries, integration of traditional knowledge
Strengthening local institutions	Self-help programs, capacity building and awareness raising for local institutions
Strengthening formal institutional structures	Local disaster management committees and financing institutions; formulating policy to catalyze enhancement of adaptive livelihood opportunities
Creating awareness and advocacy	
Supporting better research	Farm links to new or improved crops including drought tolerant varieties, and other conducive and adaptive technologies

Source: FAO and ADPC 2006

When thinking about solutions, addressing the different faces seems to be useful in identifying adaptation options which address the specific needs of the target groups (Table 17).

One important precondition for local adaptation policies is that there is a functioning local administration to develop good strategies. Local administrations need to be supported by national institutions, both in the supply of climate information and knowledge for adaptation measures as well as in the delivery of financial resources and legal tools (when needed). The correct application of such knowledge and the transfer resources to the local level need to done by the local administration. It is at that level where administration is often very weak in developing countries. Often, local administration lacks the power to make the necessary decisions because the central government controls all of the steps. On the other hand, local governments are often the agents responsible for the marginalization and discrimination of certain weaker groups in society. Decentralization is urgently needed and must start with strengthening local governments and their accountability.

The literature on local and community-based adaptation policies is increasing, and several studies are available which provide a good overview of policy options for adaptation at the local level. One example is a case study which was carried out in Bangladesh. It developed a useful typology to describe the different policy measures and policy areas that need to be involved in local adaptation measures to cope with climate change (FAO and ADPC 2006, 66f.). The authors of the study show that successful local adaptation to climate variability and change is not an easy task, and it requires multiple pathways with well-planned, interrelated short and long term measures. The task ahead for the design of meaningful adaptation policies at local levels is to find the right combination of these factors, which will give answers to the expected changes in the „geo-physical settings“ as well as the necessary adjustments in the „livelihood systems“.

4.6 Human rights set standards for adequate government responses

Adaptation measures will only reach particularly marginalized groups if a good assessment has been done. This assessment must analyze the vulnerabilities of different groups living under similar livelihood circumstances and, ideally, the vulnerability of each household.

The analyses shall be measured in how far adaptation policies applied will contribute to the implementation of the right to adequate food and other economic, social, and cultural rights of the affected households. Other examples are the rights to health, housing and water. The human rights perspective has been chosen here as the relevant point of departure, because human rights describe what can be expected from governments based on their own commitments.

Key aspects of the right to adequate food debate have been summarized before. What are the applications for the adaptation debate and for designing appropriate policies?

The complexity of the choice of specific policy options seems to stretch the limits and coordination capacity of current local institutions to find the right adaptive responses, including research and technology development. However, a rights-based approach will be helpful for the design of adaptation policies. Those groups and persons who are already marginalized and who have compromised coping capacities, will be most affected.

In chapter 1 and 2 it was described that most of the hungry today are marginalized producers or consumers who have never received government support to help them in the given circumstances. Pre-existing discriminations are likely to be aggravated and already vulnerable groups will be particularly affected. The human right to adequate food, as well as the rights to water and health, comes into play in the design and analysis of governmental response to climate change. According to the International Covenant on Economic, Social, and Cultural Rights, governments have to first focus their policy response on the most vulnerable groups and take into consideration the already existing discriminations and marginalization.

Human rights set standards for government behavior on the issues enshrined in these specific rights. Since climate change and adaptation to its consequences will influence the fulfillment of these rights, principles for an adequate design of adaptation policies can be reasonably deducted from the human rights debate. Governments have the obligation to respect, protect, and fulfill human rights – particularly for the most vulnerable groups. They have to make sure that government policies respect these rights, e.g. do not deprive people from access to food-producing resources, from obtaining an adequate income, or from the access to food itself.

Continuing with the example of the right to food, governments have to make sure that third parties do not violate the right to food (obligation to protect). Moreover, governments have to prove that they fulfill the right to adequate food by using the maximum amount of its available resources as expeditiously as possible. This cover measures the prevention of disasters and preparedness to shocks.

Human rights are also an important category, because they set standards in how far governments act in a way that is sufficiently participatory to the most affected stakeholders. The persons affected by drought, flooding, weather anomalies etc. are often experienced adaptation „experts“. They should be informed and their opinions heard before adaptation decisions are made. Moreover, they should have opportunities to complain, be it to a national ombudsman system, or to the national human rights institution.

If these people are negatively affected by the chosen adaptation policies or if they feel that their claims have been overseen, there should be a route for citizens in which they can object to unfair policies. In the context of UN climate policies, even a complaint mechanism on the international level is imaginable.

Human rights allow holding governments accountable – as well as when designing adaptation policies to cli-

mate change. Governments are requested to develop a national strategy for the implementation of each right, which shall encompass the aforementioned five crucial elements:[20]

Adaptation policies to climate change must pass the same rights-based test. Did the government identify the relevant vulnerable groups? Has a proper risk assessment been done? Are the policies reasonably focused on the vulnerable groups? Are the effects and the impact of policies being monitored? Do people have the right to complain against the policies affecting them? Do they have a legal recourse? Human rights not only ask for ending violations and for positive outcomes for the most vulnerable groups; they also set standards for the form of political processes. They must be participatory, transparent, and non-discriminatory.

It is important to recognize that there are no specific „rights-based policies“ valid under all circumstances – but the selection of adaptation policies should be done in a rights-based manner. First of all, it is a procedural obligation. This means that good adaptation policies also need to address the historic discrimination of marginalized groups in order to allow them to cope with the upcoming problems. The policies have to address this marginalization, although one cannot expect to solve all problems of marginalization from adaptation policies.

Measures to achieve this in the agricultural sector include:

- Ending insecurities in access to productive resources;
- Helping to get access to research results, the dissemination of crop varieties and breeds adapted to new circumstances, and using different varieties at the same time;
- Promoting agro-forestry, integrated farming, organic farming techniques (soil moisture, biodiversity, stress resistance of local agricultural systems), particularly oriented to subsistence and smallholder farmers;
- Improved infrastructure for small-scale water capture, storage, and use;
- Improved soil management practices;
- Minimizing post harvest losses;
- Helping to adapt farming systems and livelihood strategies to changing agro-ecological conditions.

There are many other instruments which could potentially play a role in adaptation in the agricultural sector. The procedural aspects of the rights-based approach need to be applied to those adaptation strategies being chosen. These aspects must also be seen in a wider context as there is a need for an adequate and comprehensive government response to a non agricultural food supply system. It must be ensured that no food insecure, vulnerable groups are excluded from supply systems. A combination of e.g. the following measures should be pursued:

- Safety net systems (e.g. cash transfer, micro-insurance etc.);

[20] (1) Governments must assess and identify what are the most vulnerable groups concerning the rights to adequate food, to housing, to water etc. Without proper assessment, governments cannot properly focus their policy attention to these groups.
(2) They have to make sure that existing legislation addresses the concerns of these groups and that the legislation is not leading to “de jure” discrimination and violations.
(3) The governments have to make sure that their policy response and their choice of instruments (“de facto”) is reasonable and focused on those most vulnerable under this right. Policies shall respect and protect existing access to resources and other means necessary to realize these respective rights. They must also help people cope with risks.
(4) Governments are obliged to monitor the outcome of their policies.
(5) Governments must allow for accountability mechanisms including functioning complaint mechanisms and access to recourse procedures.

- School feeding and other targeted food related interventions;

- Price support for vulnerable groups or similar measures (public subsidized distribution systems);

- Support for HIV/AIDS-affected families (orphans etc.) and

- Employment guarantee schemes.

To sum it up: Adaptation policies need to be embedded appropriately in the local context and should be oriented towards the most vulnerable groups. One of the strengths of this approach is that it helps set up procedural guarantees of participation for affected communities and people, including having access to relevant information (transparency) and the right to complain. The second strength is that rights-based approaches request a specific outcome. Governments have to prove that they focus their policy and budget decisions toward the most vulnerable groups and that no group is overlooked. Governments have to prove that their own adaptation policies do no harm, i.e. deprive people from access to food or water. It is, therefore, a very sensitive and meaningful approach to target adaptation policies for those who need it the most, as many studies demand (FAO and ADPC 2006, 95).

5 Impacts on global food security and response capacity at the international level

5.1 Impacts on global food security

Climate change will have effects on all four dimensions of the food security definition (see chapter 1). It is useful to apply the four dimensions to the potential impact of climate change. Some of the dimensions can basically be addressed at the local or national level, while others are most relevant to the global response. Although there will be some positive impacts, the following list illustrates that climate change will have mostly negative effects on the food security dimensions:

(1) Availability of food: It is likely that food availability will be reduced by a drop in food production caused by extreme events, changes in the suitability or availability of arable land and water, and the unavailability or lack of access to crops, crop varieties and animal breeds that can be productive in conditions resulting from changes in pests and diseases.

The production side of availability has global implications. The amount of sufficient food available guaranteed during emergencies is one such implication. Questions also arise as to who is going to keep certain stocks etc.

(2) Access to food: The situation might be worsened due to the fact that extreme weather events and their likely intensification resulting from climate change might lead to damages in infrastructure. Losses of livelihood assets and loss of income and employment opportunities are even more important. Access to food is an issue that first and foremost needs to be tackled at the national and household level.

(3) Stability of food supply: It is important to note that this will be influenced by food price fluctuations and a higher dependency on imports and food aid. Adequate regulation for this dimension needs to be found at the national and global levels.

(4) Utilization of food: It can be affected indirectly by food safety hazards associated with pests and animal diseases, as well as by the increased presence of human diseases like malaria and diarrhea. Again, these problems need to be solved first and foremost at the national and household levels.

In chapter 4, the potential to deal with adaptation problems at the national, local and household level was described. Chapter 5 will discuss the elements for which the international dimension will be most relevant. It will look into the response capacity of the international system in order to adequately deal with coming adaptation problems. It will discuss the role development aid can and should play as well as the response capacity of intergovernmental organisations working in the field. However, predictions on the overall availability of food supply are difficult to make due to the many intertwined factors. One line of argument in the debate is the Malthusian argument, that limited resources of fertile soil and irrigation water cannot feed the long term demand of the overall, growing population with a changing live style. Other groups are hopeful that the potential to increase yields and production is still far from being fully realized and that a second or third „green revolution“ will be necessary and possible. Chapter 2.4 analyzed agricultural market trends more in detail. The five key trends identified were the following:

- The demand for food and agricultural products is expected to grow rapidly, due to factors such as the population growth, increasing wealth etc.;

- The demand for non-food use of agricultural resource is increasing along with oil prices, in particular for energy purposes;

- Global food markets will be confronted with a shrinking surplus production in the US and the EU through reduced export subsidies and more domestic use for energy purposes etc.;

- Future environmental limitations for agricultural production including land degradation, urbanization, reduced fresh water availability etc.;

■ Climate change is likely to increase volatility on the supply side, particularly due to more intense extreme weather events, inter alia in today's surplus countries.

All of these factors contribute to a scenario of increasing demand and limitations on the supply side. Food producing resources are limited, particularly soils and water. While this scenario does not necessarily lead to scarcity of food in the coming years, it is an indication that prices for agricultural produce will not likely decrease to levels that prevailed during the last decades.

5.2 Options to increase production

The standard answers given concerning these challenges are normally technical. Suggested solutions are often to increase productivity and the yield per hectare through the use of modern plant varieties. The general model of the last decades has been to continuously innovate, reduce farm gate prices and externalize costs. This model drove the phenomenal achievements of Agricultural Knowledge, Science and Technology (AKST) in industrial countries after World War II and the spread of the Green Revolution beginning in the 1960s. Agricultural research has contributed to an average increase of yields for decades at a rate above the increase of the world population.

The increase in productivity was due to better seeds or breeds, but also to the intensification of agricultural production through the increasing use of fertilizer, pesticides, and a remarkable mechanization of agriculture. At the same time, the size of land being irrigated was increased, particularly in Asia. Only recently the increase in productivity has slowed down.

It is within this context that UN-Agencies and private philanthropic organisations are currently promoting a second green revolution for Africa. The hope is that a good supply of agricultural inputs will help African farmers increase production. An increase in irrigated land will help increase yields at a different pace in Africa than in the past decades.[21] While it is correct to look at all options to improve productivity per area of land, it is becoming increasingly recognized that marginalized communities, rather than the already intensively cultivated agricultural land, need more attention. Moreover, further intensification in favorable agricultural areas is reaching its limits. These results are, for example, due to increasing water shortages and therefore reduced irrigation possibilities, as well as through increasing environmental problems, like salinisation, that current intensive industrialized production is already causing. Recently the International Assessment of Agricultural Knowledge, Science and Technology for Development (IAASTD), which was published in Paris, gave the most encompassing documentation of the possibilities, which small holder agriculture has.

> *„Given the new challenges we confront today, there is increasing recognition within formal S&T organizations that the current Agricultural Knowledge, Science and Technology (AKST) model requires revision. Business as usual is no longer an option. This leads to rethinking the role of AKST in achieving development and sustainability goals; one that seeks more intensive engagement across diverse worldviews and possibly contradictory approaches in ways that can inform and suggest strategies for actions enabling to the multiple functions of agriculture" (IAASTD 2008, 4).*

The report, which had been kicked off in Johannesburg during the Earth Summit in 2002, lines out

> *„various policy options to meet the challenges ahead, perhaps best characterized as the need for food and livelihood security under increasingly constrained environmental conditions from within and outside the realm of agriculture*

[21] See the documents of AGRA "Alliance for a new green revolution in Africa" at www.agra.org. The ideas are supported by the FAO which highlights the potential to increase yields and production in Africa.

and globalized economic systems" (IAASTD 2008, 3).

The setting of the World Agricultural Council is similar to the IPCC. It comprises 400 scientists from all over the world. They screened the available literature and published their report on that basis (IAASTD 2008).

The report focuses on the question, how Agricultural Knowledge, Science and Technology (AKST) can be used to reduce hunger and poverty, to improve rural livelihoods and to facilitate equitable environmentally, socially and economically sustainable development. It shows how much potential exists to increase sustainable agricultural production, when small holder farmers get an adequate support in national agricultural policies:

„The main challenge of AKST is to increase the productivity of agriculture in a sustainable manner. AKST must address the needs of small-scale farms in diverse ecosystems and create realistic opportunities for their development where the potential for improved area productivity is low and where climate change may have its most adverse consequences. The main challenges for AKST posed by multifunctional agricultural systems include:

- *How to improve social welfare and personal livelihoods in the rural sector and enhance multiplier effects of agriculture?*

- *How to empower marginalized stakeholders to sustain the diversity of agriculture and food systems, including their cultural dimensions?*

- *How to provide safe water, maintain biodiversity, sustain the natural resource base and minimize the adverse impacts of agricultural activities on people and the environment?*

- *How to maintain and enhance environmental and cultural services while increasing sustainable productivity and diversity of food, fiber and bio fuel production?*

- *How to manage effectively the collaborative generation of knowledge among increasingly heterogeneous contributors and the flow of information among diverse public and private AKST organizational arrangements?*

- *How to link the outputs from marginalized, rain fed lands into local, national and global markets?" (IAASTD 2008, 4f.).*

It is not only this report which recognizes that those marginalized smallholder farmers, who have never received adequate attention or research support, could easily increase their yields – often three- or fourfold – in a different policy environment.[22] This potential for increasing yields depends on different factors, such as the type of agricultural system (organic or non-organic), environmental conditions for agriculture, and the respective ecosystems. After years of neglect, smallholders are now being taken much more seriously in the debate.

A good indicator of this are the documents of the Global Donor Platform for Rural Development. It is a platform of bi- and multilateral donors which tries to learn from the best practices and make proposals for how to foster rural development policies inside of the official development assistance. Long term solutions for achieving higher yields, which can be secured sustainably, are most important. They will require agro-ecological solutions that will increase productivity on marginal soils, and convert damaging industrial production systems into more sustainable systems. Miguel Altieri noted:

„Throughout the developing world, resource-poor farmers (about 1.4 billion people) located

[22] For details: The UN Millennium Project describes in detail how to marginal many farming areas are today. Marginal both in terms of rural remoteness and distance to streets, infrastructure, and markets, and marginal in terms of policy ranking at national and international agendas (UN Millennium Project 2005).

in risk-prone, marginal environments, remain untouched by modern agricultural technology."

Altieri states that a new approach to natural resource management must be developed so that new systems can be tailored and adapted in a site-specific way to highly variable and diverse farm conditions typical of resource-poor farmers. Agro ecology provides the scientific basis to address the production by a biodiverse agro ecosystem able to sponsor its own functioning. The latest advances in agro ecological research need to promote natural resource management compatible with the needs and aspirations of smallholder farmers.

„Obviously, a relevant research agenda setting should involve the full participation of farmers with other institutions serving a facilitating role. The implementation of the agenda will imply major institutional and political changes" (Altieri 2002).

Such agriculture can, under certain conditions, have a higher resilience against climate change impacts.

But the problems cannot be tackled only at the technical level. The situation of the rural poor has been aggravated by the fact that rural areas were neglected in national and international policy making. For a long time, the policy focus was on investments in industry and urban infrastructure, and budget allocations for rural areas were reduced substantially, as has been previously described (chapter 2.3). Support for rural development and agricultural production were judged as outmoded and reduced by more than half since the beginning of the 1990s. A radical and intelligent shift towards policies that pay greater attention to the needs of the poor and hungry is needed, and governments must implement their human rights obligations to these groups. This includes addressing other negative framework conditions such as insecure land titles and problems with access to credit or capital etc.

Therefore, we can conclude that the availability of food is not an indicator per se to explain why people are hungry. The overall availability of food is dependent on many factors, including agricultural research and productivity. This chapter has shown that it is important to look further than the high potential areas of production, because their relative advantage might suffer with climate change (less water, flooded fertile coastal zones affected by salt water intrusion etc.). Productivity gains will be best achieved when smallholder farmers get more support and incentives to produce. That support must be directed to them, in order to make sure that they can use it (linked with micro-credits and training etc). If the support is simultaneously directed to help them to adapt to climate change or to cope with the consequences, then adaptation policies are becoming more oriented towards an integrated approach including poverty concerns. At the same time, smallholder farmers are the biggest single group of the hungry worldwide. If their income can be raised, the hunger situation will become better.

5.3 Agriculture – increasing productivity or global warming?

If strategies to increase the productivity of agriculture are considered, it should be taken into account,

- to what extent this fits with adaptation strategies to climate change,
- to what extent this is coherent with a mitigation strategy based on the two degrees limit and
- what synergies between increased productivity, adaptation and mitigation can be implemented?

As outlined before, according to IPCC data, greenhouse gas emissions from the food, forestry, and agriculture sectors contribute over 30 percent of current annual total anthropogenic emissions. 13.5 percent of emissions come from agriculture and 17.4 percent come from deforestation (Barker et al. 2007, 5). It is therefore important to address these emissions and try to reduce them substantively. The main source of these emissions is the livestock sector, which accounts for about 18 percent of global emissions. Interestingly, two thirds of those 18 percent come from deforestation caused by livestock

Table 19: Best practices of climate change mitigation in agriculture

Reducing emissions of carbon dioxide through: • reduction in the rate of deforestation and forest degradation, • better control of wildfires, • avoiding the practice of burning crop residues after harvest, • avoiding pasture degradation, • reduction of emissions in arable farming by adoption of no-till systems, • reduction of emissions from commercial fishing operations and, • more efficient energy use by commercial agriculture and agro-industries.
Reducing emissions of methane and nitrous oxide through: • improving nutrition for ruminant livestock, • more efficient management of livestock waste, • more efficient management of irrigation water on rice paddies, • more efficient management of applications of nitrogen fertilizer and manure on cultivated fields, • reclamation of treated municipal wastewater for aquifer recharge and irrigation.
Sequestering carbon through: • afforestation, reforestation, and improved forest management practices, • introduction of integrated agro-forestry systems that combine crops, grazing lands, and trees in ecologically sustainable ways, • use of degraded lands for productive planted forests or other cellulose biomass for bio fuels, • improved management of pastures and grazing practices on natural grasslands, including by optimizing stock numbers and rotational grazing, • use of techniques such as conservation agriculture to improve soil organic matter management with permanent organic soil cover, minimum mechanical soil disturbance and crop rotation.

Source: FAO 2007, 18

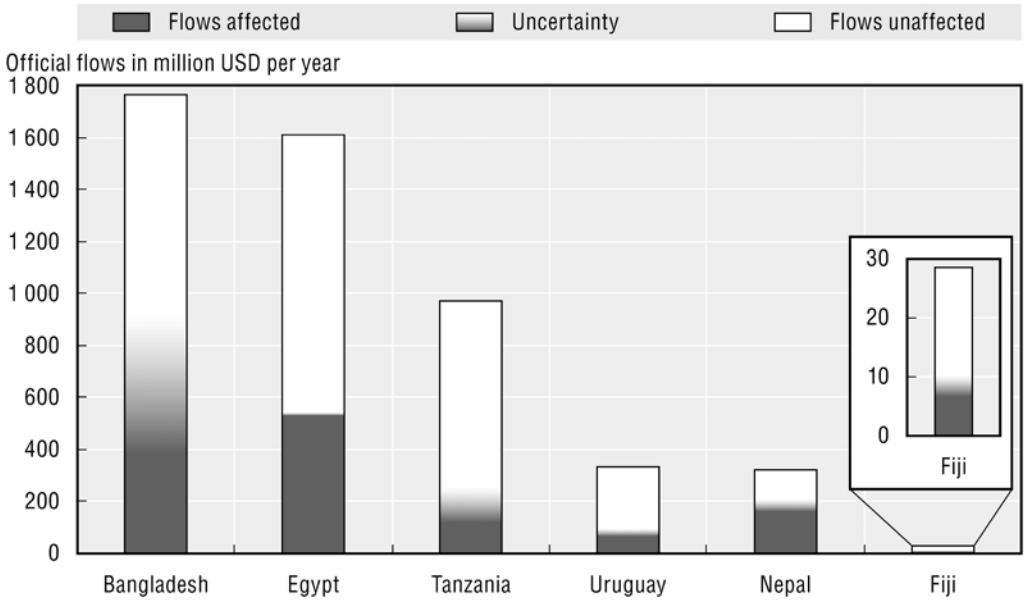
production. This means that the numbers used here for deforestation and livestock emissions cannot be added, as this would be double-counting of emissions by deforestation due to livestock extension. The other third is a result of the release of methane and nitrous oxide (FAO 2007). Addressing land use change for livestock production and reducing deforestation rates are two very important objectives for reducing agricultural-related emissions.

The design of adaptation policies in countries could be a useful opportunity to kill two birds with one stone: (1) identifying the most vulnerable populations and trying to minimize the impact of climate change on them, partly by increasing the productivity of their land, while (2) at the same time trying to change harmful developments by way of production in order to reduce agriculture‘s contribution to climate change. Many technology options proposed for adaptation can also help to mitigate the impact of these sectors.

The FAO has put together a list of proposals for how agriculture could systematically apply new technologies to help reduce greenhouse gas emissions. Such a list cannot be applied in all countries, but it provides options for which the most relevant techniques in different situations can be chosen. The design of national or local adaptation strategies has the potential to become an important occasion where such techniques could be used.

The FAO particularly highlights the potential of conservation agriculture to mitigate agricultural emissions, but the same would apply for organic agriculture. Zero-till techniques of conservation agriculture could help sequester up to 3 billions of tons of carbon per year for

Figure 21: Annual official flows and shares potentially affected by climate change



Source: OECD 2005

about 30 years (FAO 2007, 18). Conservation will also use much less fossil energy in the production of agricultural goods.

There can also be negative trade-offs between adaptation and mitigation. Adaptation measures in one sector can negatively affect livelihoods in other sectors. For example, river fisheries can be negatively affected from adaptations in other livelihood sectors upstream. In particular, additional irrigation water needs, such as in the Ganges region, can reduce flows and affect seasonal spawning and fish productivity.

Negative trade-offs could also evolve in the other direction. Mitigation measures, such as reducing emissions from deforestation by financing the non use of certain forest areas, can threaten the land rights, traditional-user rights, and livelihood forms of rural people. This process could even undermine efforts to improve food security and sustainable development for these groups. It is possible to reduce trade-off risks by sensitively applying a rights-based approach to analyze and avoid possible adverse effects of policies on other groups. However, in many cases, adaptation, mitigation, food security enhancement, and rural development can go hand in hand if well planned.

Furthermore, there can be positive feedback loops.

> *„Agriculture and forestry strategies can simultaneously increase adaptive capacity and mitigate climate change. For example, increasing soil organic matter in cropping systems, agro forestry and mixed-species forestry can improve soil fertility and soil moisture holding capacity, reduce impact of droughts or floods, reduce vulnerability and sequester carbon. There is need to explore and promote the synergy between adaptation and mitigation in the agriculture and forestry sectors (IPCC)“ (FAO 2008, 8c).*

Although the most vulnerable countries should focus on food security and adaptation they also should try to realize benefits of synergies with mitigation whenever pos-

sible. Adaptation (including increase of the productivity of land) and mitigation and their respective synergies and antagonisms are often location specific, although some patterns are based on elements such as climate, soil type, farming system, and level of development.

5.4 Response capacity in development cooperation

Climate change is becoming a central issue for development cooperation. Bi- and multilateral donors, as well as private non governmental agencies, have embarked on programs and policy advice related to both mitigation and adaptation policies. Climate change will become a major trend influencing all endeavors to reduce or combat poverty and in reaching the Millennium Development Goals (MDGs). Development cooperation must therefore take climate change seriously and develop adequate solutions. A second motivation for taking up this issue is the demand from the donor governments.

Development cooperation agencies have started to develop tools to „mainstream“ adaptation into their project portfolio by attempting to climate-proof projects that they carry out. Analyses have shown that, in some cases, up to 40 percent of ODA investments are climate sensitive (Figure 21). While increasing experience is gathered on a project level, mainstreaming has moved more towards the higher level of policies, rather than the operational level. A limited number of donors have systematically started to integrate adaptation into their work. Those who have are still in the early stages (OECD 2007; Harmeling, Burck and Bals 2007). However, by mid-2008, OECD countries themselves had identified progress, but also further challenges in a number of fields (Table 20).

An issue of increasing relevance is the addition of financing for adaptation and mitigation. Almost all of the donor countries, with the exception of a few, primarily Scandinavian countries, have never met their 30-year-old commitment of spending 0.7 percent of their GNI into Official Development Assistance.[23] Only recently, the Bali Action Plan reaffirmed the commitment for additional resources, however, this term is not exactly defined. It could be additional to existing ODA spent on adaptation, to overall existing ODA, to the ODA commitment of spending 0.7 percent of GNI. Many developing countries and NGOs call for the latter approach, given the large gap in actual ODA compared to the needs (see e.g. Oxfam 2007; Klima-Allianz 2007). They fear that ODA is being diverted from its original purpose.

Secondly, the money that is likely to come out of the UNFCCC process has the objective to support coping with situations or consequences of climate change; a challenge, which to a large extent, has been caused by developed countries. Financial flows to mitigate climate change and particularly flows to cope with the impact of climate change are, by nature, compensatory. Development Assistance was often demanded from developing countries as compensation for historic harm done by former colonial powers, but the ODA is not formally paid because of that reason. Developed countries have refused to accept such a compensatory function of ODA. The United Nations working group on the Right to Development has been “poisoned” for years inter alia with this debate (see Eide, Krause and Rosas 2004). In the context of the UNFCCC commitments, the case is different.

Development actors are well prepared to engage in the financing and implementation of adaptation policies. They have the methods and tools (from policy advice to budgets support) to develop practically, and they have approved ways to channel the money. One of the biggest risks of using the same actors for the delivery of funds is that development aid has also produced many

[23] In 1970, the UN proclaimed the goal that developed countries should spent 0.7 percent of the Gross National Income (GNI) as development aid. The OECD Development Assistance Committee is monitoring the implementation of that goal and is publishing a regular report about trends in development aid (OECD-DAC 2007).

Table 20: Progress and challenges ahead in mainstreaming adaptation, as identified by the Development Assistance Committee of the OECD

Progress	Challenges
Many development co-operation agencies and Multilateral Development Banks have taken formal commitments to integrate climate change concerns as part of their operations.	Donors should play a more active role in bringing climate change related risks and possible opportunities to the attention of developing country policy-makers and seek entry points for climate change-related dialogue.
Donor agencies and International Financial Institutions have made considerable progress in raising awareness among their staff of the risks posed by climate change and the importance of integrating climate change into development activities. Several donor agencies have also made special efforts to discuss these issues with their partners in the context of policy dialogues at various levels.	Donors must work towards harmonized approaches for assessing and integrating climate risks in the projects and programs which they support.
Many donor agencies and International Financial Institutions have begun to systematically assess the climate vulnerability of the various activities which they support, with a view to building in corrective precautionary measures as needed.	Donors and partners need to move from identifying the risks posed by climate change to ongoing projects to reducing those risks in a pro-active and strategic manner, starting from the early stages of policy and program formulation. Current trends towards providing development co-operation support at the level of policies, programs and plans open up new opportunities in this regard, as well as avenues for enhanced policy dialogue on policies and strategies which can support "climate-resilient" long-term development.
Some donors have begun working with vulnerable communities to build resilience into development projects and encourage integration of National Adaptation Plans of Actions (NAPAs) with Poverty Reduction Strategy Papers (PRSPs).	Donors also need to recognize that traditional knowledge may offer experience and insights to building resilience, which may help develop and implement locally-appropriate and situation-specific approaches.
Detailed assessments of climate change-related vulnerabilities have been conducted in many developing countries.	Donors should support methodologies for assessing climate risks that are based on scientific data, including observed climate data and climate model projections, as well as provide tools to enable developing countries to access information to inform their own development decisions, e.g. through regional earth observation and climate projection tools.
Donor agencies have developed tools and methodologies to assess climate vulnerabilities and to identify adaptation options in development policies, plans, programs and projects. These tools, which build on existing approaches such as Strategic Environmental Assessment (SEA) and Environmental Impact Assessment (EIA), should be shared to reduce redundant efforts.	

Source: based on OECD 2008b

of mistakes and mal-development. The design of adaptation policies should therefore try as hard as possible to avoid repeating old mistakes. Only a few percent of development aid is directed to poverty alleviation. A larger portion of aid is still being given to foreign policy and economic interests.[24] Rural development, as an issue of development aid, lost attention, and the overall size of it in aid budget was halved between 1995 and 2005.

Most of the policy advice given in past decades was oriented towards freeing market forces. The international financial institutions recommended to opening up markets, privatizing infrastructure, and reducing subsidies to non-competitive sectors. As a result, poor people in many developing countries lost most support institutions that had been available in rural areas some decades ago. Some examples include government-run veterinary services, government marketing boards, input support for farmers and price support for consumers etc.. A general slowdown of public investment in rural infrastructure, the breakdown of extension services, and the depletion of natural resources without protection measures are all factors that contributed to the uneven growth in many countries worldwide (GDPRD 2005). The strategy was based on macroeconomic assumptions rather than on a sound needs assessment of the particularly poor segments of the society. Growth rates were soaring in several developing countries, but poverty remained high, and the relative inequality increased in many countries – one of the reasons why so much literature has been published on how to foster pro-poor growth (see e.g. Ali and Son 2007a; Ali and Zhuang 2007).

Strategies in development policy should be oriented towards the needs of the most vulnerable groups. A positive trend is that rural development has started to come back on the agenda as an important issue in national and international aid. The process of reviving this issue started at the beginning of this century. In light of the current world food crisis, it is now gaining momentum. The African Head of States committed to aim for using 10 percent of their budgets for agriculture and rural development in Maputo in 2003 during an African Union conference. They developed the Comprehensive African Development Policy (CAADP) in the realm of NEPAD in 2004, a plan that guides the revival of different sectors. Several bi- and multilateral donors have created the „Global Donor Platform for Rural Development“ which tries to revitalize and harmonize the aid going into the agricultural sectors and into rural development. The World Bank chose the issue of „Agriculture for Development“ for its World Development Report 2007/08. These are all indicators of growing interest in rural development after decades of neglect. However, the World Bank‘s approach to differentiate three agricultural worlds and to suggest specific policies (chapter 2.3) by inter alia recommending migration to the particular poor producers and less laborers, might be economically rational, but it forces too many people to migrate to cities without any security that they might receive a sufficient, or even any, income there. A rights-based approach requires the government to first focus the resources available on the most vulnerable people.

Climate change, in combination with an increased competition of different land uses (food – fodder – fuel), will probably be the most important driver for rural development policies in the coming decades. It is therefore important that adaptation policies are developed in favor of the most vulnerable and marginalized groups. Adaptation funds and adaptation-related policy advice should focus on them. A human rights-based assessment can help to best orient the policies and the use of all instruments towards those most in need and to set priorities of who should get support first and what can be implemented progressively.

Development cooperation can play a crucial tool in all stages of adaptation policies. Different aid actors can play different roles in development aid. Bi- and multilateral aid can help integrate adaptation into policy development. Capacity must be built at all stages of the ad-

[24] Eurostep, a European network of developing organisations, regularly publishes a DAC–shadow report, which documents the spending priorities of development assistance.

aptation process in developing countries, from disaster preparedness and early warning to insurance schemes and policy design issues. Other stakeholders, such the scientific community and NGOs, should be integrated into adaptation planning. Each of these institutions can help to best design adaptation policies. Aid organisations can help with their experiences in project management and implementation and also by mobilizing internationally available knowledge.

5.5 Response capacity in intergovernmental organisations

To deal adequately with the consequences of climate change, good and harmonized institutional architecture is required. Effective cooperation will be a key component for a successful international response, with the prime objective to strengthen national government institutions involved in adaptation. National governments have been identified as those having the obligation and responsibility to guarantee that the impact of climate change is assessed and that national policies are set up to use the available resources best in order to implement sound adaptation policies. They have to organize the scaling-up of lessons learned and design the policies needed. Adaptation needs to be integrated into various sector policies.

National governments can and should be supported in their endeavour to implement adaptation policies by intergovernmental organisations which have started to work on the issue of adaptation. The following overview shall highlight existing commitments and procedural regulations inside the climate regime. It will also discuss the roles of other intergovernmental organisations who could contribute to a functioning adaptation infrastructure.

For the first years, adaptation to climate change was only of marginal importance within climate negotiations and inside the international climate change community. It was perceived as a distraction from tackling the root causes of climate change and mitigating global emissions. This perception has changed. The affects of climate change are already visible, and the scientific evidence that global warming is causing adverse impacts is overwhelming. Because of this, adaptation to climate change has become a key element in international climate change negotiations.

Article 4.1 of the United Nations Framework Convention on Climate Change (UNFCCC) states that parties shall „(...) formulate, implement, publish and regularly update national and, where appropriate, regional programs containing measures to (...) facilitate adequate adaptation to climate change, (...)“ and „(...) cooperate in preparing for adaptation to the impact of climate change.“ Article 4.4 states that developed countries shall „assist the developing country parties that are particularly vulnerable to the adverse effects of climate change in meeting the costs of adaptation to those adverse effects“ (UNFCCC 1992).

The negotiations under the UNFCCC and the Kyoto Protocol are increasingly paying attention to adaptation issues. The Convention addressed the issue of funding for adaptation in 1992 for the first time, and then in 1997 the Kyoto Protocol became more concrete regarding the obligations to support adaptation in developing countries. However, it was not until the adoption of the Marrakesh Accords in 2001 that adaptation became a prominent area for action. Since then, the pressure from affected developing countries has become stronger and stronger.

In 2004, the Parties to the Convention concluded a far reaching agreement with the Buenos Aires Program of Work for Adaptation and Response Measures to adverse impacts of mitigation policies. The agreement sets up a two-track approach for adaptation work; track 1 is the development of a five-year program of work on the scientific, technical, and socio-economic aspects of vulnerability and adaptation to climate change, and track 2, with the improvement of information and methodologies, implements concrete adaptation activities, technology transfer, and capacity building. In November 2006, during the meeting of the Conference of the Parties (COP 12) and the 2nd Meeting of the Parties to the Kyoto Protocol convened in Nairobi, adaptation was finally

becoming a key issue of the negotiations. Governments renamed the five year program, calling it the „Nairobi Work Program on Impacts, Vulnerability and Adaptation to Climate Change (NWP) (see Harmeling 2008). The NWP carries out activities, basically workshops and technical papers, to improve countries‘ understanding and assessment of impacts, vulnerability and adaptation, and „to make informed decisions on practical adaptation actions and measures to respond to climate change on a sound scientific, technical, and socio-economic basis, taking into account both current and future climate change and variability“, in the following areas (UNFCCC 2008c):

1. Methods and tools
2. Data and observations
3. Climate modeling, scenarios and downscaling
4. Climate related risks and extreme events
5. Socio-economic information
6. Adaptation planning and practices
7. Research
8. Technologies for adaptation
9. Economic diversification

For the financing of adaptation to climate change, a number of funds have been established in the UN climate change process. As part of its general tasks, inside the GEF (Global Environment Facility‘s Trust Fund) the SPA (Strategic Priority on Adaptation) has been set up. With the Marrakesh Accords, the Least Developed Countries Fund (LDCF) and the Special Climate Change Fund (SCCF) were established under the COP, but operated by the GEF. Finally, the Adaptation Fund under the Kyoto Protocol started work at the beginning of this year (UNFCC). This is a breakthrough as it is the first of these funds which is not based on voluntary contributions but on a levy of project-based emission trading in developing countries (Clean Development Mechanism, CDM).

While the SPA, the LDCF, and the SCCF are already fully operational, the governing Board of the Adaptation Fund is now in the process of developing and agreeing upon guidance for its work, including criteria of how to use the funding (see www.adaption-fund.org). Without any doubt, there has been some progress during the last years. But so far the financing for the funds is not on the right order by far.

In that context, it becomes clear that the UNFCCC is the key negotiation platform for adaptation policies. The advantage of the UNFCCC as a host for the Adaptation Fund is that the UNFCCC is a Convention under the United Nations allowing all members to participate with equal voting rights. Funds managed only by the World Bank or by the GEF would follow the decision-making structure of the World Bank with weighted votes according to the financial engagement. The World Bank and the GEF aim at playing a stronger role in the debate, in order not to be sidelined in the adaptation debate, which might receive a lot of funding in the future. The GEF is administering the SPA and is currently providing secretariat services on an interim basis to the Adaptation Fund. But the fund is working on a UNFCCC-based governance structure.

With regard to adaptation related to food security, a very important set of intergovernmental organisations are the Rome-based agencies working in the area of food security, the Food and Agriculture Organization (FAO), the International Fund for Agricultural Development IFAD, and the World Food Program (WFP). The strength of the FAO in adaptation policies could be to coordinate early warning assessments and to coordinate the disaster preparedness of the UN-system for agriculture and rural areas with the WFP.

Another role for the FAO could be to specialize with IFAD in policy advice on how to set up adaptation policies that are oriented toward rural poor and the most vulnerable. The FAO should build that policy advice around the Voluntary Guidelines on the progressive implementation of the right to adequate food, which was adopted by the FAO-Council in November 2004. The role of WFP would be to help countries identify the most vulnerable groups with sound needs assessments. Together with IFAD and FAO, the WFP should develop a policy proposal for safety nets in rural areas as tools in adaptation policies. IFAD is a financing mechanism specializing in the support of rural poor. It is the

one organization from the Rome-based agencies which is most oriented towards particularly poor and vulnerable groups. It should be discussed in which form the emerging UNFCCC finance structure could cooperate with IFAD.

Unfortunately the current food security architecture of the United Nations is quite weak and needs reform. There is much overlap between the three Rome-based agencies; however, all were recently evaluated, and are in the process of restructuring. The FAO process shall come to an end in November 2008. These reorganization processes should also be used to develop a good division of labor concerning their future work related to climate change. Other organisations involved in this process are the UN-OCHA, the UN-office for the coordination of humanitarian affairs, and the Food Aid Convention, which also needs to be re-negotiated up to June 2009.

The coordination among these institutions needs to find a division of labor with respect to the following tasks:

- Which organisations shall be involved in work related to food security, disaster preparedness and early warning?

- Who is involved in using the available climate data and applying them to agriculture, fisheries, and forestry? Who can help developing countries receiving up to date information?

- Which are involved in humanitarian assistance and emergency aid?

- How can it be guaranteed that humanitarian assistance and emergency aid get the long term food security of the affected and vulnerable population in the focus?

- Who is primarily responsible for policy advice for adaptation policies at the national and local level?

- Who is going to organize a global minimum reserve of food in order to cope with several weather catastrophes in one year?

- Who will support countries in implementation projects and programs?

Other institutions with relevance to this issue are those where important macroeconomic rules are being set. The World Trade Organization, regional or bilateral trade, and investment agreements are examples of these institutions. They need to make sure that rules and regulations promoted by them do not hinder governments to adapt to changing circumstances. Emergencies, for example, the increase in extreme weather events, might force countries to stop exporting agricultural goods in order to supply its own population. Some countries have approved export bans during the current world food crisis. Even if institutions, such as IFPRI, speak out against such a step, because it takes away the incentives to local farmers to increase production, there will be situations in the future that will require governments to act. Trade rules should also have all the necessary flexibility to react to the potential impact of climate change.

To conclude, several intergovernmental organisations (IGOs) have embarked with work related to adaptation to climate change. This is often related to their particular mandates such as food or health, which will be affected by climate change. On the other hand, all IGOs are interested in getting a share of the financial flows that are to be expected for adaptation policies in developing countries. So far, the financial flows are not high, but this might change soon, particularly with financing mechanisms such as the Adaptation Fund, which will be funded from carbon market instruments.

Details of the financing mechanisms will be presented in chapter 6.3. The number of organisations involved is already quite high, and it is therefore an individual task to coordinate the work of the different IGOs in order to avoid duplication of work and to best support countries in developing a national adaptation strategy. The final coordination will be an ongoing task for the climate negotiations, but also for the coordination among UN-agencies.

6 Climate change and poverty – economics of adaptation

The impact of climate change is already visible today. Climate change will hit poorer countries and their people particularly hard. It will change their development perspective, and might destroy their opportunities. It puts development at risk – but it also creates new opportunities.

This chapter will discuss the connection between climate change and development, or more precisely between climate change and the prevalence of poverty. Moreover, it will discuss the estimated cost of adaptation policies and present key economic aspects of adaptation to climate change.

6.1 Climate change, the MDGs and development prospects

UN Millennium Development Goals provide the most precise definition of what should be achieved when the UN talks about development. Climate change will affect the realization of all MDGs as has already been shown above. „Forget about making poverty history. Climate change will make poverty permanent“ is a slogan of the British non-governmental organisation Practical Action. The relevant impact of climate change on development will be on the income opportunities people might loose or be reduced as a result of climate change. The loss of productive land through salt water intrusion or through desertification can destroy the livelihood of a family.

Climate change will alter economic opportunities of larger segments of the population. Adaptation policies need to cope with these socio-economic changes if adequate answers are to be found as to the problem of these affected groups.

Climate change will also have an impact on the economy as a whole. The cost of importing food, in the case of low income food deficit countries, might increase drastically. Larger scale losses of fertile land will lead to substantive changes in the national economic structure. It will also influence the income situation of the government, which will be one of the important sources to finance adaptation policies.

Public budgets will not only face a decrease of income, but also potentially an increase in public expenditure, for example, for food and water supplies. Public budgets will be potentially affected largely by the costs for financing infrastructure to cope with climate change, such as the dam constructions etc. The spread of additional diseases will create extra costs. As a result, less money will be available for the regular implementation of the MDGs.

Climate change will lead to additional risks for development perspectives, particularly in those countries which will be substantially hit. But climate change will also require a lot of investment in adaptation and mitigation measures. However, these measures might – if they are not done in an intelligent way, – compete with investment into poverty reduction and sustainable economic growth.

However, as shown before, if done in the right manner, adaptation can bring about direct benefits for poverty reduction. Where there are limited prospects for successful adaptation, for example in low-lying communities because of the threat of sea-level rise, it might even be necessary to use financial resources to compensate people for their losses instead of investing into adaptation.

The increasing environmental scarcity in some regions might be one important factor to trigger conflicts. Darfur is one example showing that the ongoing depletion and overuse of livelihoods can become one of the reasons for conflict. Such processes, both environmentally-induced conflicts and situations where the impact of climate change might aggravate existing conflicts, will increase the number of refugees and cause migration. Migrants and internally displaced persons (IDP) are becoming two of the most vulnerable groups that might be affected by climate change. And they are without many coping capacities to deal with this new situation.

6.2 Financial aspects of adaptation to climate change: assessing costs and benefits

Financing adaptation will be a key issue in the coming decades.

> *„The poor have mechanisms to cope with climate variability since generations, but many of these will be overwhelmed by the extent of changes or other pressures on their livelihood" (DfID 2006).*

The economic costs of more extreme weather events will reduce financial possibilities to finance development, but also to finance adaptation measures. Several current government functions (financing water services, financing import bills for food in LIFDC) will become more expensive. Losses in agricultural income are, for many countries, equivalent to general losses in growth and GDP. For many poor people, climate change will destroy their livelihoods and make them even more vulnerable to food insecurity.

Calculating the costs of adaptation and climate change is not an easy task. But it is necessary as a precondition to receive financial support for climate change-related activities. Costs assessment approaches should be exemplified for the agricultural, forestry, and fisheries sectors according to an UNFCCC study. Adaptation costs in the year 2030 are estimated, which means that they are relatively independent of mitigation activities in the next years, due to the inertia in the climate system and the delayed warming effects.

In any case, a baseline scenario is needed, on top of which additional adaptation costs will be estimated. Based on scenarios of population and economic growth, it is expected that the level of resources spent on research in this sector will continue to grow by about 2 percent per year. Resources spent on extension are assumed to rise by 20 percent in developing countries due to their current and emerging food issues.

Thirdly, certain levels of investment in physical assets are estimated based on scenarios of the OECD and the International Energy Agency. As additional adaptation costs, the following is assumed:

- an additional increase of 10 percent is assumed for research and extension expenditures,

- an additional 2 percent for new capital is needed to inter alia irrigate areas, adopt new practices etc. This relatively low percentage is due to the assumption that „most agricultural and fisheries capital have a short life

Table 21: Estimated additional investment and financial flows needed for adaptation in 2030 (billions of USD)

Sector	Global	Developing countries (Non Annex I Parties)
Agriculture, forestry and fisheries	14	7
Water supply	11	9
Human health	5	5
Coastal zones	11	5
Infrastructure	8 to 130	2 to 41
Total	49 to 171	28 to 67

Source: based on UNFCCC 2007a

(10 to 20 years) and would be replaced and adapted as climate change proceeds“ (UNFCCC 2007a, 102). For the latter one, research is important.

This analysis, which is based on estimated investments and financial flows of USD 305 billion in 2030 in this sector in developing countries, results in additional adaptation costs of USD 7.2 billion, which is about 2.3 percent (UNFCCC 2007a). In research, the additional costs are estimated to be about 10 percent of the investments of USD 13 billion. In capital formation, it is about 2 percent. The UNFCCC made similar analyses for other sectors (water supply, human health, natural ecosystems, coastal zones, and infrastructure) and ended up with estimates of additional adaptation costs (see Table 21).

It is important that this, and other analyses, only address parts of the costs that will be necessary to cover, and it also lacks a human face. One key challenge will be to prepare people, in particular agricultural farmers, to the risks that changing climate brings. Capacity building for communities on a large scale is one task that is a blind spot of many cost estimates (Oxfam 2007). UNDP, for example, includes estimates specifically for strengthening poverty reduction programs in ways that build resilience and reduce vulnerability. It assumes an extra investment of 0.1 percent of OECD countries‘ GDP, which results in USD 40 billion in 2015, plus USD 2 billion to strengthen disaster response, and USD 44 billion for „climate-proofing“ those investments that are taking place as part of the Official Development Assistance (UNDP 2007,194).

The recent study of the OECD on economic aspects of adaptation concluded that global studies of adaptation costs are available, but face very serious limitations (OECD 2008a). Some sectoral adaptation cost studies are very good, but there are no studies for all relevant sectors. Such an overview would be needed in order to set priorities correctly. In general, there are a number of difficulties in assessing the costs. According to the UNFCCC, key limitations for estimating adaptation costs can be grouped in four areas (UNFCCC 2007a, 96):

(1) differences in adaptive capacity: different economic resources, countries will not develop in the same ways with regard to the economy, population etc;

(2) most adaptations will not be solely for the purpose of adapting to climate change: Most useful adaptation actions will have benefits even without climate change, and addressing adaptation in an integrated manner is desirable; however, some actions are needed specifically due to climate change (e.g. coastal protection infrastructure) (see also OECD 2008a);

(3) the uncertainties associated with any readily available method to estimate adaptation costs: These methods will be further explained below; and

(4) the existence of an adaptation deficit: Existing property and activities are insufficiently adapted to current climate, including its variability and extremes. They are not climate-proof, and they do not even take climate change into account.

Under 3, UNFCCC distinguishes four methods:

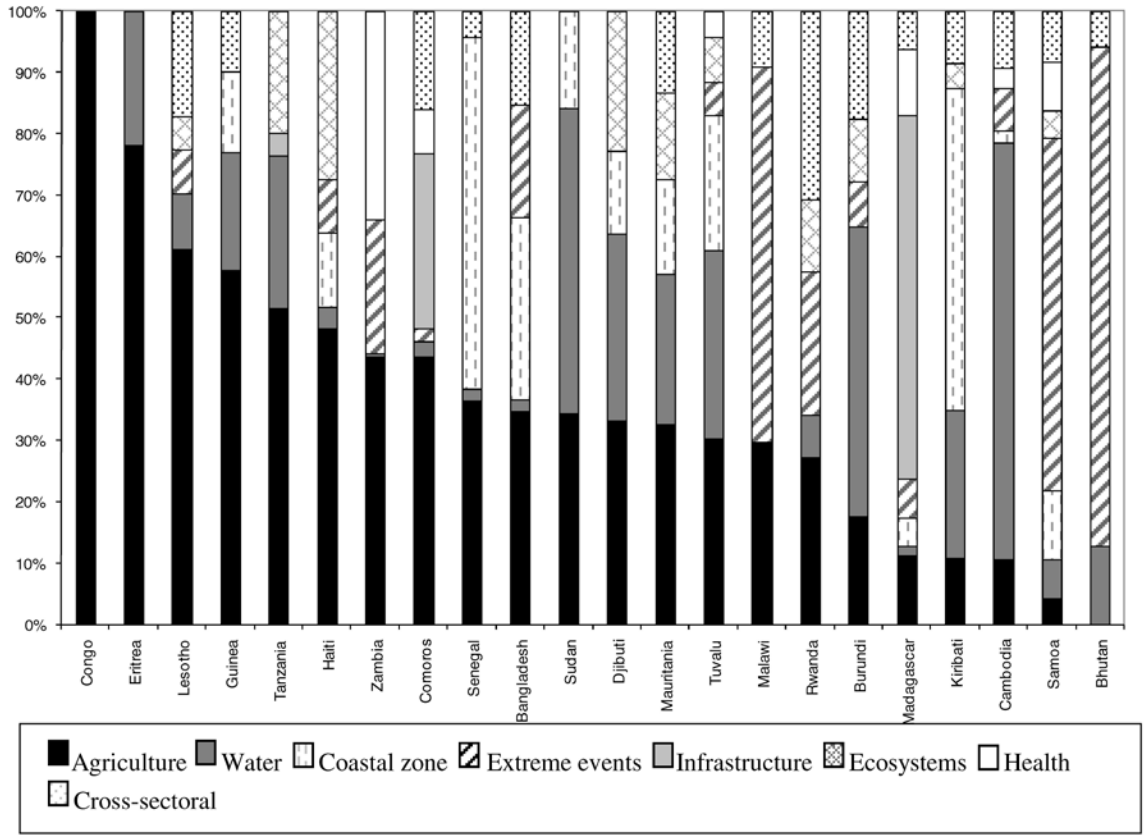
(1) A complete bottom-up approach: Cost estimates refer to projects and programs being identified as necessary, like in the NAPAs.

(2) Extrapolation of the bottom-up method, as Oxfam has done. Based on the cost estimates of existing NAPAs, these were scaled up to all 49 LDCs based on factors such as population, income, and land area (Oxfam 2007).

(3) The UNFCCC used current global expenditures in sectors and applied a rule of thumb to estimate additional costs for meeting development needs and climate change adaptation. This method can at least give an order of magnitude, but results can vary depending on the assumptions being made.

(4) Top-down quantified analysis, in which the UNFCCC uses the water and coastal resources and a human health analysis in this study. Models and uniform cost rules can be applied to estimate costs. The advantage is that „dif-

Figure 22: Distribution of adaptation costs by sector for each country



Source: OECD 2008a, 66

ferences across countries can reflect different conditions and needs“ (UNFCCC 2007a, 98).

A general lesson is that the choice of method depends on the purpose of the estimate. Even at a national policy levels, different methods will have to be applied in order to assess the overall risk for a country, but also to identify resources that are needed to support those groups that have been identified as the most vulnerable. More global estimates will help to identify the „bill“ that has to be covered by governments according to their „differentiated responsibilities and respective capabilities“. Again, it has to be recalled that non linear developments are usually not taken into account in these estimates. But adaptation necessities in regardto these developments might easily outweigh all other costs.

The NAPAs, as outlined before, also include cost assessments of the projects identified as priorities in a more bottom-up approach. Figure 22 analyses how the costs of priority projects are distributed across different sectors. In most countries, agriculture and water combined to make up more than 50 percent of the costs, which underlines the importance of these sectors.

As more and more examples of community-based adaptation emerge, it is also interesting to look at their costs. Oxfam gives three interesting examples (Oxfam 2007):

- Coastal exposure: In Vietnam, the Red Cross has worked with its local branches and communities to plant 22,000 hectares of mangroves, providing 100 km of protection for sea and river dykes. The project ben-

Table 22: Ten countries most affected by absolute and relative economic losses from extreme weather events in 2006

Rank	Country	Total losses in million US-Dollar in PPP 2006	Average 1987-2006	Rank	Country	Losses in % of GDP	Average 1987-2006
1	India	31,144	9196	1	Vietnam	2.39	1.34
2	China	24,515	39,356	2	Korea (DR)	1.67	-
3	USA	18,765	26,306	3	Philippines	0.96	0.32
4	Vietnam	6,841	2,015	4	India	0.74	0.46
5	Philippines	4,459	854	5	Malaysia	0.46	0.09
6	Indonesia	2,588	1,968	6	Indonesia	0.27	0.31
7	Japan	2,575	2,107	7	China	0.24	0.89
8	Germany	1,970	1,698	8	Australia	0.22	0.18
9	Russia	1,783	1,896	9	Afghanistan	0.22	-
10	Australia	1,563	776	10	Austria	0.22	0.14

Source: Harmeling 2007, 19

efited 1.2 million people – successfully protecting many communities from the impact of Hurricane Damrey in 2005 – and cost USD 5 million over nine years.

■ Flood risk: In India, Oxfam‘s local partners piloted a scheme to raise the foundations of 600 flood-prone mud houses, costing around USD 70 per house. In Bangladesh, CARE worked with sixteen local NGOs to support communities in adopting more flood-resilient livelihood strategies, stockpiling food in flood-proof storage, harvesting rainwater, and creating floating vegetable gardens in waterlogged areas. The project benefited 7,500 households, at a cost of USD 2.5 million over three years.

■ Water shortage: In Peru, where farmers face increasingly heavy rain, but dry winters, Practical Action‘s local partners have supported rural communities (covering 3,600 people) to understand the risks they face, diversify their livelihoods, and cultivate native crops – costing USD 200,000 over two years. In Zambia, where farmers face reduced and more erratic rainfall, Tearfund has supported local NGOs in spreading the practice of minimum tillage farming, to retain soil moisture, aiming to benefit 12,500 households, as part of a project costing USD 528,000 over five years. In Nicaragua, where farmers face both droughts and floods, Oxfam‘s local partners have supported communities with conservation agriculture, tree planting, and water.

These examples show that even with a limited amount of money, many people can benefit if investments address the right priorities and needs.

Given the large amount of damage costs that, for example extreme weather events can bring about (Table 22), there is little doubt that investments in adaptation measures, in this case in disaster preparedness, pay off in principal. It is estimated that one dollar invested into disaster preparedness saves between 2.5 and 13 dollars of disaster aid (DfID 2005).

Thus, a full analysis of the costs of adaptation would have to include the benefits of adaptation. In this regard, it is interesting that

> *„adaptation costs are usually expressed in monetary terms, while benefits are typically quantified in terms of avoided climate impacts, and expressed in monetary as well as non-monetary*

terms (e.g. changes in yield, welfare, population exposed to risk)" (Adger et al. 2007, 724).

Benefits of adaptation can often not be distinguished from non-climate related benefits, given the fact that, for example, reducing vulnerability to climate change often reduces vulnerability to other stressors, which makes it more complex.

Thus, the development of pragmatic approaches is important to handle costs and benefits. But even if there are net benefits, initial investments have to take place, sometimes large ones, and in countries where on the one hand public resources are already too scarce to fulfill non-adaptation development, and which on the other hand have not contributed significantly to the cause of climate change, external financial resources have to be generated to support adaptation.

A key element under the UNFCCC to advance the understanding and practical approaches to assess adaptation costs and benefits, is the Nairobi Work Program on Impacts, Adaptation and Vulnerability (NWP). The NWP has the main objective of helping all countries improve their understanding of the impacts of climate change and to make informed decisions on practical adaptation actions and measures. Thus, it is a good example for cooperative action and sharing of experience among Annex-I and Non-Annex-I Parties.

Key components for governments for making informed decisions are cost assessments. Many governments have stressed the need that further work of the NWP should contribute to the considerations under the Bali Action Plan. Improved cost assessments will also be important for the work of the Adaptation Fund Board.

In June 2008, at the climate negotiations in Bonn, activities for the second part of the NWP's five year work program were agreed upon (UNFCCC 2008a). Inter alia, the UNFCCC secretariat will prepare a technical paper on literature on the costs of adaptation before Poznan. Also, parties have been invited to submit their views on efforts undertaken to assess the costs and benefits of adaptation options, as well as their views on lessons learned, good practices, gaps, and needs in September 2009. A workshop is supposed to follow in June 2010. It is unfortunate that this work is not being undertaken before the important UN-climate summit in Copenhagen in December 2009, because such information will be absolutely relevant for considerations of and decisions on the scale of adaptation funding in post-2012 and mechanisms to generate the funding. Developed countries, in particular the US, also prevented more work being undertaken on the question of what future costs of adaptation will arise depending on different mitigation scenarios, it as has been discussed in a previous decision draft.

There is no doubt that further research and capacity building on all levels is needed on adaptation costs and the methodologies to assess them. On the international level, different mitigation levels also have to be linked to estimates of the adaptation costs, in order to clarify the implications of different long-term reduction goals being discussed.

6.3 Current financing for adaptation

A number of funding instruments exist under the Convention, the Kyoto Protocol, and Official Development Assistance (ODA). The overall resources available lag far behind the cost estimates:

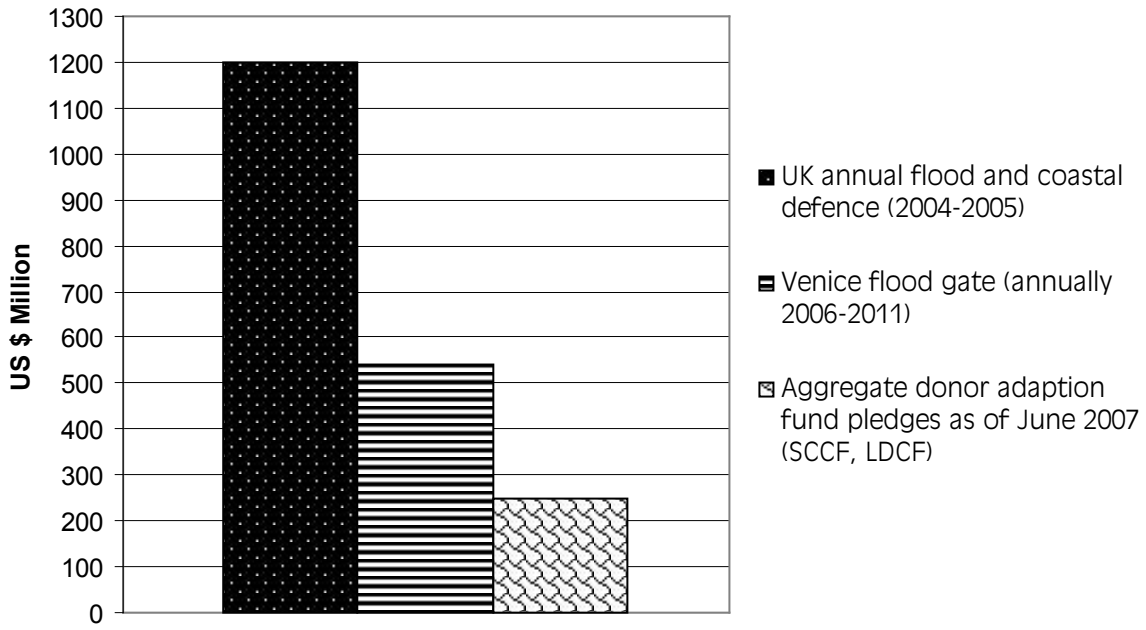
- Investments through integration of adaptation in Official Development Assistance: approx. USD 100 million for five years (UNFCCC 2007a);

- Funds under the Convention: approx. USD 73 million (pledged: 90 million) for the Special Climate Change Fund (SCCF) and USD 92 million for the Least Developed Countries Fund (LDCF) (pledged 172 million) (GEF 2008);

- Global Environment Facility (GEF) Strategic Priority for Adaptation: USD 50 million (UNDP 2007).

At the same time developed countries start to invest heavily into domestic adaptation (see Figure 23).

Figure 23: Developed country investments into adaptation and their contributions to UNFCCC Funds



Source: based on UNDP 2007

As part of the efforts to implement adaptation with regard the Convention, Parties agreed to support the Least Developed Countries (LDCs), which are particularly vulnerable to the adverse impacts of climate change, in formulating National Adaptation Programs of Action (NAPAs). The key objective of the NAPAs is to identify, in a participatory national process,

> *„immediate needs – those for which further delay could increase vulnerability or lead to increased costs at a later stage" (www.unfccc.int/adaption/napas/items/2679.php).*

By May 2008, 33 Least Developed Countries had submitted their NAPAs to the UNFCCC, which are posted on the website. In most cases, the NAPA process has been useful in better understanding the challenge of climate change, analyzing key sectors impacted, and identifying priority projects. Following the progress from this process, other countries have called for expanding the use of this instrument to other non-LDC vulnerable countries, e.g. the Small Island Development States. Many developed countries could benefit from the NAPA guidelines and the lessons learned in designing their own adaptation strategies, including active participation of vulnerable groups.

However, there are a number of limitations to the NAPAs, like the inadequate funding for preparation, which is USD 200,000 for each LDC no matter which size they are, the project-bias, and, according to UNDP, weak links to human development (UNDP 2007). However, the NAPA process must be seen as a first step – not more but not less – which creates useful experience on the way to designing comprehensive and integrated national adaptation strategies. In a recent meeting, the Least Developed Countries Expert Group

> *„noted with satisfaction the degree of integration of NAPAs and NAPA priorities in national development plans and activities" (UNFCCC 2008c, 4).*

Nevertheless, implementation of the NAPAs has experienced little progress so far, and the prospects are quite bleak. The key instrument for funding the NAPAs is the Least Developed Countries Fund (LDCF) under the Convention. It constitutes of voluntary financial contributions by Annex I countries. By March 2008, USD 172 million were being pledged to the LDCF, but only USD 92 million were actually paid. The project volume financed so far is significantly less than that (ca. USD 12 million) (GEF 2008, 3).

At the moment, 16 NAPA projects from different countries are under consideration within the GEF (UNFCCC 2008c, 5). While some Annex I countries have made significant contributions to the Fund, others, including the USA, Belgium, and Greece, have not even pledged to contribute. Comparing these resources with the financial demand of all 49 NAPAs, reveals the financing gap; it has been estimated to be somewhere between USD 1 and 2 billion (Oxfam 2007, 21). Developing countries have often complained about the complex and lengthy procedure for proposals addressed to the Global Environment Facility (GEF), which manages the LDCF. This is a key reason why until now, only a few number of projects have been approved. The implementation of NAPAs, including accessing the funds, will play an important role in the 29th session of the SBI in Poznan, based on submissions submitted by 19th September 2008.

The Adaptation Fund is one of the most innovative funding instruments, because it is not fed by voluntary contributions but rather by a levy on project based emission reductions issued under the Clean Development Mechanism. The present forecast of the resources that will flow into the AF from the levy on the CDM will probably be larger than the voluntary contributions into the Convention Funds, but still insufficient to cover the needs. At current prices of around EUR 20 per tonne, the available resources are estimated to be between about EUR 500 million to 1 billion (UNFCCC).[25] After Parties agreed on the governance structure of the Adaptation Fund, with a non-Annex-I majority on the Adaptation Fund Board, it now has its work to do to fully operationalize the Adaptation Fund. It is important to note that the AF can not only finance projects, but also programs and activities. It is not principally tied to mere projects, which many Annex-I countries fear, since integrating adaptation into national development plans and activities is more promising in a longer-term perspective.

The Adaptation Fund has the potential to successfully demonstrate that effective international financing mechanisms with direct access for developing countries and independent from the conventional donor-recipient structures are possible. The better the AF will serve the goal of advancing adaptation in developing countries, the better it is suited to play a key role in future adaptation financing beyond 2012. When developing its guidelines, it should address the questions of how to monitor project and program implementation in order to ensure effective disbursement of the resources, and, more importantly, how to ensure that particularly vulnerable communities are prioritized as target groups.

In Poznan, the Fourth Review of the financial mechanism of the Convention (LDCF, SCCF etc.) will also have to deal with the obvious inadequacy of resources provided thus far by Annex-I countries to the Funds and other activities relevant to adaptation under the Convention. This process has political implications for the post-2012 discussion, as the EU remarks:

> *„This review should be seen as an integral part of future efforts with respect to a post-2012 climate agreement. It is therefore important to take fully into account the Bali Roadmap as it has a bearing on the review of the financial mechanism“ (UNFCCC 2008b, 21).*

The EU also underlines that the

> *„financial and investment flows will have to be considerably scaled up and redirected towards*

[25] Own calculation based on www.cdm.unfccc.int/statistics/index.html

> *low-carbon sustainable development, if we are to credibly address the challenge before us" (UNFCCC 2008b, 21).*

Here, the inadequacy of the financial resources available under the Convention's financial mechanisms has been described. Increasing the financial flows is urgently needed. It is also a matter of building trust from developed to developing countries, and that they are willing to better meet their commitments manifested in the Convention to support the developing countries.

The G8 summit in Hokkaido launched two new climate-related funds under the World Bank: the Climate Technology Fund and the Strategic Climate Fund. The latter, through the Pilot Program for Climate Resilience (PPCR), is supposed to support a number of developing countries in the integration of climate resilience into their development activities. The size of this fund is expected to be around USD 300-500 million. There has been considerable irritation for the UNFCCC process emerging from this initiative. Japan, the US, and UK are the key drivers behind these new funds, but other G8 members might also make contributions.

While the key objective of this Fund is for good reason – advancing the understanding and experience with approaches to integrate adaptation into national planning processes – a number of issues raise serious concerns. Providing loans for adaptation is inappropriate given the compensatory nature of adaptation, and concessional loans are mentioned as one potential instrument. Any adaptation financing has to be in full cost grants, in addition to the ODA commitments. It has to be seen how the governance structure balances in reality between developing and developed countries, which are now – after many protests – supposed to have an equal number of votes. And finally, it was seen as very strange that only a couple of months after an agreement was reached on the governance structure of the Adaptation Fund under the Kyoto Protocol – in lengthy and very contentious discussions – that the World Bank came up with another Fund which – by the World Bank's nature – had to be less fair and appropriate than the Adaptation Fund's structure.[26] The international pressure on the proposed funds has resulted in some improvements. Of particular importance is the sunset clause, which states that the PPCR will not finance activities beyond the year 2012 when the entry into force of a new international climate agreement is expected (World Bank 2008). This reiterates that the UNFCCC is the primary actor on climate-related purposes.

However, at a time when the negotiations on a new post-2012 climate change agreement are gaining speed, it was highly insensitive to have funding opportunities outside the UNFCCC process emerge, especially funds with a probably much larger financial volume, while the UNFCCC instruments still remain largely underfunded. In the first place, the existing UN Funds, including the Adaptation Fund, should be supported. And setting up a new fund with the objective to build on the experience of the NAPAs seems strange if the fund intended to finance the NAPA implementation was suffering from scarcity of finances.

Even more important is the question of the different roles different institutions will have to play. While there are great expectations that a post-2012 framework will deliver large-scale financing for adaptation in the developing world, it remains clear that even if that will happen, other instruments will continue to exist or even emerge. One such example is the regional adaptation cooperation funds linked to ongoing policy processes, like the Joint Africa-EU strategy. The World Bank will probably continue to exist. For an overall financing framework, and also for the credibility of those who give money and those who receive it, it will be important to develop a minimum standard of key principles, in order to avoid sidelining the UNFCCC process and disturbing

[26] The governance structure of the adaptation fund forsees sixteen members, each representing country groups. Least Developed Countries (LDCs) and Small Island Developing States (SIDS) have different seats. Each of these heavily-affected groups has one vote to adopt decisions, independent of their power or financial contributions to the Fund.

this debate by disrespecting certain principles. It could be considered that the UNFCCC process also sets the criteria for regional funds. Key principles for adaptation financing will be outlined in the following subchapter.

6.4 Principles for adaptation financing and future instruments

The new and developing world of funding and financing for climate change adaptation poses many challenges: morally, politically and economically. However, it is necessary to consider a range of fundamental principles based on an equity approach for steering the discussion and design of the policy and institutional architecture. The following principles are based on the Framework Convention (UNFCCC) as well as the Bali Action Plan (see Harmeling and Vaughan 2008):

- Financing adaptation by developed countries should be seen as an obligation originating in harmful actions being taken, namely fostering global warming by greenhouse gas emissions. Thus, it is of compensatory nature, and any adaptation financing has to flow in grants and not loans;

- Timely and predictable delivery, which overcomes the failure of relying on voluntary contributions;

- New and additional resources, which basically means that resources delivered by developed countries for adaptation have to be additional to the existing and mostly unfulfilled commitments to spend 0.7 percent of their Gross Domestic Product into Official Development Assistance (ODA) (it at least should be additional to the agreed upon steps to reach the 0.7 percent target);

- The principles of equity and of common but differentiated responsibilities and respective capabilities should be the underlying principles for allocating these funding obligations. Responsibility is closely linked to the „polluter pays“ principle;

- Adaptation funds should respond to needs identified at the national and regional level;

- Governance structures have to reflect the „one country, one vote“ principle and must result in a voting majority of those countries most affected by climate change – the small island states, states with low-lying coasts, as well as least developed countries;

- Expenditures for adaptation should have a focus on increasing the adaptive capacity of those people who are most vulnerable to climate change. Developing country governments are expected to prioritize vulnerability reduction as much as possible for the most vulnerable people. This is part of their obligation to secure the human rights of its people whose fulfillment is threatened by climate change. Examples include people‘s right to food security, the right to health, and access to sufficient fresh water etc.;

- Transaction costs should be kept to a minimum and coordination between funding mechanisms maximized;

- Transparency of criteria, disbursement, and monitoring is needed.

Delivering on these principles will be one of the key challenges for a post-2012 agreement as well as for adaptation work in other forums. The negotiations under the UNFCCC have to quickly become quickly more concrete if an effective and comprehensive outcome in Copenhagen 2009 is to be agreed on. This deal cannot be a gradual improvement of the Kyoto Protocol, but must result in a quantum leap forward on mitigation as well as adaptation for developing countries. The June negotiations in Bonn have shown that some Parties are becoming more concrete and have put specific proposals on the table, including ideas on how to generate large amounts of resources needed for adaptation and other purposes. Müller in a recent paper prepared a very useful overview of the different instruments for generating resources being discussed.

Some countries have proposed instruments that would end up in a formula for sharing contributions to a fund, similar (but perhaps less sophisticated) to Table 8 in chapter 2.8 (UNFCCC 2008d):

- The „Alliance of Small Island States (AOSIS)“ proposed that an adaptation fund under the Convention should be established, based on indicators of responsibility for greenhouse gas emissions and capability;

- Mexico put forward a proposal for a world climate change fund to support mitigation, adaptation, and technology cooperation through financial contributions from developed and developing countries based on criteria such as emissions, population, and gross domestic product (GDP);

- China proposed scaling up funding from developed countries through a percentage of GDP (0.5 percent) in addition to existing official development assistance to support an adaptation fund and a multilateral technology acquisition fund. Developing countries would have to contribute nothing to this fund, independently of their responsibilities for greenhouse gas emissions or economic capability.

In addition, Switzerland proposed a global carbon tax with an exemption for countries whose annual per capita emissions are less than 1.5 tonnes of carbon dioxide. The resources generated would flow into a multilateral fund for adaptation and insurance along with national climate change funds in all countries. Also this idea would indirectly take into account the capabilities, since developing countries would receive a much larger share of the revenues for adaptation, and also because the 1.5 t carbon dioxide threshold can be interpreted in relation to the level of economic capability.

These proposals would, in theory, provide relatively sustainable, predictable resources, and could also generate the adequate scale (tens of billions of USD) of necessary finances. However, the contributions from most of the developed countries would probably not be additional to the 0.7 percent ODA commitment, since most countries would strive to fill up their ODA quota with these resources. But even more important is what Müller called the domestic revenue problem. When resources for international purposes come from national budgets – even if they were generated through mechanisms other than taxes – there is the perception that it is tax payers´ money. At a stage where resources provided would reach the scale of billions, it is likely – and that shows past experience – that countries would step back from their commitments (Müller 2008). Given this, realistically, the aforementioned proposals are unlikely to provide resources in a predictable and sustainable manner.

There are other proposals which have a better performance in such principle-based analysis. Norway proposed that adaptation should be financed through auctioning a share of assigned amount units (AAUs), the emission allowances granted to developed countries which have ratified the Kyoto Protocol. In that case, it would be, for example, private companies who have emission obligations under national/regional emission trading systems. They would have to auction part of their obligations, or Parties might miss filling emission reduction targets domestically. These payments would truly generate resources in addition to ODA flows.

Norway also proposed to use revenues from auctioning in the maritime sector to fund adaptation activities in developing countries, e.g. through the Adaptation Fund. Other possible approaches were mentioned in Parties´ presentations, including a levy on international air travel, extension of the share of proceeds that currently exists under the CDM to other mechanisms, and a levy on bunker fuels (UNFCCC 2008d).

These proposals would address private companies and individuals and would be more or less compatible with the „polluter pays“ principle. For example, an aviation levy (per ticket or in percentage of price), even if also imposed in developing countries, would only target those who book flights, particularly intercontinental flights. These produce relatively large „CO_2 footprints“ for individuals, and those who can afford these flights are not the poor.

Since each instrument has its strengths and weaknesses, a combination of some of the latter possibilities seems to be the most promising approach, and it would still be in line with the leading principle of common but differentiated responsibilities and capabilities. The auctioning of AAUs would only apply to countries and sectors which

have emission obligations under an emission trading scheme (Annex I and maybe some rapidly developing countries with sectoral agreements), and instruments like the aviation levy would address those individuals who have a bigger „CO_2 footprint“ and are capable of paying flights. In all instruments, the amount of resources generated – the adequacy – depends on a number of assumptions and influencing factors, some of which will solely depend on the political decisions and others on the market price of emissions.

Once a large scale of resources is generated, if this does occur, it remains to be decided if one operating entity will strategically manage these funds or if they will be disbursed to different sub-entities who have particular expertise in certain fields or to regional entities etc. Part of this strategic management must be to assist the implementation of incentivizing frameworks for adaptation within countries, for both actions undertaken by the public and private sectors. Public and private adaptation investments are needed. In many developing countries, the share of public investments and the share of adaptation costs – especially when addressing the most vulnerable communities – may be higher than in developed countries. Nevertheless, many actions relevant for adaptation are being undertaken by different private actors (OECD 2008a). It is argued that

> *„in theory, such actions should be autonomous. Self-interest should be a sufficient incentive for such actors to undertake measures that reduce their vulnerability to climate risks or to exploit potential business opportunities“ (OECD 2008a, 26).*

But in practice, governments will have a role to play to create enabling environments through different kinds of measures to incentivize adaptation in the private sector and to support those who can not afford private sector solutions.

Eventually, any mechanism and the actors involved, including governments in developing countries, will have to prove that they are able to deliver adaptation and climate resilience to the most vulnerable.

Part III

Regional studies on climate change impacts, food security and response capacity

7 Research results for Africa[27]

Most forms of agriculture and food production activities in Africa are sensitive to change in the climatic system. Change in climate (moisture, heat or wind) can affect food production directly, while climate shocks (such drought or floods) may wipe out crops, push up food prices, and destroy properties, thereby confronting people with stark choices. However, it is important to recognize that agricultural production is based on three types of resources which include, but go beyond climate:

- natural resources (climate, soil, topography, genetic endowments),
- capital resources (e.g. fertilizers, energy and other inputs), and
- human resources (labor, management practices, market conditions).

For Africa, limited capital resources required purchasing farm inputs, like fertilizers, and climate and soil conditions play an important role in the level of agricultural production.

7.1 Effects of climate change on food production, agriculture and water availability

7.1.1 Changes in climatic conditions

The global scientific community views climate change as the most significant environmental threat of the 21st century – endangering the sustainability of the world's environment, its agriculture, and consequently the health of its people (IPCC 2001).

It is anticipated that African countries in particular will endure some of the worst effects of climate change, mainly because of the heavy reliance on rain-fed agriculture. These countries are already limited by social (the region has the highest proportion of people living in extreme poverty (UN 2006)), technical, and environmental factors including widespread poverty, fragile ecosystems, weak institutions, conflicts and ineffective governance. The latest IPCC report confirmed that because of Africa's high dependence on natural resources and other climate sensitive sectors, such as agricultural systems heavily dependent on rainfall, climate change is likely to exacerbate the threats to the livelihoods of the many people in Africa.

Climate data for Africa for the last 30-40 years show that the continent has been warming, which is contributing to more erratic but intense rains. In other words, warming is causing more droughts but also more floods (Nyong 2005). Climate change threatens both crop and livestock production in a number of ways. Crop yields are expected to fall in regions predicted to become hotter and drier; this may make some areas too dry for agriculture and food production, especially the arid and semi arid areas.

Rainfall exhibits notable spatial and temporal variability. But in general, a decline in annual rainfall has been observed from several studies. Studies also observed a decline in the amount of precipitation but an increase in intensity, which at times results into floods; this obser-

[27] Based on a contribution by Stephen O. Anyango (Department of Environmental Science, Kenyatta University, Kenya) and Victor Orindi (International Development Research Centre, Kenya).

Table 23: Observed changes in precipitation in parts of Africa

Region/Country	Observed Changes
West Africa (4°-20°N; 20°W- 19 40°E	A decline in annual rainfall has been observed since the end of the 1960s, with a decrease of 20 to 40% noted between the period of 1931 and 1960 and the period of 1968 to 1990
The tropical rainforest zone	A decline in mean annual precipitation of around 4% in West Africa, 3% in North Congo and 2% in South Congo for the period 1960-1998
Southern Africa	Increased interannual variability in the post-1970 period, with higher rainfall anomalies and more intense and widespread droughts noted
Angola, Namibia, Mozambique	A significant increase in heavy rainfall events
Guinean coast	A 10% increase in annual rainfall for the last 30 years

Source: Nicholson et al. 2001; Fauchereau et al. 2003; Chappell and Agnew 2004; Dai et al. 2004; New et al. 2006

vation is consistent with some of the projections from regional circulation models (Table 23).

Large parts of Africa already experience climate variability, which is experienced in terms of changes in rainfall distribution, frequency, and intensity of dry spells (Reason et al. 2005). Droughts have long contributed to human migration, cultural separation, population dislocation, and the collapse of prehistoric and early historic societies (Pandey et al. 2003). About one third of the people in Africa lives in drought-prone areas and is vulnerable to the impacts of droughts. Droughts have mainly affected the Sahel, the Horn of Africa, and southern Africa, particularly since the end of the 1960s (Richard et al. 2001; L'Hôte et al. 2002; Brooks 2004). This may worsen with long-term climate change.

Observational records show that Africa has been warming throughout the 20th century at the rate of about 0.05° C per decade, with slightly larger warming in the June-November seasons than in December-May (Hulme et al. 2001). Since the mid-1970s, precipitation has declined by about 2.4± 1.3 percent per decade in tropical rainforest Africa. This rate is stronger in West Africa (-4.2± 1.2 percent per decade) and in northern Congo (-3.2± 2.2 percent per decade) (Nicholson et al. 2001; Nyong 2005).

Only limited experiments have been conducted in Africa on regional climate change scenarios using climate models or empirical downscaling are mainly due to restricted computational facilities and problems of insufficient climate data in the region (Swart et al. 2002; Jenkins et al. 2002). But the results show serious concerns about agriculture and food insecurity situation in Africa due to current climate variability and soil degradation associated with climate change.

If current trends continue, it is predicted that by 2060, sub-Saharan Africa will be warmer by 2.9°C, and it will have 4 percent less rainfall in the interior. Water loss will be further exacerbated by higher evaporation rates (UNDP 2007; Nyong 2005). Indeed, the latest IPCC report projects that warming will likely be above the global average throughout the sub-Saharan Africa.

7.1.2 The state of food insecurity in Africa

According to Hellmuth et al.,

> *„Africa's variable climate is already contributing significantly to its development problems. The key development sectors of agriculture, water, energy, transport, and health are all particularly sensitive to climate variability."*

Table 24: Hunger in Africa and the developing world

Region	Total Population	Total undernourished	Undernoursihed as % of total population
North Africa	144,400,000	6,1000,000	4%
West Africa	230,300,000	36,400,000	15%
Southern Africa	90,100,000	35,700,000	39%
East Africa	226,500,000	92,400,000	40%
Central Africa	82,000,000	45,200,000	55%
Developing world	4,712 200,000	797,900,000	16%

Source: FAO 2005

Models show that the effects of climate change are likely to be very different across the continent, since the initial climate conditions are quite different with precipitation varying greatly across sub-regions (Ngaira 2007). However, overall the impacts of climate change on Africa are expected to worsen the situation Hellmuth describes.

Currently a significant proportion of the food in Africa is grown as rain-fed annual crops, which means that even small changes in the climate can have big impacts on productivity. Countries that produce only a few principal commodities are generally thought to be more economically sensitive to climate impacts, simply because of the greater chance that a significant portion of their production will be affected by the same meteorological event or climate fluctuation. For water scarce regions, climate change is likely to result in further reduction in available water through increased evaporation and changes in patterns of rainfall and runoff (UNDP 2007). An integrated approach including both socio-economic and environmental aspects is necessary in the elimination of hunger and malnutrition. According to Jones and Thornton (2003), food production has to double in the next 35 years if the world is to meet future needs.

To date, Africa has the highest rate of food insecurity with sub-Saharan Africa (SSA) being the most food insecure region against a rapidly increasingly human population. The region accounts for 13 percent of the world population and 25 percent of the undernourished people in the developing world (FAO 2006). In the period 2001-03, 33 percent of the SSA population was undernourished compared to 17 percent in the developing countries as whole (see Table 24). But the proportion rises to 55 percent in central Africa (Oxfam 2006). Other worse off regions in Africa – with more than a third of their population undernourished – include southern and eastern Africa. In both regions, the number of food insecure people has increased since the last world food summit held in Rome in 1996, despite a general reduction in the prevalence of global hunger. It should, however, be noted that regional or continental figures often hide lower level differences.

Some of the hunger hotspots in SSA include Niger, Sudan (specifically the Darfur region), Democratic Republic of Congo, Mali, and Southern Africa as a region. While many factors may be responsible for the state of food insecurity in these places, wars and conflicts are largely responsible for the food insecurity situation in the Central African Republic and in the Darfur region of Sudan. It has been noted that an increase in the numbers of hungry people in SSA since the year 1990-92 (WFS Baseline) was driven mainly by five war-torn countries including Burundi, the Democratic Republic of Congo, Eritrea, Liberia, and Sierra Leone. These countries combined account for 29 million out of the regions increase of 37 million hungry people (FAO 2006). Particularly worrying is the Democratic Republic of Congo, where

the number of undernourished people tripled from 12 to 36 million with prevalence rising from 31 to 72 percent of the population (FAO 2006). Conflicts therefore play an important role in the food insecurity situation in these countries, and may be exacerbated by climate variability and change. In eastern Africa, the situation in Eritrea is of particular concern, because successive years of inadequate rains have seriously undermined crop and livestock production (FAO 2005). The expected demographic growth and socio-economic development in many African countries would result in substantial increases in food requirements exacerbating the negative effects of climate change (Gregory et al. 2005). It was predicted that by 2005, one third of the African population was at risk from widespread hunger and malnutrition, a situation likely to get worse with long-term climate change (Royal Society 2005).

7.1.3 Effects on food production, agriculture, water, forests, fish and livestock

Extreme climatic events such as droughts and floods often affect food production negatively, and result in severe food shortages. In Malawi, for example, the 2002 drought left approximately 5 million people in need of emergency food aid. This aid took a long time to arrive just like in Niger, where in 2004/2005, around 2.5 million people, or one fifth of the population, required such assistance (UNDP 2007, 84). The cycles of drought experienced in many of the poor sub-Saharan African countries create poverty traps for many households. These events constantly thwart efforts to build up assets and increase income. For pastoral and agro-pastoral groups, vulnerable households often find it difficult to sell under-nourished animals for income to buy cereals, and the drop in prices adversely affects their food security and terms of trade during drought.

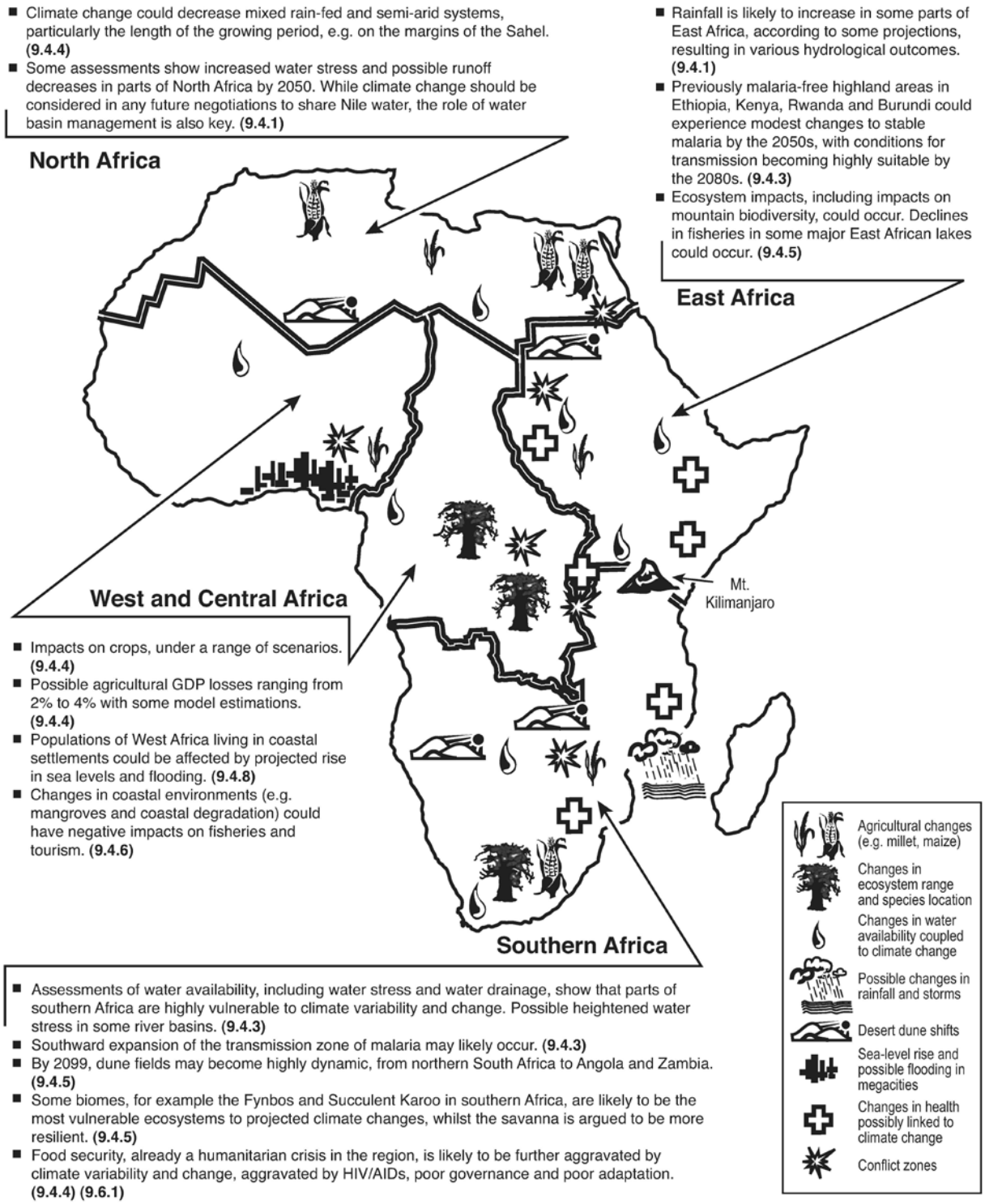
Climate change impacts on agriculture and food security could push additional 600 million people worldwide at risk of hunger by 2080, in addition to projected revenue losses of 26 percent by 2060 for dry land areas in sub-Saharan Africa. These figures are calculated at a threshold of 2°C (UNDP 2007, 90). In this case it is important to note, with a high likelihood, temperature will only stay under this threshold in this century, if worldwide a very harsh mitigation policy is realized. Agricultural production in SSA could fall by up to 9 percent. In Kordofan in northern Sudan, climate models indicate that temperatures could rise by 1.5°C between 2030 and 2060. This would mean decline in rainfall of 5 percent, which could result in a 70 percent drop in sorghum yields. Cash crop production will not be spared either. In Uganda, an increase of 2°C in average temperatures could significantly reduce the land available for growing coffee, which is an important source of income to farmers and foreign exchange earner to the country. While it may be possible to maintain tea production in Kenya, production will have to move to higher slopes currently occupied by forests, suggesting that this can only be achieved with some extent of environmental damage.

For North Africa, which is already dry, even modest temperature increases could significantly reduce water availability. An increase of 1°C could reduce water runoff in one of the watersheds in Morocco by 10 percent by the year 2020. Reduction in water availability will seriously affect irrigated agriculture currently practiced in many dry areas. It is also worth noting that compared to other regions, SSA has lowest amount of land under irrigation.

Floods are also critical and impact food production. Recurrent floods in some countries are linked to negative economic and human losses as a result (e.g. in Mozambique, Obasi 2005). Even countries located in dry areas (Algeria, Tunisia, Egypt, and Somalia) have not been flood-safe (Kabat et al. 2002). A rise in temperature in excess of the agreed 2°C threshold would accelerate the rise in flooding, and cause widespread displacement of people in such countries, especially in the low lying coastal areas. If the predicted temperatures increase by the year 2030, then climatic zones would likely change and support very limited agriculture, as most of the land will be too marginal for farming, and probably only some form of nomadic pastoralism may be viable.

Among the cereals, wheat production potential in the sub-tropics is expected to be worst affected, with signifi-

Figure 24: Overview of expected consequences of climate change in Africa



Source: Boko et al. 2007, 451

cant declines anticipated in Africa just like in South Asia and Latin America. In addition to the yield, changes in climate are anticipated to affect crop quality. For example, decreases in protein content in some grains have been associated with climate variability, which could have major impacts on food quality. Other effects on crop quality include pests and diseases, such as dangerous levels of mycotoxins in groundnuts (Royal Society 2005).

The low-lying coastal zones of Africa are also likely to be affected with a rise in sea-levels. In Lower Egypt for example, possible displacement of 6 million people and flooding of 4500 km^2 of farmland is likely with a 1-metre rise in sea-level. This would drive many people into destitution, considering that 17 percent of the population in the area live below poverty line (UNDP 2007, 100).

Not all expected changes in climate will be negative. Growing seasons in certain areas may lengthen (as in the case of Ethiopian Highlands mentioned above), and parts of dry areas may experience increased rainfall with climate change. As a result of a reduction in frost on the alpine zones of Mt. Kenya and Mt. Kilimanjaro, for example, it may be possible to grow more temperate crops, e.g. apples, pears, barley, wheat, etc., on the adjoining elevations (Parry et al. 2004). Mild climate scenarios predict further benefits across African cropland for irrigated and especially dry land farms. However, it is noted that even in these favorable scenarios, regions in the Mediterranean, central, western and southern Africa that currently produce such crops stand to be adversely affected (Kurukulasuriya and Mendelsohn 2006).

Summarizing the Africa-related conclusions of the FAR, it becomes obvious that climate change compromises the ability of many African societies to achieve the different Millennium Development Goals (MDGs) and to improve food security. The SPM of Working Group II of the IPCC expects that the area suitable for agriculture, the length of growing seasons, and yield potential, particularly along the margins of semi-arid and arid areas, will decrease. The yields from rain-fed agriculture are expected to decrease by up to 50 percent in some countries until 2020 (IPCC 2007b, 13). Also, the number of people under increased water stress will significantly increase in the next 15 years, from 75 to 250 million people (with a further increase until 2050). This will primarily take place in Northern and Southern Africa. In addition, local food supplies are projected to be negatively affected by decreasing fisheries resources in large lakes due to rising water temperatures, which may be exacerbated by continued over-fishing. Lake Victoria for example represents an important food source for 30 million people in danger.

However, Boko et al. (2007, 457) also note that

> „*the contribution of climate to food insecurity in Africa is still not fully understood, particularly the role of other multiple stresses that enhance impacts of droughts and floods and possible future climate change. While drought may affect production in some years, climate variability alone does not explain the limits of food production in Africa. Better models and methods to improve understanding of multiple stresses, particularly at a range of scales, e.g., global, regional and local, and including the role of climate change and variability, are therefore required.*“

In addition to the direct impacts of climate change on food security and the MDGs, recent research pays increasing attention on the role of water scarcity or reduced food availability in the emergence of conflicts, and through an increased competition concerning scarce resources. These may further aggravate the livelihoods of people. Climate change already represents an important causation of existing conflicts, as several experts conclude for the Darfur conflict, where a long-term decline in rainfall has significantly contributed to the scarcity of available fresh water (Ban-Ki Moon 2007). A recent study by the German Advisory Council on Global Environmental Change (WBGU) concludes that Africa is likely to be particularly affected by climate change-induced security risks (WBGU 2008). In Northern Africa, the potential for political crises and the pressure from migration increases due to the intertwining of an increased number of droughts and water

Table 25: Some examples of complex adaptations already observed in Africa in response to climate and other stresses

Theme	Emerging characteristics of adaption
Social resilience	
Social networks and social capital	Perceptions of risks by rural communities are important in configuring the problem (e.g., climate risk). Perceptions can shape the variety of adaptive actions taken. Networks of community groups are also important. Local savings schemes, many of them based on regular membership fees, are useful financial 'stores' drawn down during times of stress.
Institutions	Role and architecture of institutional design and function is critical for understanding and better informing policies/measures for enhanced resilience to climate change. Interventions linked to governance at various levels (state, region and local levels) either enhance or constrain adaptive capacity.
Economic resilience	
Equity	Issues of equity need to be viewed on several scales Local scale (within and between communities) Interventions to enhance community resilience can be hampered by inaccessibility of centers for obtaining assistance (aid/finance) Global scale: see IPCC 2007b
Diversification of livelihoods	Diversification has been shown to be a very strong and necessary economic strategy to increase resilience to stresses. Agricultural intensification, for example based on increased livestock densities, the use of natural fertilizers, soil and water conservation, can be useful adaptation mechanisms.
Technology	Seasonal forecasts, their production, dissemination, uptake and integration in model-based decision-making support systems have been examined in several African contexts (see examples given). Enhanced resilience to future periods of drought stress may also be supported by improvements in present rain-fed farming systems through: – water-harvesting systems; – dam building; – water conservation and agricultural practices; – drip irrigation; – development of drought-resistant and early maturing crop varieties and alternative crop and hybrid varieties.
Infrastructure	Improvements in the physical infrastructure may improve adaptive capacity. Improved communication and road networks for better exchange of knowledge and information. General deterioration in infrastructure threatens the supply of water during droughts and floods.

Source: Boko et al. 2007, 453

scarcity. Along with a high population growth, this situation is weakening agricultural potentials and limiting political capabilities to solve the problem. The densely populated Nile delta is threatened by sea-level rise and the salination of agricultural areas. In the Sahel, climate change causes additional environmental stress and social crises (e.g. droughts, harvest losses, fresh water scarcity) in a region which is already characterized by weak states (e.g. Somalia, Chad), civil wars (e.g. Sudan, Niger) and large streams of refugees (Sudan: more than 690,000 people; Somalia: more than 390,000 people). In Southern Africa, climate change could further weaken the agricultural potentials of countries belonging to the poorest societies in the world. This would worsen the state of human security and overstretch the governments' capabilities to respond adequately.

7.2 Adaptation – experiences and priorities

Research shows that adaptation is already taking place within the African agriculture system. Hellmuth et al. introduces 2007 examples of drought management in Ethiopia, flood management in Mozambique, drought insurance in Malawi, and agriculture in Mali. Ethiopia established policies and planning for drought management, in order to better cope with the recurring droughts. An early warning system was developed in order to ensure that sufficient external food aid reaches the country. Inter alia, it contains early warning committees on all government levels. Table 25 provides an overview of already observed adaptation activities across Africa.

A number of African countries have developed National Adaptation Programs of Action (NAPAs) where they identified priority activities (Table 26). These now await implementation.

An analysis of the NAPA processes in different countries in Eastern and Southern Africa gives an outline of strengths and weaknesses in the development of the NAPAs (Osman-Elasha and Downing 2007). According to this analysis, the important role of the NAPA process has been underlined by many stakeholders, which is largely attributed to an emphasis on participatory processes, consideration of both vulnerability and adaptation to climate change, investigation of climate variability as well as climate change, a bottom-up approach, and capacity building and awareness raising.

Although a number of constraints are mentioned in the analysis – communication problems between the central offices and states, lack of sufficient technical capacities needed at local levels to play an active role in the assessment process, and insufficient financial resources and time, especially for large countries like Sudan and Ethiopia – it can be concluded that the NAPAs serve as a good starting point to assess which adaptation needs African countries and their civil societies have. They are indeed country-driven processes, and many of them have contributed significantly to raising awareness and building adaptive capacity among national stakeholders, as much as it has been possible in a time span of about 18 months which it usually takes to prepare a NAPA (Osman-Elasha and Downing 2007).

Although adaptation to anthropogenic climate change is still young in Africa (and in the rest of the world), different studies and workshops have tried to identify some early lessons. For example, one regional workshop to discuss early lessons from climate change adaptation projects in South-Eastern Africa was held in April 2007 in Maputo, Mozambique (see IISD). It was organized by IISD and SouthSouthNorth. More than 60 adaptation experts and practitioners from the region participated and shared their experience. Key findings include:

Coping with extreme events:

- The unpredictability of natural disasters contrasts with the short-term planning of local level policy.

- To understand the differences between and within adaptation to climate change projects, we need to attempt to define what is meant by ‚adaptation'.

- There needs to be an understanding of how disaster relief fits into adaptation. The views expressed are to-

Table 26: Overview of NAPA priority projects as submitted by African LDCs

Country	Most common climate risks	Examples of priority projects	Totaled costs in million USD (number of projects)
Congo, Democratic Republic of	Intense rainfall event Seasonal droughts Flooding Coastal erosion	Dissemination of improved maize seeds Dissemination of improved rice seeds Dissemination of improved manioc seedlings	5.6 (3)
Djibouti	Temperature and sea-level rise Salination Flooding Droughts	Risk reduction for coastal production systems, with community participation Promotion of adaptation measures in water management	6.6 (8)
Eritrea	Increased climate variability Sea-level rise Recurring drough Flash flooding	Introducing community based pilot rangeland improvement and management in selected agro-ecological areas Encourage afforestation and agro forestry through community forestry initiativ Groundwater recharging for irrigation wells	33 (5)
Lesotho	Drought High temperature and heat waves Strong winds and dust storms Cold winters, early frost and heavy snowfall	Improve resilience of livestock production systems under extreme climatic conditions Promoting sustainable crop based livelihood systems Capacity building and policy reform to integrate climate change in sectoral development plans	12.8 (11)
Madagascar	Change in agricultural conditions Degradation of fresh water resourcesSoil degradation Saltwater intrusion Biodiversity loss Shoreline retreat	Rehabilitation and/or construction of dykes to safeguard water resources Implementation of water management committee Combat erosion through soil conservation measures which stabilize dunes	3.9 (15)
Malawi	Floods Recurring droughts	Improving community resilience to climate change through the development of sustainable rural livelihoods Restoring forests in the Shire River Basin to reduce siltation and the associated water flow problems Improving agricultural production under erratic rains and changing climatic conditions	22.9 (5)

Source: Harmeling, Burck and Bals 2007, 37

wards future, long-term adaptation of the communities affected, as well as a need for stakeholder engagement in collaboration.

■ More funds go towards disaster relief instead of disaster preparedness. This fact could indicate that funders are not clear as to what action to take (relief versus adaptation). There is also a clear distinction between what has happened (disaster relief) and what can be prevented from happening (is this adaptation?).

■ There is still debate over whether adaptation is separate from development. Verification of inputs (data, needs, etc) could be a way to discern adaptation from development (if this is appropriate).

■ Adaptation to climate change has more to do with social research and social institutions.

■ Vulnerability is created by factors other than climate change, yet it is increased by climate change and variability. Social processes must be included in how we deal with adaptation.

General aspects:

■ There is a clear need across South-Eastern Africa region (and globally) to form partnerships and understand vulnerabilities to climate change and variability, based on the affected community's perspectives;

■ The sustainability of responses must be incorporated into planning;

■ For disaster response, integration into development strategies is needed;

■ Better energy policy and regulation in light of climate change and adaptation is required to mitigate negative effects on this sector;

■ More rigorous, participatory and socially-sensitive project processes (including learning assessments) are needed;

■ Understanding must reach the donor sectors to have more projects funded and the adaptive capacity of vulnerable communities ensured.

Although this was only a regional workshop, it can be assumed that many of these lessons are valid for most of Africa.

7.3 Responses and capacity

7.3.1 Vulnerable communities

The most vulnerable groups include smallholder farmers who are reliant on rain fed agriculture, pastoralists, and fishing communities. For example, there may be over 130 million poor livestock keepers in SSA – a group that is struggling with many challenges, even without climate change. Such challenges range from the harsh environmental conditions and distance from markets to inappropriate policies on natural resource management. In many countries, the more productive land in pastoral areas is being increasingly taken over by the farming communities, thereby confining pastoral livelihood systems to more marginal areas (drier and water limiting conditions) that can hardly support their livestock production system, increasing risks of livestock loss and low productivity as well as faster degradation of such areas. Extreme climatic events like drought also play a role in conflicts over natural resources. This sentiment is true of pastoralists whose competition for water and grazing areas often become stiff during the dry seasons, and can sometimes lead to violent conflict among neighboring communities. All of these factors combine to increase livelihood vulnerability and food insecurity of the affected communities.

Communities across the continent have developed ways of dealing with impacts of climate related events over time. Drought and floods are not new to many communities in Africa. However, the increasing frequency and intensity these events are rendering some of the strategies that have served communities well in the past inadequate. For the farmers, mixed cropping served as insurance against total crop failure, and rotational crop-

ping allowed for the rejuvenation of soils sustaining production at reasonable levels. Pastoralists migrated to better areas in times of drought, traded animals for cereals and other products from neighboring communities, and kept animals with friends and relatives elsewhere as a form of insurance.

With the rapid changes in climate in the recent past, some of these strategies are no longer viable. And there is also evidence of erosion of coping and adaptive strategies as a result of varying land-use changes and socio-political and cultural stresses (Boko et al. 2007). As a result, many people have had to cope with extreme events as they happen. Indeed some of the strategies adopted of late, like sales of animals, which are productive assets among the pastoralists, have further weakened their ability to survive such events in future.

It is therefore necessary that a combination of responses be put in place to safeguard people from anticipated impacts. Such responses should combine individual/community level strategies with national and regional/international, or so-called political strategies. Political strategies may include responses geared towards limiting further increase of greenhouse gas concentrations by raising awareness about how individual and collective actions contribute to the problem of climate change. This mitigation strategy could – as part of a worldwide approach – minimize the cost of adaptation in future. Without a worldwide mitigation strategy, limits to adaptation could be easily reached in parts of Africa.

However, where response strategies are being designed, it is important that they address those most vulnerable to climate change. For example, Hellmuth et al. (2007, 44) conclude that the early warning system in Ethiopia

> *„could play a much more useful role if it could also reach farmers and pastoralists more directly, with timely advice on specific problems as well as general information. This implies tailoring climate information to specific local needs, and would require greater involvement of agricultural sector specialists than is currently the case.“*

On the one hand, this shows that the direct needs of people tend to be neglected. On the other hand, this is an example of the importance of effective communication and information dissemination in coping strategies at the household level. Such a strategy should be successful and bring short-term benefits.

Another example is the use of fast-maturing hybrid maize. This crop is seen as necessary because of the unpredictable nature of rainfall, however, it has its own challenges. First, farmers are forced to buy new seeds year after year, as performance of hybrids greatly reduces with replanting. Second, hybrid seeds need inputs like fertilizers that many poor households cannot afford, a problem worsening with increasing energy prices. This is one reason why poor farmers rarely achieve the optimum yields with hybrids. Thirdly, due to their uniform nature, the risk of total crop failure from any single disaster (drought, floods, and pests) is usually high.

In a recent paper, Vermuelen et al. (2008) show examples of grassroots initiatives to build climate resilience, and conclude that this

> *„kind of experience, gained at the grassroots, boosts resilience as no top-down initiative can.“*

Their key messages, based on an analysis in Benin, Kenya, and Malawi, are that

- For communities dependent on natural resources, adaptation involves a mix of technical solutions (such as different crops or planting patterns) and institutional solutions (such as new means of sharing information);

- Local adaptations include responses to specific trends (such as fishing with finer-meshed nets), but also building of capacity and resilience – say through savings clubs and diversified agriculture – to cope with future uncertainties;

- Supporting local initiatives and institutions may be the most effective way to support climate change adaptation.

Table 27: Suggestions to improve responding to climate change

Improve communication between reaserchers, people and poltical decision makers	Reinforcing the scientific capacities of African organisations working in fields linked to CC and establishing functional interfaces between those structures, political decision-makers and local communities.
	It is also important to think about the best channels of communication to use; more data and decision-making tools are also needed to influence development strategies and policy.
	Creating a sub regional framework for consultation involving the different actors to discuss and exchange on issues and gains in terms of CC in the sub region and reducing the dispersion of financial resources, efforts and partners.
	Developing means of communication (bulletins in a simplified form accessible to decision-makers and the people, rural radios, brochures to disseminate information on technologies).
	Regular seminars or information, training or capacity-building workshops for the different actors but also for journalists.
To improve integration of CC by political decision-makers	Involving local elected representatives and developing appropriate communication tools.
	Raising awareness through flyers on CC issues and involving decision-makers in national, continental and international events on CC; the issue of using and translating scientific information into a suitable language for decision-makers is crucial.
	It is also necessary to prove the interest of adaptation, for instance by indicating the cost of doing nothing and through advocacy addressed to decision-makers so that they take account of CC in the design and implementation of development programs and projects;
	Developing documents for decision-makers to support them in their decision-making and organizing a series of information and communication events to provide them with all of the information they need to understand the advantages and disadvantages of implementing CC adaptation activities.
	Avoiding compartmentalization of services and promoting better visibility for institutions working on CC in relation to aid organisations. Passing on two messages to the decision-makers: CC is not tomorrow, it is now; adaptation to CC is not just an environmental issue, it is necessary to avoid compromising development and poverty reduction efforts. Also communicating with the technical advisors of political decision-makers.

Source: compiled from Niang 2007

This experience underlines the fact that starting where the most vulnerable are is not only right for principal and procedural reasons, but can actually deliver adaptation and climate resilience by building on local strengths. Niang has identified, based on an assessment in West and Central Africa, important proposals to improve adaptation of vulnerable people (Niang 2007):

- Information, awareness and education for local people on CC issues (causes and effects);
- Improving knowledge about CC and its impacts. Uncertainties give the impression that there is no emergency, and envisaging integrated research and development (natural resources, agriculture, environment, health);
- Adopting genuine bottom-up approaches with full involvement of the people, and encouraging the involvement of NGOs that are in more contact with the people;

- Promoting the self-adaptive capacities of local people, supporting good adaptation practices at the local level;

- Involving and coaching the people in seeking anticipative and curative measures to adapt to CC;

- Providing adequate funding for the implementation of projects to reduce the impact of CC;

- Generally speaking, fighting against poverty contributes to reduce the vulnerability of vulnerable populations.

7.3.2 Political and institutional capacity

Until recently, climate change adaptation has hardly played a role in African politics. An analysis undertaken in 2007 on existing Poverty Reduction Strategy Papers showed that both adaptation and climate change were hardly mentioned (Harmeling, Burck and Bals 2007).

However, at that time the available PRSPs were quite old, and the picture is changing. Adaptation has gained a lot of policy profile in the last two years, as can be seen for example in the Addis Abeba Declaration on Climate Change and Development in Africa, adopted by the African Union in 2007 (AU 2007), or the Joint Africa-EU Strategy (Africa-EU 2007).

As shown, the NAPA process has helped governments to understand the challenge of adaptation, although it is only a first step.

The institutional capacity, including that of political institutions, is a key issue to develop comprehensive adaptation strategies. Based on an assessment of the institutional framework in relation to climate change in West and Central Africa, a number of suggestions for further action to improve response capacities have been developed.

All the aspects mentioned here could be developed in a way that specifically addresses the links between climate change and food security.

7.4 Advocacy and policy recommendations

Food insecurity results from many causes, ranging from poor production to inappropriate policies that may hinder access to markets. For the majority of poor subsistence crop farmers and livestock keepers, climate plays an important role in determining whether they secure food or not. Climate change will greatly affect their security status unless appropriate measures are put in place to facilitate their adaptation. Recognizing that the needs for adaptation will likely exceed their ability in terms of knowledge and resources, it is important that a combination of approaches both technical and political are used to ensure that the potential negative impacts are minimized, especially with regard to their assets and production systems.

Also, it has to be recognized that

> *„the causes, impacts and legacies of various strategies – including liberalization policies, decades of structural adjustment programs (SAP) and market conditions – cannot be ignored in discussions on poverty alleviation and adaptation to stresses, including climate change" (Boko et al 2007, 464).*

The focus should be on preventing the impacts as much as possible, rather than reacting to what has happened. Hence we suggest the following:

1. Awareness creation at all levels as a first step in sensitizing the global community on need to tackle climate change.

2. The need to promote mitigation activities in developing countries, and recognizing that the best way to adapt in the future is to minimize the impacts.

3. For poor countries, adaptation must start, and be strengthened as much as possible, to avoid loss of assets and means of livelihood. Developed countries should recognize source limitations and help poor countries in this process.

4. Reforming the WTO terms of engagement to ensure it is fair to poor developing countries as a way of promoting equity and self sufficiency in food systems.

5. There is a need for coordination of efforts at the different levels (local, national, international) to ensure that limited resources are used optimally.

8 Research results for Asia[28]

Asia, the most populous continent with almost 4 billion people, 38.5 percent of which live within 100 km of the coast and house 70 percent of the world's poor, is facing changing climate trends, increasing variability, and extreme events.

8.1 Effects of climate change on food production, agriculture and water availability

8.1.1 Changes in climatic conditions

An increasing trend in surface air temperature has been observed during recent decades ranging between less than 1°C to 3°C per century. Moreover, 2.0 to 4.5°C net global average surface warming is expected by the end of the present century (2090-2099), and all of Asia is very likely to warm during this period (Christensen et al. 2007). Increases in the amount of precipitation are very likely in high-latitudes, while decreases are likely in most subtropical land regions, continuing observed patterns in recent trends (Christensen et al. 2007).

Glaciers in Central Asia, Western Mongolia, North-West China, and the Tibetan Plateau are reportedly melting faster in recent years than ever before (Pu et al. 2004). Consequently, glacial runoff and the frequency of glacial lake outbursts causing mudflows and avalanches have increased (Bhadra 2002; Rai 2005). Changes have also been observed in extreme climate events like frequent occurrences of more intense rainfall, increasing frequency and intensity of flooding, drought, and tropical cyclones. Regions of Asia, such as South Asia, East Asia, and South-East Asia, will experience an increase in the occurrence of extreme weather events (Cruz et al. 2007). Based on regional HadRM2 simulations, Unnikrishnan et al. (2006) expect an increasing trend in the frequency and intensity of tropical cyclones by the 2050s. This development is supposed to occur as a result of increased greenhouse gas (GHG) forcing in the Bay of Bengal, which will cause heavier precipitation in the surrounding coastal regions of South Asia during both the southwest and northeast monsoon seasons. Furthermore, a general warming of 2 to 4°C in Sea Surface Temperature (SST) is projected to increase tropical cyclone intensities by 10 to 20 percent in East Asia, South-East Asia, and South Asia (Knutson and Tuleya 2004). Table 28 gives an overview of projected impacts of climate change in Asia.

8.1.2 Effects on food production, agriculture, water, forests, fish, and livestock

Production of rice, the staple food of most of the impoverished in Asia, is the key concern, as the continent consumes 90 percent of the world's rice. Warming, along with decreasing precipitation, have been reported to increase water shortages, particularly in parts of Asia where water resources are already under stress from growing water demands and inefficiencies in water use (Ma and Fu 2003; Manton et al. 2001). The production of rice, maize, and wheat has been reported to decline in many parts of Asia during the past few decades due to warming-induced water stress, increasing frequency of El Niño, and reduction in number of rainy days (Tao et al. 2004). Even an apparently water-rich country such as Bangladesh will face increasing risks of phenological drought due to increased aridity and subsequent moisture stress (Ahmed and Alam 1999).

Recent studies suggest a 2 to 5 percent decrease in yield potential of wheat and maize for a temperature rise of 0.5 to 1.5°C in India (Aggarwal 2003). In Bangladesh, potential yield of the major pre-monsoon rice crop would be reduced by as much as 32 percent, assuming a 4°C rise in temperature associated with a 60 percent increase in moisture stress. The goods and services from coastal ecosystems have been substantially inter-

[28] Based on a contribution by Ferdausur Rahman, Mizanur Rahman Bijoy, Nusrat Habib (all Network on Climate Change, Bangladesh) and Umme Kulsum (Climate Change Focal Point, Prodipan).

Table 28: Projected impacts of climate change in Asia

Sector	Projected impacts
Agriculture/ Forestry	Increased risk of hunger in South Asia due to 30% decline in cereal yields (266 million Asians may face hunger by 2080). Increase in agricultural water demand by 6 to 10% or more for every 1°C rise in temperatur. Decline in net productivity of grasslands and milk yield.
Water	Decline in water availability from ~1,820 m³/yr to ~1,140 m³/yr in India by 2050; may adversely affect >1 billion people. Decline in annual flow of Mekong river by 16 to 24% by 2050. Disappearance of Tibetan Plateau glaciers of <4 km length with 3°C rise. Shrinkage of area of glaciers by 80% over Tibetan plateau from 500,000 km² in 1995 to 100,000 km² by the 2030s. Deterioration of water quality due to salt water intrusion. Decline in fish larvae abundance in coastal waters.
Health	Exacerbation of cholera in South Asia due to increase in water temperature. Increased endemic morbidity and mortality due to diarrhea across Asia due to floods and droughts. Increase in infectious diseases for livestock.
Coastal/Marine ecosystems	Loss of 2500 km² mangroves in Asia with 1 meter sea-level rise. Flooding of Red (5,000 km²) & Mekong (15 to 20,000 km²) River deltas. About 2.6 to 18.8 million people along the coasts of Southeast Asia may be at risk of flood by 2100. Large scale inundation and recession of flat sandy beaches affecting tourism. Loss of ~30% of Asia's coral reefs in next 30 years.

Source: IGES 2008, 59 (based on IPCC)

rupted/declined across Asia due to major changes in the coastal zone from a combination of extreme climate and non-climate events (Li et al. 2004a). The abundance of fish populations in Asian waters is threatened with future changes in ocean currents, sea-level, seawater temperature, salinity, wind speed and direction, strength of upwelling, the mixing layer thickness and predator response to climate change (Zhang and Guo 2004). Livestock and poultry development is important to meet the increasing demand of meat and animal products for Asian people. However, the expansion of livestock numbers has been limited in most regions of Asia (India, China, and Mongolia) due to constraints in pasture availability.

Easterling et al. (2007) report that

> *„(...) increases in frequency of climate extremes may lower crop yields beyond the impacts of mean climate change."*

In Bangladesh, USD 2.8 billion, or about 4 percent of GDP, are the estimated combined losses from two devastating floods, a super cyclone ‚SIDR', and a tidal wave

Table 29: Hotspots in Asia

Hotspots in Asia	Causes of insecurity
Central Asia	Global warming and glacier melts could affect crop and water distribution issues in a region that is already facing civil conflicts in countries like Tajikistan and conflicts over water and energy resources.
China	Climate change will intensify the existing environmental stress (e.g. air and water pollution, soil degradation) due to the increase in heat waves and droughts, which will worsen desertification and water scarcity in some parts of the country. Sea-level rise and tropical cyclones will threaten the economically significant and populous east coast. The government's steering capacities could be overwhelmed by the rapid pace of modernization, environmental and social crises, and the impacts of climate change.
India, Pakistan and Bangladesh	The impacts of climate change will be especially severe in this region; glacial retreat in the Himalayas will cause increased floods and soil erosion, jeopardize the water supply for millions of people, and changes to the annual monsoon will affect agriculture for some decades. Sea-level rise and more intense or frequent cyclones and storms will threaten human settlements around the populous Bay of Bengal. These dynamics will increase the social crisis potential in a region which is already characterized by cross-border conflicts (India/Pakistan) and unstable governments (Bangladesh/Pakistan).

Source: WBGU 2008

that hit the country all within span of few months at the first half of 2008. The disasters heavily disrupted agriculture by affecting crops, livestock, poultry, and fish farms (ADB 2008*)*.

8.1.3 Hot spots and countries at risk

WBGU (2008) identified the regions and areas as hotspots due to their special ecological, demographic, or socio-economic features; climate change will present particularly major challenges for these places in the next decades Bangladesh (3), Vietnam (4), and India (7) are three of the 10 most affected countries by extreme weather, following only countries in Africa, in the decadal Climate Risk Index (CRI) for 1997-2006 (Harmeling 2007). In the future, food scarcity projections for South and South-East Asia are highly vulnerable with high confidence, while East Asia is highly vulnerable with a very high degree of confidence (Cruz et al. 2007). The densely populated mega deltas of Asia, which are more apparent in megacities (e.g. Bangkok, Shanghai, Tianjin), are vulnerable to both climate change and sea-level rise (Cruz et al. 2007). 2,500 km^2 of mangroves in Asia are likely to be lost with 1 meter of sea-level rise. Approximately 1,000 km^2 of cultivated land and sea product culturing area in Bangladesh is likely to become salt marsh (Cruz et al. 2007). In the arid and semi-arid regions of Asia, irrigation demand is estimated to increase by at least 10 percent for an increase in temperature of 1°C (Fischer et al. 2002; Liu 2002). The current melting trends of Himalayan glaciers (e.g. Gangotri glacier) are one of the tipping elements. It is projected that the Ganga, Indus, Brahmaputra, and other rivers that criss-cross the northern Indian plain could likely turn into seasonal rivers in the near future as a consequence of climate change. This fact might likely affect economies in the region (Cruz et al. 2007).

In total, 37 countries are facing food crises and require external assistance; 10 of these countries are in Asia (FAO 2008a). Those countries lack the ability to deal with critical problems of food security due to exceptional shortfalls in food production (Iraq), widespread lack of access (Afghanistan & Korea DPR), or severe localized food insecurity (Bangladesh, China, Indonesia, Nepal, Sri Lanka, Timore-Leste & Viet Nam). Except in conflict-

Vulnerable Zones/ Hotspots in Bangladesh

The Government of Bangladesh has identified climate change hotspots using the vulnerability zone of the BCAS/RA/Approtech (1994) study in it's National Adaptation Plan of Action (NAPA) submitted to UNFCCC in 2005 (GOB 2005). As the impacts of climate change are likely to be felt almost across the entire country, the whole country, except the Chittagong Hill Tracts, is segregated into nine vulnerable zones depending on the agro-ecological zones and water planning zones defined by the BCAS/RA/Approtech (1994) study, as shown here in Table 30. Several studies indicate that the coastal zone vulnerability would be acute due to the combined effects of climate change, sea-level rise, subsidence, changes of upstream river discharge, and cyclone and coastal embankments (BCAS/RA/Approtech 1994 and WB 2000). The coastal people of Bangladesh are under severe threat to become climate refugees due to extreme events and other climate-induced losses of production. Suitable areas for Aman rice would decrease significantly due to sea-level rise along the southwestern region of Bangladesh (CEGIS 2006).

prone Afghanistan, Iraq, and Sri Lanka, natural catastrophes have played the most decisive role in undermining food security and have contributed to generating the recent high global cereals price, which has in turn led to widespread increases in domestic food prices of the Asian LFDC's (FAO 2008a).

8.2 Adaptation needs

8.2.1 Adaptation priorities

Reflecting the knowledge of projected impacts of climate change on different sectors would allow the identification of likely priority actions on adaptation from a top-down perspective. Initiated and supported by the UNFCCC process, LDCs in Asia and elsewhere have started to or have already finished elaborating on their National Adaptation Programs of Action (NAPAs). The guidelines agreed on under the UNFCCC specifically underline the objective to identify and address the most urgent adaptation needs and identify priority projects. In principle, these should be developed in a participatory process (UNFCCC 2001). However, the guidelines are much less concrete than, for example, the procedural elements from the FAO voluntary guidelines introduced above. Thus, it is not so easy to judge how far NAPA processes have been sufficiently participatory.

Nevertheless, these NAPAs serve as the best and most recent starting point when looking at adaptation priorities. They also provide reference when assessing likely costs of adaptation, although it has to be repeated that they are only about the most urgent adaptation needs. These show that activities linked to food production and water supply feature prominently in this selective.

While NAPAs have been a valuable exercise for determining national priorities in adaptation, they are not supposed to be the tool to systematically integrate adaptation into all development policies and planning processes. However, it is remarkable that Bangladesh is one of few countries that have explicitly included capacity building for mainstreaming in its NAPA.

8.2.2 Barriers to adaptation

There are a number of barriers which need to be removed to allow for a better and faster increase of adaptive capacity.

The prevailing level of poverty can be judged as the largest barrier to developing the capacity to cope and adapt. The poor usually have a very low adaptive capacity due to their limited access to information, technology, and other capital assets which make them highly vulnerable to climate change (Cruz et al. 2007). Adaptive capacity in countries where there is a high incidence of poverty will likely remain limited.

Furthermore, Cruz et al. (2007, 492) conclude that

> *„insufficient information and knowledge on the impacts of climate change and responses*

Table 30: Critical vulnerable areas/hotspots with most impacted sectors in Bangladesh

Sln	Climate and related elements	Critical vulnerable areas	Most impacted sectors
1	Temperature rise and drought	• North-West (NW)	• Agriculture (crop, livestock, fisheries • Water • Energy • Health
2	Sea-level rise and salinity intrusion	• Coastal area (SW, SC and SE) • The Sundarbans (SB) and • Island	• Agriculture (crop, fisheries, livestock) • Water (water logging, drinking water, urban) • Human settlement • Energy • Health
3	Floods	• Central region (CC) • North-East region (NE) • Charland	• Agriculture (crop, fisheries, livestock) • Water (urban, industry) • Infrastructure • Human settlement • Health • Energy
4	Cyclone and storm surge	• Coastal and • Marine zone	• Marine fishing • Infrastructure • Human settlement • Life and property
5	Drainage congestion	• Coastal area (SW, SC & SE) • South-West (SW) • Urban	• Water (Navigation) • Agriculture (crop)

Source: after GoB 2005

> *of natural systems to climate change will likely continue to hinder effective adaptation particularly in Asia".*

This is also true regarding the challenge of mainstreaming adaptation in planning and policy processes on different levels. A recent consultation process undertaken by the Institute for Global Environment Studies (IGES, Japan) addressed the issue of mainstreaming adaptation. There seems to be common recognition that systematically integrating climate change into affected fields of development policy and planning is becoming increasingly important. And although many sectoral and other entry points could be identified in order to integrate long-term climate change into, for example, food security and water policies, progress on mainstreaming in Asia has been limited. Among the key barriers identified are

> *„information (communication and coordination) barriers, institutional barriers, stakeholder participation-related barriers and the lack of suitable incentives and resources" (IGES 2008, 64).*

While some of these barriers, like the lack of clarity in adaptation policy guidance and the lack of incentives

Table 31: Priority activities of adaptation and their costs as identified in NAPAs from selected Asian LDCs

Country	Adaptation measure	Cost (million USD)
Bangladesh	Construction of flood shelter, and information and assistance centre to cope with enhanced recurrent floods in major floodplains	5.00
	Enhancing resilience of urban infrastructure and industries to impacts of climate change	2.00
	Promoting adaptation to coastal crop agriculture to combat increased salinity	6.50
	Adaptation to fisheries in areas prone to enhanced flooding in North East and Central Region through adaptive and diversified fish culture practices	4.50
Bhutan	Landslide management and flood prevention	0.89
	Weather forecasting system to serve farmers and agriculture	0.42
	Flood protection of downstream industrial & agricultural area	0.45
	Rainwater harvesting	0.90
Cambodia	Rehabilitation of upper Mekong and provincial waterways to reduce risks caused by floods, improve fishery resources, supply sufficient water for irrigation and domestic uses	30.00
	Vegetation planning for flood and windstorm protection	4.00
	Development and improvement of community irrigation systems	45.00
	Community mangrove restoration and sustainable use of resources	1.00

Source: IGES 2008, 71

and adequate resources, are applicable to the entire region, yet others, like inadequate institutional structures, exist in specific countries or sub-regions (IGES 2008). The lack of awareness among sectoral policymakers about adverse economic impacts of climate change at the local level seems to be one of the key bottlenecks.

Another point, which verifies that climate change challenges the way of conventional policy-making, is that both national planners and development assistance agencies were judged to be over-reliant on structural and technological options. Often, these options are inflexible and insensitive to the local contexts; while at the same time being „technologically and financially demanding“ (IGES 2008, 64).

Governments and their institutions have to ensure food security as well as advance the understanding and knowledge of adaptation within their national circumstances. Overcoming institutional barriers is very important in achieving this goal. Also, the conclusions from the IGES consultation are useful in this regard (IGES 2008, 67):

(a) Managing adaptation plans by a ministry or agency with a high level of leverage so that institutional linkages and coordination can be fostered;

(b) Encouraging the private sector to mainstream adaptation concerns in various operations;

(c) Ensuring a coherent approach to mainstreaming through regular and broader engagement of stakeholders at various levels;

(d) Building „boundary institutions“ which can help to bring information on implications of climate change for sectoral planning and decision making.

In this particular context, suggestions for the catalytic role of the UNFCCC process were also made. Its primary roles in fostering mainstreaming could be to provide (a) guidance to development agencies to preferentially support mainstreaming, (b) guidance to policymakers on inter-agency coordination and mainstreaming at national level, and (c) capacity building on mainstreaming options in critical sectors.

8.3 Responses and capacity

8.3.1 Development, poverty, and human rights implications

Bangladesh shows significant success in achieving some of the midline targets of the MDGs by the year 2005. The number of poor people living below the poverty line (USD 1 per day) was reduced from 59 percent to 40 percent, and the proportion of people in extreme poverty was reduced from 28 percent to 19.5 percent. This is a good indication of the right path for the first goal of eradicating extreme poverty. But MDGs are not a complete human development agenda; this achievement can be hampered by climate change that is already impacting the lives of the poor.

Enhanced adaptation is one necessary requirement for supporting progress toward the 2015 targets. In the world beyond 2015, climate change will act as a brake on human development – holding back or even reversing human progress until mitigation starts to take effect (UNDP 2007).

The economic and social impacts of climate change will result in both shortages of and increased inaccessibility of resources (i.e. fresh water, staple food). Above all, frequent and intensified storm and flood disasters have a positive correlation with intensification of conflict, violent unrest, and/or political crises. Several studies concluded that the severe floods and storms followed by severe shortages of food and insufficient aid measures in 1970, 1974, and 1988 were some factors in the domestic political crisis in Bangladesh (then East Pakistan) and deteriorating human security (WBGU et al. 2008).

8.3.2 Marginalization, consumption and hunger

Poor, marginalized people, who are most vulnerable to the impact of climate change, will be further marginalized through all forms of discrimination induced by climate change: i.e. geographic, social, production specific, political, and gender processes.

Children in the developing world bear the brunt of the health impact of climate change through the increased incidence of diseases such as diarrhea, malaria, and respiratory infections. As of International Center for Diarrhoeal Disease Research, Bangladesh (ICDDR, B), climate change and sea-level rise in Bangladesh is likely to have important effects on the prevalence of infectious diseases in addition to heat stress due to rising temperature. The risk of malaria is still limited to over 10 million ‚minority' populations in the Chittagong Hill Tracts and similar areas. It is possible that global warming would produce more rapid replication of the dengue virus. This, in turn, is expected to favor visceral leishmaniasis (VL) vectors, and may result in increasing cases of VL in Bangladesh. Cholera and other diarrheal diseases are an obvious risk in Bangladesh following the increased amount of extreme events (ICDDR,B 2007).

These health impacts of climate change have a discernible implication on malnutrition and hunger. In Bangladesh, a large group of the total population consumes less than 1805 kcal; the minimum requirement needed is 2110 kcal. The trend shifts downward nationally and rurally. However, it is rising upward in urban areas excluding the year 2005. At the same time, we see rises in the number of urban poor due to rural-urban migration, whereas the number of the very poor remain huge at 27 million nationally.

8.3.3 Most vulnerable groups

Easterling et al. (2007) infers with high confidence that smallholder and subsistence farmers, pastoralists, and artisanal fisher folk will suffer complex, localized impacts from climate change. Climate change may affect the poor through changes or depletion of common property resources, such as fisheries, rangelands, or for-

ests on which they depend for their livelihoods (DFID 2004). A number of studies found negative effects from rising temperature on rice-wheat systems across Asia; this area is home to the world's majority (87 %) of small farmers[29] (Aggarwal et al. 2000; Lal et al. 1998).

Increased plant disease and pest outbreaks due to climate change will likely be directly felt by the rural poor. They are often closely linked directly to food production and have low capacity for food purchases (Alig et al. 2004 and Cruz et al. 2007). Competition for land and other resources, for example between food and biofuel production, may coincide with the loss of farmer income. For instance, in the Philippines, expanded sugarcane production meant that tenant farmers lost access to land for maize production (Rinot and Hill 2007). O'Brien et al. (2004) also reveals that small farmers in India will have to face the brunt of being ‚doubly exposed' by both climate change and globalization.

An analysis of poverty in small-scale fisheries has identified greater vulnerability to external shocks and trends including climate change, variation, and extreme events, than to asset or income poverty (Allison et al. 2005). A reduction of primary production in the tropical oceans is predicted, because of the changes in oceanic circulation in a warmer atmosphere (Cruz et al. 2007).

The timing and amount of precipitation in the plains could also affect the migration of fish species from rivers to floodplains for progeny, dispersion, and growth. As a result, the fishing communities that depend on inland fisheries are likely to be particularly vulnerable to climate change (Muir and Allison 2007). The huge majority of the world's fisherfolk are found in Asia. China, Indonesia, India and Vietnam are the four countries with the largest number of fisher folk (Allison et al. 2005).

In South Asia, large declines in the natural assets of grasslands and savannas are likely to be a consequence of climate change. Reduced precipitation and a rise in temperature are estimated to reduce pasture productivity in the Mongolian steppe by about 10 to 30 percent (Tserendash et al. 2005). It is also projected that the vegetation zone in the Tibetan Plateau could move to higher altitudes, and climate change may cause a shift of the boundary of the farming pastoral lands (Cruz et al. 2007).

In recent years, the poor have been moved more quickly than before to urban centers and poverty is becoming more urban. This urban poor are also negatively affected by an increase in food prices. One important reason in Bangladesh was that natural disasters have caused shortfalls in food production (Cruz et al. 2007). Also, the poor will have to endure increasing risks from floods and other climate-related hazards (Adger 2003). As the impacts of climate change are unequally distributed over space and time and disproportionately affect the poor it is likely to cause additional inequity (Stern 2006).

Climate change also has a gender dimension. The majority of women working in the informal sectors are frequently worst hit by climate change-related disasters and other shocks. Women and children are 14 times more likely to die than men during disasters, and that makes them more vulnerable to cope with unexpected events and disasters or to adapt to change (Brody et al. 2008; Araujo/Quesada-Aguilar 2007)

Traditional food sources may become more volatile and meager due to climate change, and will thus consistently affect women. Women and young girls largely responsible for water collection, especially among poor people, are more sensitive to the changes in seasons and climatic conditions that affect accessibility and quantity of drinking water. These changes make its collection even more time-consuming (Brody et al. 2008). Saline water infiltration also could affect livelihoods from fishing, another sector in which women are frequently involved.

[29] Land areas below 10 m elevation from sea-level (above mean high water). China alone occupies about 48 percent of world's 404 million small farms (less than 2 hectares), while India is home to about 23 percent, Indonesia 4.2, Bangladesh 4, and Viet Nam about 2.4 percent (Nagayets 2005).

Indigenous people's dependency on natural resources for their livelihoods and homes puts them on the frontline to deal with climate change. Often, these people are living on the most marginal natural areas. A recent study (Gunter et al. 2007) suggests that the tribal people of Chittagong Hill Tracts (CHT) of Bangladesh seem to be highly vulnerable to a climate change-induced increase in drought, floods, land slides, and cyclones. The area is expected to suffer a number unusual drought during the Rabi and Pre-Kharif season (typically November to February) by 2030.

According to Cruz et al. (2007, 490),

> *„the ability of local populations to adapt their production systems to cope with climate change will vary across Asia and will be largely influenced by the way government institutions and policies mediate the supply of, and access to, food and related resources. The adaptive capacity of poor subsistence farming/herding communities is commonly low in many developing countries of Asia. One of the important and effective measures to enhance their adaptive capacity is through education and the provision of easy access to climate change-related information."*

8.3.4 National/Government response (Bangladesh)

Responding to climate change

Since the Rio Earth Summit in 1992, climate change has become more recognized in policy discourse in Bangladesh; but a comprehensive national policy on climate change is yet to be formulated. The Government of Bangladesh (GoB) has participated in all the UNFCCC conferences and submitted the Initial National Communication (INC) in 2002 (Agrawala et al. 2003). The most significant achievement of Bangladesh in terms of adaptation is to prepare the National Adaptation Program of Action (NAPA) in 2005, which identified 15 priority projects in different vulnerable areas (GoB 2005). Recently, the government has prepared a Country Framework for climate resilient development, and it is currently working on the Climate Change Action Plan for Bangladesh (Cell 2008). This process will help the nation to shift their policy activities towards coherence and away from ad hoc decision making.

A number of climate change-related projects (focusing on mainstreaming and capacity building) are being implemented by both governmental and non-governmental organizations with financial support from donor agencies. The remarkable ongoing projects are (a) Comprehensive Disaster Management Program (CDMP), (b) Poverty and Climate Change, and (c) Land use Change, Food Security, Water, and Biomass Energy in the context of Climate Change, etc. (Rahman et al. 2007). In 2003, a Climate Change Cell was also established as a component of CDMP in order to develop a connection with the Ministry of Environment & Forest (MoEF). The MoEF is the focal point of UNFCCC within government of Bangladesh (Rahman et al. 2007).

Research and studies

A number of studies have been performed throughout the last decade on the impacts, vulnerability, and adaptation assessment for Bangladesh to climate change and SLR. Most of the studies have assessed impacts, vulnerability, and adaptation to climate change and SLR by sectors and geographic areas such as water, coastal zone, agriculture, infrastructure, forestry, and health (Rahman et al. 2007). These studies can be separated into three parts: (1) About 20 studies have analyzed vulnerabilities resulting from climate change-induced disasters, (2) about 10 studies have looked at the vulnerabilities related to socio-economic criteria, and (3) about 20 studies have examined a diversity of climate change-induced vulnerabilities (Gunter et al. 2007).

Response on food security

Constitutionally, the fundamental duty of the state is to secure its citizens the provision of basic necessities of food (article 15.a of the constitution of Bangladesh). But as per Government's Allocation of Business, it is the duty of the Ministry of Food and Disaster Management

(MoFDM) to establish a dependable food security system for the nation. The National Food Policy (2006) was developed in light of the present Poverty Reduction Strategy Plan (PRSP)[30], and with the objective, to ensure a dependable food security system for all people of the country at all times', matching the broader perspective of food security as adopted in the World Food Summit of 1996. The policy also considers the GATT Uruguay Round Agreement (1994) and the Millennium Development Goals (2000) in setting a dozen of strategies under three broader objectives (GoB 2006). Several strategies under objective one (ensure adequate and stable supply of safe and nutritious food) and objective two (enhance purchasing power of the people for increased food accessibility) could be incorporated into the climate change adaptation process, although the food policy has failed so far to find climate change as a risk for ensuring food security. The policy may favor private food distribution systems over public distribution systems.

At present, 27 Social Safety Net programs are being run by the government (GoB and SW 2007). The most important safety nets programs are broadly divided into two categories (provide food or cash transfer), and cover only about 4 to 5 million people (WB 2006). The government spends less than 1 percent of the GDP and about 4.4 percent of public expenditure in these social safety-net programs (GoB and SW 2007). The World Bank assessment (2006) shows that the budgetary sanction for Social Safety Net programs has been declining relative to GDP and public expenditure since the late 1990s.

8.3.5 Civil society response

The civil society has played an active role on both the national and global levels in creating pressure for environment and climate concern. Despite the number of various studies, there was a gap on testing adaptation measures for vulnerable communities. Reducing Vulnerability to Climate Change (RVCC) was the first project (2003 to 2006) of its kind on Community-Based Adaptation (CBA) to climate change.

The project was implemented by CARE Bangladesh in association with 17 partner organizations in the Southwestern coastal region of Bangladesh. The project focused on diversification of livelihood options in vulnerable communities, and generated valuable local knowledge in how to address climate change (and adaptation) at the community level (Rahman et al. 2007). Awareness, campaigning, and adaptation facilitation has continued since 2005 in coastal districts by two RVCC Partners, PRODIPAN and NABOLOK, through Network of Climate Change in Bangladesh (NCC, B).

At present, a number of projects, such as ‚Increase Resilience of Disaster Prone Communities in Gaibandha' by Practical Action, ‚Building Adaptation Strategy to Climate Change for Selected Drought and Flood Prone Areas of Bangladesh' by BCAS, ‚Livelihood Adaptation to Climate Change (LACC)' – jointly implemented by the FAO and the Department of Agriculture Extension (DAE), under Climate Change Cell, Department of Environment (Rahman et al. 2007) – are under way. Several networks and NGOs are also implementing various projects on advocacy, research, and CBA. Four CDM projects also have been approved by the Designated National Authority (DNA) in 2006 (Climate Change Cell 2008).

8.4 Advocacy and policy recommendations

The mainstreaming of climate change into relevant policies for the Government of Bangladesh is an urgent thrust needed in all development sectors. The Bangladesh government can play a key role in the Least Developing Countries (LDCs) Group within the G77+ China and

[30] The present Poverty Reduction Strategy Plan (PRSP), 'Unlocking the Potential: National Strategy for Accelerated Poverty Reduction', has been adopted in October 2005, but recently the government decided to continue this PRSP only up to 30 June 2008 and a revised PRSP will take.

in the UNFCCC negotiations. It should pursue its role in developing adaptation policies, mobilizing of global funds for LDC countries and local communities, and establishing better linkages between climate change and development. The policy makers and South Asian Government negotiators can be offered annual training on Climate Negotiations with leading Bangladeshi and other South Asian partners. Climate change adaptation is becoming the centre of the post-2012 Kyoto framework, and international partnerships are recommended for poverty reduction. The following steps can be recommended:

- In the most vulnerable countries, like Bangladesh, policy coherence is necessary to face, adapt to, and fight climate change. Therefore, linking climate change with all development sectors and sub-sectors (e.g. land, food, agriculture, trade, energy etc.) under a comprehensive National Climate Change Policy is necessary and recommended for other vulnerable countries.

- Effective global mechanisms should be developed to ensure funds under the UN for climate-coping initiatives by poor countries.

- Global food production should be increased by using suitable technology and potential agricultural lands in an environment friendly way.

- The vulnerable people should be empowered and enabled to adapt to climate change by building resilience through investments in social protection, health, education, and other measures.

- The Poverty Reduction Strategy Papers (PRSPs) can be used to conduct national estimates of the costs of scaling-up existing programs and identifying priority areas for reducing vulnerability.

- Countries that could experience a potential food deficit under climate change, need effective local policies. Such polices include establishing social safety net and programs aiming at creation of access to food. Pro-poor agricultural development should be given very high priority.

- Food deficit countries should establish mechanisms, either individually or collectively, with neighboring countries. They should also create an emergency food reserve which may be mobilized in case food is not available from international sources following a shock.

- Coastal infrastructure, like dams and cyclone shelters, should be built, with support from highly-emitting countries, to face the onslaught of extreme events.

The private sector and civil society should advocate mitigation process such as using the CDM, energy efficiency, renewable energy, and adaptation activities such as infrastructure developments and mainstreaming climate change. Common Regional Policies and programs for implementation should make use of the South Asian Association for Regional Cooperation (SAARC). Regional modeling and response strategies in relation to food security and climate change can be initiated early on. Existing networks of South Asian NGOs and research institutes can be strengthened and put to work on regional government initiatives and programs. Advocacy should be developed to ensure justice in food trade for the LFDCs, and that climate change is incorporated into international trade negotiations. Advocacy for the rights of climate refugees beyond country boundaries is an emerging issue under food security constraints and developing nations under climate change. The health impact of climate change has a wide range of malnutrition implications, and can be another advocacy issue in a food-impoverished, vulnerable country like Bangladesh.

9 Research results for Latin America

The effects of climate change on food production, agriculture and water availability in Latin America, the respective adaptation needs and policy recommendations are summarized in Chapter 11.7.3.

Part IV

The way forward: conclusions

10 Conclusion: elements of a rights-based strategy

Rights-based strategies have been increasingly discussed in several policy areas relating to the right to adequate food, water, health, adequate housing etc. since the middle of the 1990s (summarized discussion, Windfuhr 2001 and IISD 2004). The rights-based approach has gained support as a result of the frustration arising from the very slow improvements achieved for vulnerable groups, particularly in countries with non functioning governments. These governments often hinder the implementation of policies needed to overcome deprivation. The incentives provided through traditional development policies often do not work adequately if or when the national policy setting is not supportive. For example, training farmers is a positive measure, but will only have a long term effect when secure access to tenure rights guarantee farmers the access to productive resources.

Processes of social exclusion, discrimination in access to productive resources, exclusion from decision-making bodies, and the exploitation of vulnerable women and men are important reasons for the persistence of poverty. Inequalities are becoming institutionalized in many countries. These disparities are reinforced by political, economic, social, and cultural structures. Systematic discrimination on the basis of gender, class, caste, ethnicity, and other identities persist and lead to the structural exclusion of large groups of women and men from developmental processes and benefits.

National policies often reflect the interests of sectors holding the most power. They are seldom oriented towards the interests and needs of vulnerable and marginalized men and women. Health, education, social services, taxation and subsidy systems, property rights and their legal protection etc. often favor local elites. Formal and informal political decision-making structures often work against poor and marginalized women and men, particularly in rural areas and in poor urban pockets. These areas are where most of the poor and politically excluded segments of societies are to be found. For poor women and men, access to health, education, productive resources, a functioning legal system, land-registration systems, justice and appeals mechanisms for checking discriminatory laws or their practices etc. are often limited. The access to these resources would constitute effective remedies to react adequately, in any substantive way, their situations.

In the case of adaptation policies to climate change, such forms of discrimination and exclusion should be avoided and not reinforced. A rights-based orientation for adaptation policies can help to overcome such problems. Adaptation policies will probably be unable to overcome all forms of institutionalized and historic marginalization, but they can avoid aggravating existing inequalities. Moreover, if adaptation policies are faultily designed, they might not achieve their intended objective – supporting those most affected. Instead, the support will again be directed towards those more powerful within the society with far less intense adaptation problems.

A rights-based approach describes, therefore, a strategy for increasing government accountability to its own citizens. It helps secure the entitlements people need in order to use existing chances, or it helps to widen their overall opportunities. A rights-based approach strengthens and complements other strategies in North-South development cooperation, such as strengthening capacities of local partners and enhancing their capabilities to use productive resources or other income-earning op-

portunities. It stimulates analysis and reflection on the causes of entitlement-failure and allows the more precise description of roles, obligations, and responsibilities of different actors in the development process. It is a way of reducing the accountability gap that, in many countries, works against the poor.

National governance issues are not the only determinants of poverty and exclusion; international policies can also exacerbate existing local forms of social exclusion and foster poverty. International trade policies can, and often do, directly impact the income poor producers or consumers derive from their work.

Policies of multilateral institutions can limit states‘ capacities to act in favor of poorer segments of their societies. Losses by developing countries through trade protection, immigration barriers, and increasing debt burdens amount to many times that of the aid developing countries receive. Social exclusion is a consequence of many economic policies pursued by multilateral institutions. Collective frustration about processes of social disintegration is sometimes expressed in religious intolerance, spontaneous migratory movements and security issues. These developments can affect whole regions and put democratization at risk.

This study has shown that climate change will affect food security and often marginalized producers and other vulnerable groups. Without a strong international mitigation policy, climate change in many parts of the world might easily move beyond certain thresholds and overwhelm the adaptive capabilities.

The situation of marginalized and vulnerable groups might be aggravated, and they may need particular attention because of their low coping capacities. New vulnerable persons or groups might develop as a result of climate change. Developing a rights-based strategy for adaptation policies in national and international policies can therefore be an effective tool to concentrate and orient such measures and policies towards the people most in need. This study has also shown that adaptation policies need to take into consideration existing forms of marginalization when developing adaptation policies.

Factors that create or support vulnerability need to be addressed as much as possible, otherwise the adaptation policies designed cannot adequately help the people they are supposed to assist. For example, say a family headed by a woman is excluded from locally available credit schemes or agricultural extension services because of gender discrimination. This family will not gain much if the same services are then expanded to deliver credits for adaptation purposes or to deliver knowledge on adaptation techniques. The same household might still be excluded from these services because of same reasons as before. Adaptation policies should address or be sensitive to such older forms of marginalization.

Climate change and human rights are related in situations where the impact of climate change substantially affects livelihood circumstances. Some potential effects of climate change on livelihood could be that people are starving or losing access to productive resources like land or water. Often, governments are not adequately supporting people to cope with these changes. In the context of adaptation policies, governments must guarantee that adaptation policies do not lead to violations of any human rights. Governments have to ensure that persons or groups affected by climate change are not overlooked and that they have access, without discrimination, to compensation measures offered by the government.

Another dimension of interlinkages existing between climate change and human rights is that in some countries, where impacts are severe, the effects can exacerbate internal conflict. Such conflicts include struggles over land use or access to scarce resources between pastoralists and farmers, or problems between large farms that might overuse scarce water resources and the surrounding smallholder farmers. Groups that start demanding their rights might be politically prosecuted or threatened. Such conflicts might lead, therefore, to violations of civil and political rights. Adaptation policies need to be able to deal with conflicting situations and conflicts of interests. Armed conflicts might also become sources or contributions to substantive clashes over access to natural resources. The Darfur conflict is often seen as a conflict driven, at least partially, by the

overall scarcity of access to natural resources across the entire region. A rights-based approach to adaptation policies can be helpful in discussing potential solutions for groups competing for the same resource base. Such access conflicts need to be overcome by focusing attention on the demands of the different groups involved.

Elements of a rights-based strategy

This study has focused on the impact of climate change on the enjoyment of human rights related to food security, particularly the right to adequate food, water, and health. What are the core elements of a rights-based strategy to adaptation policies that can be drawn from the results?

1. A human rights-based approach has to cover both sets of human rights: civil and political (CP-rights) and economic, social, and cultural rights (ESC-rights). While the ESC-rights are important for poverty-related problems, CP-rights are relevant for the overall approach. For example, CP-rights guarantee that each person is treated in a way acceptable to human rights standards for participation during political trials. The right to be informed, freedom of expression, the right to organize, transparency etc. are all important civil and political rights. Adaptation policies need to follow these procedural requirements. Every person has the right to be heard and to participate in the development of adaptation policy measures that might be decisive for his or her future.

2. Human rights create entitlements of persons vis-à-vis their government. These entitlements can be legally claimed, and are a good tool to use in holding governments accountable. Complaint procedures need to be accessible for everyone. They can materialize in different formats and should cover different legal qualities, from arbitration procedures to quasi judicial and judicial procedures. Human rights institutions, ombudsman systems, and judicial procedures must be open to complaints from everybody without discrimination. Special provisions for legal aid should be provided to effectively guarantee access to justice for extremely poor people. These are core conditions for the equal treatment of all people according to the law and for a comprehensive understanding of citizenship. These complaint procedures are normally accessible at the national level, but also exist at the international level. There are existing regional human rights instruments. For example systems are available in Europe, in the Inter-American Human Right System, and in Africa. And there are also international instruments for most of the core human right treaties, which can be used when the state is responsible for a violation, has ratified the specific optional protocols and all other criteria for adminissibility are met.

3. A rights-based framework better describes government obligations and develops criteria for designing and evaluating policy processes. A human rights-based framework requires governments to follow standards at all different levels of activities. For most of the ESC-rights, such a framework is laid out in the General Comments, which the Committee on ESC-rights has developed within the course of the last years. The General Comments No. 12-15 require governments to develop a national strategy for the implementation of each of the respective rights. The General Comment No. 12 on the right to adequate food was adopted at the 20th session of the CESCR in 1999, No. 13 on the right to education at the 21 session in 1999, No. 14 on the right to the highest attainable standard of health at the 22nd session in 2000. The three comment on specific rights of the covenant follow the same structure in describing state obligations and government action (UN 2001) In November 2002 the CESCR adopted additionally a General Comment No. 15 on the right to water that follow the same structure (see Windfuhr 2003).

(A) The strategies shall start with an analysis and identification of the victims of violations together with an assessment of the causes of the situation.

(B) Based on that, the governments shall check and improve their national legislative framework, modify or amend laws, and develop legislation where appropriate.

(C) Additionally, the governments should design an adequate policy framework for the implementation of

each right. The implementation should be guided by the following standards: The policies shall be implemented without discrimination towards improving equity, and the progressive realization of the rights shall be controlled by set benchmarks. The benchmarks can then be measured by indicators which will prove if they have been achieved or not. Governments are required to use the maximum amount of their available resources. The policy development process should prioritize the concept of vulnerable groups being addressed first.

While setting priorities, it is important to keep in mind the interdependence of the different rights. The indivisibility and interdependence of all rights mean that there should be no hierarchy in the different kinds of rights. Nevertheless, it cannot be denied that scarcity of resources and institutional constraints may require the setting of priorities. However, the implementation of the core obligation of all human rights must be simultaneously guaranteed and addressed. It is impossible to focus only on the implementation of some selected rights, such as the right to food, while neglecting others, like access to essential health care.

(D) This will only work if constant monitoring and assessment is done to guarantee that these standards are applied and that the rights are effectively implemented. Governments need to know if their policy decisions are effective and if they reach those groups they are supposed to reach.

(E) Finally, people need to have the right to complain, if they are overlooked or negatively affected by policy decisions.

These five elements of national strategy can be used in the formulation of national adaptation policies. The Voluntary Guidelines on the implementation of the right to adequate food, adopted by the FAO Members, encompass 19 guidelines that describe for each policy field, how governments can best design policies in order to support the implementation of the right to adequate food. A similar check list for the design of adaptation policies to climate change should be developed at the national level.

4. It is important to note that not all persons suffering from hunger are automatically victims of violations through government policies. Not all forms of hunger or malnutrition result from harmful government activities and therefore cannot be judged as violations. The impact of climate change might be so monumental in one country or region that the government will not have the means to adequately help all affected persons to adapt. Therefore, hunger, as a result of natural disasters cannot automatically be judged as a violation of the right to adequate food. A violation can only be identified when hunger is caused because of the government‘s failure to develop a minimum response system for disaster-preparedness, when the adaptation measures are not oriented towards the neediest, or when the government is not using the available resources. A rights-based approach requires a careful analysis of what can be considered a government responsibility and what cannot.

5. A rights-based assessment and framework must not only look into the obligations and responsibilities of national governments, but it should also assess the potential impact of governmental policy effects on persons living in another country. The Covenant on ESC-rights specifies in Art. 2.1. that „each state party to the present Covenant undertakes to take steps, individually and through international assistance and co-operation (...)“. The Committee has interpreted that paragraph by stating that states should not violate the rights of persons in other countries either directly through its own policy measures or indirectly through policy decisions of intergovernmental organizations in which they have influence. States should also check that national private actors working abroad do not contribute to human rights violations. Such extraterritorial negative impacts should be avoided. In the development debate, the issue is normally discussed as a „coherence problem“ that needs to be solved in order to create a more development friendly, international environment.

Although the issue of extraterritorial obligations is still new in the human rights discourse, yet it might be possible to agree that negative impacts from foreign policy effects should be avoided. The question becomes more difficult when positive support measures are reflected.

How much international assistance and support can countries, which are unable to fully implement rights in their own country, expect after having shown that they have completely exhausted their own means? What can they expect from donor countries? Are there legally binding entitlements to help them? These questions need to be answered with a resounding yes. Art. 2 of the Covenant on ESC-Rights emphasizes the obligation of international cooperation. The international community has the obligation to support those countries who cannot alone implement the rights of the covenant, although there is no specific amount mentioned.

Such international support is also required to poor countries in the implementation of national adaptation measures. This is a particularly important aspect of any adaptation regime, because poorer countries will suffer substantially from climate change and must cope with a high burden of adaptation needs. The UNFCCC contains the recognition that those countries which have historically caused most of global warming have first the obligation to reduce their emissions. The Kyoto Protocol is formulating binding reduction targets. The UNFCCC also recognizes the obligation to support poorer countries affected by climate change in helping with adaptation. As we have seen, the amount is currently not prescribed and the development of the adaptation fund came slowly, but the obligation is recognized. It is a first step to support countries which are unable to cover all costs for implementing adequate adaptation policies. Much more is needed in the envisaged post-2012 agreement.

6. Human rights are individual entitlements. They set limits on the restrictions and deprivations that individuals can permissibly bear, even when promoting noble social goals or overall development objectives like economic growth. Rights protect individuals, minorities, and other particularly marginalized groups from policies that may benefit society as a whole, yet place huge burdens on them individually. A human right asks for zero tolerance for violations. In the same way that it is not acceptable to tolerate slavery for economic growth, it is hard to explain why some people die from hunger for the benefit of higher societal goals. A rights based approach does not allow certain trade-offs which are possible in development-oriented thinking. Adaptation policies should be designed so that the price affected persons must pay is not too high. If infrastructure investments are needed, such as the construction of dikes or dams to better regulate river flow and people needs to be resettled, adequate compensation must be ensured and people should have the possibility to file complaints in courts. A rights-based framework requires that an assessment is done of how different policy choices will affect the prospects for the implementation of a certain right, and how the different choices affect different individuals and groups. This process must occur before choosing among different policy alternatives. It can also help governments set priorities in national budget decisions.

7. General achievements in human development are not always accompanied by achievements in human rights fulfillment. Certain development processes may go hand in hand with the deterioration of livelihoods and the human rights fulfillment for particularly vulnerable groups. The liberalization of agricultural markets may increase the economic opportunities of a society, while the number of hungry and malnourished among smallholder farmers, who do not profit from the same policy, may simultaneously increase. In some cases, this can occur on a dramatic scale. Impact studies done by the FAO show the divergent effects on the effect of trade liberalisation following start of the WTO Agreement on Agriculture in 1995 on agriculture in developing countries. Human rights create entitlements, and the language of claims can be of great importance to developmental processes, which often create conflicts over resources and social struggles. Arbitration and litigation can be important measures to regulate such conflicts.

8. A rights-based framework can be a helpful tool to complement climate change adaptation policies. It can help assess problems and analyze causes of the impacts of climate change. It can help to make decisions on modification of the policy design of adaptation policies to climate change, in order to avoid violations of the right to food. It allows individuals seeking remedies to discover whether policy measures will have negative

outcomes for them, or if they are negatively affected by the results of certain adaptation policy measures. Rights create entitlements; and a rights-based framework can be seen as an important tool to effectively demand policy changes from governments through legal means. A rights-based framework can therefore help to mobilize political will against corporate and other vested interest and bad governance. This approach has the potential to improve the quality of adaptation policies.

9. Developmental thinking helps to focus on long term development needs and processes, and takes into consideration the broader processes of societal change. The two frameworks (development-oriented, rights-based) should not be seen as being in conflict – even though some potential conflicts between the two models have already been addressed here – but as complementary tools. The human rights framework is a strong device because it defines minimum standards for state behavior. Development thinking helps to follow long term strategies and to take sustainability limitations into consideration.

10. In cases of failing states where a national rule of law no longer exists, people lose access to judicial procedures. They can no longer legally claim their rights, and direct accountability mechanisms will no longer work. These countries will have major difficulties in developing any kind of adaptation policy in reaction to experienced or expected impacts from climate change. Nevertheless, the basic human rights present an internationally recognized standard. Thus, a reference base can be constructed to check on lawless states. This structure can be a source of strength and orientation for people struggling against oppression in such conflicted countries. A universally recognized, binding framework with the human rights treaties already exists and can hold neglecting governments accountable for their actions with formal legal procedures at the international level.

11. There is an open discussion in international law about the following question: Can the „do no harm“ principle mentioned above regarding a rights based-approach to adaptation policies also be applied to mitigation-related aspects of climate change? Can the non-action of those countries contributing most to climate change be legally challenged? The arguments in favor pinpoint the fact that different scenarios for climate change will have dramatically different impacts on the right to food and other human rights for a huge number of people. The human rights accountability of polluting states needs to be carefully analyzed. One option for dealing with the situation would be to apply the Polluter Pays Principle (PPP). The PPP normally applies to concrete situations where both the pollutant and the victim are identifiable; yet the causal chains for climate change are much longer, and it is difficult to connect certain victims to certain polluters. However, it should be noted that the scientific evidence is striking so that a revised PPP could be developed. Both principles, the Polluter Pays Principle and the „do no harm“ principal should be utilized and further developed in international climate negotiations.

12. In conclusion, rights-based adaptation policies are one good tool to ensure that money earmarked for adaptation is spent reasonably. We suggest, that the Office of the High Commissioner for Human Rights, the FAO, and the UNFCCC develop a guideline, which helps governments to design adaptation policies accordingly.

11 Conclusion and recommendations: climate change, food security and human rights

1. Food security as it relates to climate change is an issue that had not been at the forefront of the climate change debate for many years. Several reasons contributed to this fact. (1) For a long time, climate models were not precise enough to forecast local or regional trends in weather patterns, precipitation etc., so it was difficult to describe trends in agriculture with a sufficient solid data based. (2) The IPCC did not even dedicate a chapter to food and other agricultural products in any of its first three assessment reports. The FAR's chapter on „Food, Fibre and Forest Products" was the first step in broaching this topic. (3) The CO_2 fertilizer effect was overestimated. The FAO had hoped for several years that global food production would be fostered by this fertilizer effect. At the same time, the climate change risks were underestimated in the area of food production. All in all, the perception has changed from one of optimism to a more realistic assessment of climate change risks.

2. This study is based on the assumption that a two dimensional response to climate change is necessary: avoiding the unmanageable and managing the unavoidable. Managing the unavoidable means mitigating the impact of climate change and avoiding dangerous climate change from happening. An emerging consensus among scientists states that global warming must be limited to a temperature increase well below 2°C compared to pre-industrial levels.

In order to reach that goal, industrialized countries need to take the lead in drastic emissions reductions. Globally a 50 to 85 percent reduction of emissions by 2050 is necessary and actual CO_2 emission should start to decrease, at the latest, by 2015. Managing the unavoidable means that sound adaptation policies are needed to deal with the inevitable consequences of climate change, some of which are already visible and immense. While this study focuses on the adaptation needs particularly related to food security and the realization of the right to adequate food, the authors nevertheless are aware that unmitigated climate change easily might overwhelm adaptation capacity in many parts of the world.

3. The impact of climate change on food security will be substantive. The local and regional assessments of impact will become better known, when more detailed studies are available. So far, the debate has been biased towards global food security concerns, i.e. the global balance of how much and where food can be produced. However, it is of utmost importance that household effects are taken into consideration when predicting the impacts on hunger and malnutrition. Climate change will impact people and groups already vulnerable to food insecurity, but new groups will also be affected by climate change. The main driver for climate change is increasing surface temperatures, which in turn influence most other factors contributing to changing climate conditions such as precipitation, water availability, and weather extremes.

4. At the same time, agriculture is one of the main sources of carbon emissions. The agricultural sector contributes to over 30 percent of current annual total emissions. Agriculture itself provides 13.5 percent, and deforestation supplies 17.4 percent of global total emissions. Adaptation and mitigation measures should therefore go hand in hand in the agricultural sector. Techniques are available to reduce emissions. Examples like engaging in conservation agriculture or reducing emissions of methane and nitrous oxide from livestock production and are available and summarized in chapter 4.7.

5. Adaptation to the adverse impacts of climate change has long been neglected as a development issue by both governmental and nongovernmental organisations. Adaptation measures were not at the centre of climate negotiations in the first few years. They were often seen as a road to distract attention from the most difficult and politically controversial task of reducing emissions, particularly in countries that have contributed most to climate change. Since then, it has become clear that the additional benefits of adaptation will be monumental and that early action is cheaper than a post-disaster re-

sponse, even though there are still many uncertainties in existing adaptation cost estimates.

6. Adaptation requires substantive investment in infrastructure such as dams, flood-resistant storage facilities, and techniques for reducing water loss in distribution systems etc. It requires monitoring weather extremes and developing disaster preparation strategies. Higher prices for energy, agricultural inputs, water, and food imports must be expected. And capacity building in communities particularly at risk, in national, regional, and local administrations etc. is of utmost importance and will require resources. Due to these impacts and the resources required to adapt to them, resources that would have otherwise been available to realize the Millennium Development Goals (MDGs) might be diverted to adaptation measures. The realization of the MDGs might further be influenced by the direct impact of climate change on food, water, and health.

> *„How the world deals with climate change today will have a direct bearing on the human development prospects of a large section of humanity" (UNDP 2007, 8).*

The recent rounds of climate negotiations after Bali – in March/April 2008 in Bangkok and in June 2008 in Bonn – have shown that the costs of adaptation and the present under-funding by the perpetuators of climate change remain a key contentious issue. This is true despite the goodwill of many developing and some developed countries to work jointly on developing a new climate regime. Most developing countries hardly contribute to the emissions which cause climate change, and often they see domestic emissions reductions as a hindrance to development. If development rights are taken seriously, industrialized countries must invest in mitigation and reduce emissions even more substantially. They will also have to finance and support deployment mechanisms for mitigation and adaptation technologies and make these technologies widely available. At the same time, developing countries need to realize that climate change is a development issue, and thus this challenge has to be integrated into development policies and planning. For example South Africa is the first rapidly developing country, which accepts that emissions have to peak also in their own country between 2020 and 2035.

7. A clear recommendation from this study is that a reliable financial-based mechanism must be created within the UN-climate negotiations if the unavoidable is to be managed. Substantial additional financial resources are needed to cope with the expected adaptation needs for developing countries. However, more aid does not necessarily mean that more funds will reach the most vulnerable groups. This is one reason why the UNFCCC negotiations must discuss which frameworks can incentivize adaptation. Adaptation measures need to be properly designed and focus on particularly vulnerable groups. The rights-based framework is one very promising option to help measure progress, review government activities, and to generate resources.

11.1 Climate change, vulnerabilities, and groups at risk

8. The concept of „food security" is a key concept in the United Nations to measure the food and nutrition situation of people and groups. The latest standard definition used in the FAO (2007b, 6) is:

> *„food security exists when all people at all times have physical or economic access to sufficient, safe, and nutritious food to meet their dietary needs and food preferences for an active and healthy life. To achieve food security, all four of its components must be adequate. These are: availability, stability, accessibility, and utilization."*

Additionally, food security depends on a variety of underlying determinants; food must be nutritious and safe. The body must be in a condition to consume food without becoming ill. UNICEF and other nutritionists emphasize the fact that half of the children dying from hunger are not dying because of missing food supply, but rather because they cannot digest nutrients due to sickness, e.g. diarrhea (Eide 2004). This study utilizes

the differentiation of three levels of food security to describe those groups that are vulnerable to the effects of climate change.

(1) Food security on a global scale: Which is the level to analyze overall trends and to understand which effects climate change might have on agricultural production, fishery production, and livestock production at the global level. This is important because these trends will translate into agricultural prices and will influence decisions of producers worldwide.

(2) Food security on a national level: This level of analysis is equally as important, because the national level is where most agricultural policy decisions are made. It will be decided here if food security concerns are covered by imports and how much financial resources are made available for national agricultural policies. Central elements of adaptation policies will be defined at the national level.

(3) Food security on a household level: Without a detailed look at the impacts at the household level, the analysis would lack an understanding of the difficulties and specific necessities each person faces in regard to food security. This knowledge is crucial in designing adequate adaptation policies that support those groups, particularly marginal producers and vulnerable consumers, which are most likely to become food insecure. All three levels of the food security definition have been taken into consideration in the present study.

9. Around 80 percent of the hungry live in rural areas; half of them are smallholder peasants, 22 percent are landless laborers, and 8 percent are hunter-gatherers, fishers, and pastoralists. This situation is expected to persist. While the urban poor are the fastest growing group of food insecure people, more the 50 percent of the hungry are still projected to live in rural areas in 2050. The majority of these groups live on extremely marginal conditions. They often live in remote geographical locations, in ecological vulnerable areas, or on slopes or drought-prone areas/rainforest etc. They have difficulties accessing means of transport, such as roads, and thus access to markets where they can sell their goods. Most have limited or no adequate access to extension services, credits, or insurance mechanisms. Absence of land reform forces poor and marginal farming households to use land highly exposed to catastrophes like floods or droughts. Usually, they are also politically marginalized, without an important voice in local or national politics.

10. In order to deal adequately with the impact of climate change on food security, work has to start with a good analysis of those groups which are already particularly marginal today. They will often be the most affected by climate change, and they have very limited coping capacities. Given the crucial role of marginalization in the food security debate, it is clear that agricultural and food production problems cannot be tackled at the technical level. The situation of the rural poor has been aggravated by the fact that rural areas were neglected in regional, national, and international policy making. For a long time, the policy focus was on investments in industry and urban infrastructure, causing budget allocations for rural areas to be reduced substantially – often by more than 50 percent. The same happened with bi- and multilateral aid budgets.

11. A recent FAO/OECD study highlighted that prices should decline from their recent peak, yet they will remain above the average of the past decade (OECD/FAO 2008). The study summarized all of the factors that are contributing to a long term scenario where increasing demand goes hand in hand with limits in food producing resources – particularly soils and water. While this scenario does not necessarily lead to scarcity of food in the coming years, it is an indication that prices for agricultural produce will not decrease to the levels that prevailed during the last decades. There is a continued rise in fertilizer prices and energy costs, which are major input factors, for farmers. Climate change will affect several factors which influence the supply side. Governments have to deal with this challenge when designing policies to adapt to climate change and implementing the right to adequate food.

12. In this study the term food security is compared with the concepts of the right to adequate food and food

sovereignty. While food security describes a goal; the right to adequate food obliges governments to qualitatively respond to the problem of hunger and malnutrition. Food security therefore describes the outcome of the realization of the right to adequate food. The implementation of the right to adequate food is guided by specific government obligations. A human rights-based monitoring system has the specific focus on analyzing whether governments are implementing their specific human rights obligations. It measures the outcomes regarding questions whether government policies constitute an adequate answer to the human rights obligations. It is a platform to analyze whether governments use their respective resources adequately and most reasonably to fully guarantee these rights. Food security monitoring looks at how many and to what degree people are malnourished. A third term gaining prominence within debates of civil society organisations dealing with issues such as hunger, malnutrition, and rural development is food sovereignty. Food sovereignty is a political concept primarily developed in the context of La Via Campesina, a global small farmers' movement. In March 2007, Via Campesina coordinated an international gathering of civil society in Mali, which was prepared by the umbrella organization of small farmers in West Africa, ROPPA, and other civil society organisations. The outcome was a common statement that describes the ideas behind the concept of food sovereignty quite well (see Nyeleni-Declaration 2007). Food sovereignty has been developed as a concept by social movements and farmers organisations to protest the neglect of rural areas and rural development in national and international policies.

13. Agriculture, forestry, and fisheries are all sensitive to climatic conditions. Climate change will have direct impacts on these three sectors, including their productivity. In turn, this will affect the income of vulnerable groups that depend on resources and products derived from these sectors. The scale of the direct adverse and positive effects varies with specific geographical situation. However, macro-level projections are not sufficient to identify the most vulnerable groups within regions or countries. This requires further efforts. Vulnerability assessments on the national and community levels are crucial for developing adequate responses to food insecurity in the face of climate change. The vulnerability-specific information, which primarily looks at the internal constitution of a region or a community with regard to non-climate stressors, is the necessary first step. It then must be connected to climate-related factors, for example the likeliness of extreme weather events, changing precipitation trends etc. This will result in general assessments of vulnerability to climate change, but may also – and this would be appropriate in the context of this study – be translated into sector-specific climate change risk, for example with regard to food security. Climate change will therefore impact groups which have been always at the risk of food insecurity, but it will also affect new groups who become vulnerable do to changing weather conditions in their region. Many vulnerable groups are already „experts" in risk management, but their ability to adapt to climate change is often restricted because of their extremely limited coping capacities.

14. A person or a family is vulnerable due to their livelihood situation and their factor endowment. The question of whether a vulnerable situation translates into persistence of or to additional hunger or malnutrition is dependent on the form of the government response. A given (insufficient) factor endowment of families is already partially a result of government policy. This study therefore recommends using the right to adequate food in the design of adaptation policies. Increasing the accountability of governments will also help to guide the implementation of effective adaptation policies.

11.2 Relevant trends in climate change

15. The impacts of climate change on food security will be substantive and will be found in all components of the global, national, and local food systems. The FAR Working Group II summarized some major trends which show that many natural systems are affected by similar processes of climate change, particularly those related to temperature increase (IPCC 2007b).

(1) There is a high confidence that natural systems are affected on all continents by changes in snow, ice, and

frozen ground, including permafrost. This conclusion includes the enlargement and increase of glacial lakes, increasing ground instability in permafrost regions, rock avalanches in mountain areas, as well as substantial changes in Arctic and Antarctic ecosystems.

(2) In regard to hydrological systems, there is high confidence, that many glacier- and snow-fed-rivers will experience increased run-off and earlier spring peak discharge. A warming of lakes and rivers in many regions is projected.

(3) There is also high confidence that recent warming is strongly affecting terrestrial biological systems, with effects such as earlier timing of spring events, leaf-unfolding, bird migration, and egg-laying. Earlier greening of vegetation in the spring is also supported by satellite observation studies which show that trend occurring since the early 1980s. Longer thermal growing seasons due to recent warming is also related to this observation.

(4) Substantive new studies have shown that rising water temperatures will impact marine and freshwater biological systems. It will lead to range changes and earlier migrations of fish in rivers, and it will contribute to shifts in ranges and changes in algal, plankton and fish abundance in high-latitude oceans and high-altitude lakes.

16. This study has described the major effects climate change will have on food security through the increase of variability of weather patterns, particularly the expected increase in extreme weather events. The impact of climate change on food production and agriculture, forests, fisheries, pasture and livestock production, water resources, and health and nutrition has been shown and can be summarized in the following way: Countries and groups of countries will be hit differently. Many studies indicate that

> *„the impacts of climate change will fall disproportionately upon developing countries and the poor persons within all countries, and thereby exacerbate inequities in health status and access to adequate food, clean water, and other resources. Populations in developing countries are generally exposed to relatively high risks of adverse impacts from climate change“ (IPCC 2001, 12).*

India, for example, is projected to experience significant losses, with large areas of current cropland losing significant productivity. It is anticipated that this will lead to higher levels of food insecurity in many vulnerable, developing countries. They will need support to cope and finance the necessary adaptation measures. Developed countries will not be immune from large effects of climate change on their agricultural sectors.

17. The impact of climate change will be particularly substantial to smallholder and subsistence agriculture. Their livelihood systems, particularly in low latitudes, will be affected by major changes due to climate change. The farming system will be affected by the previously described changes in temperature, elevation of CO_2, precipitation on yields of both food and cash crops. The productivity of livestock and fisheries systems will also be affected, as well as potential income gained from collecting activities in forests.

18. Climate zones will be forced upwards or pole-wards. Linear trends can go hand in hand with the quickly growing possibility of non-linear – and potentially catastrophic – changes. The relationship between global climate and the earth system is a complex one, particularly due to the fact that climate and non climate drivers are interrelated. Additionally, non-linear processes include several feedback loops, and these loops are very difficult to predict.

The history of the earth shows that non-linear processes have happened quite often, particularly in the Holocene epoch. Ocean streams have frequently stalled abruptly, ice shields have suddenly melted, or monsoons have unexpectedly collapsed. Often small disruptions are sufficient to entail fundamental changes. Simulations based on the knowledge of abrupt climate change in the past and the scientific school of analyzing highly complex processes that was established in the 1970s support the finding that our climate and the earth system might re-

act to the increasing temperature from anthropogenic climate change with enormous magnitude. The study describes some of the latest research on such tipping points.

19. A recommendation from the impact analysis of this study concludes that specific family situations need to be studied, because livelihood systems are typically complex and include a number of interfering factors. For example, several crops and livestock species are involved in intercropping systems, and many smallholder livelihoods are comprised of a variety of income sources such as the use of wild resources from forests, remittances, and other non agricultural income strategies. Government support can also play a role, but so far many of the smallholder farmers are faced with a marginalization process in national and international agricultural policies. Therefore, support is often unavailable or insufficient. Effective adaptation policies should start here and support coping and adaptation strategies of poorer groups in rural and urban environments. Coping strategies are characterized by changes in the relative importance between different income opportunities, and they will vary with the factors influencing the income situation of families. Adaptation can be much better managed if good government support and responses are developed and implemented.

11.3 Response capacities to climate change – nationally and internationally

20. The dimension of the problems linked to adaptation to climate change will be huge for developing countries. The IPCC report shows that poorer countries will be relatively more affected by the impact of climate change. Their limited capacities to react are one important reason for this particular affectedness. Adaptation policies cover a variety of interventions[31] starting from the ability to predict changing weather conditions, particularly extreme weather events, to infrastructural investments in methods and techniques of disaster management such as dams or other mechanisms of flood control. They cover changes in the use of agricultural crops and varieties, irrigation, and land use techniques to support affected families in coping with the need to migrate or to cover the cost of other forms of damage to the house or the land of the family. It is also important to differentiate adaptation policies at the different levels and define what can be done at the household level, locally, by national governments, or with international support.

21. Analytically, the IPCC further differentiates between two categories of adaptations:

> *„autonomous adaptation, which is the ongoing implementation of existing knowledge and technology in response to the changes in climate experienced, and planned adaptation, which is the increase in adaptive capacity by mobilizing institutions and policies to establish or strengthen conditions favorable for effective adaptation and investment in new technologies and infrastructure“ (Easterling et al. 2007, 294).*

The advantage of this IPCC differentiation is that it looks into the coping strategies and capacities available locally to adjust to the changing circumstances without any government interference. This perspective helps to also identify the need for planned interventions as the available coping capacities might be very limited.

22. While some action needs to be implemented urgently in order to adapt to the short term consequences of climate change, adaptation must be viewed as a long term challenge for societies. „Mainstreaming“, or the integration of this challenge into sectoral and other policies and programs at different levels of decision making, will be necessary, and it requires a prominent role in the reduction of vulnerability from climate change. Ecosystem management plans that allow a multi-sectoral response in dealing with whole livelihood systems are needed in addition to sectoral responses. At the same time, adaptation policies must address negative effects on the most

[31] A detailed overview about adaptation measures for key vulnerable sectors are shown in chapter 4.3 .

vulnerable groups in order to avoid hardship for groups most affected by climate change. Adaptation must also include correcting mal-adaptations – for instance, by no longer providing flood insurance that encourage risky development in flood zones. This study summarizes the instruments available for response capacities at all levels. It also presents adaptation measures in key vulnerable sectors which developed countries highlighted in their national communications to the UNFCCC. This study recommends that adaptation policies must be closely monitored in order to guarantee that resources are spent meaningfully.

23. Improved response capacity needs to include better climate information systems. On the one hand, developing countries need assistance in generating and processing relevant data. On the other hand, the available data needs to be distributed within the country. All groups potentially affected by climate change need to have access to relevant climate information.

This study has summarized the recent discussion about the scope and relevance of private or private/public insurance instruments for adaptation to climate change. Experience so far has been too limited to determine with certainty if internationally backed public/private insurance systems are viable in the long haul. But there are very promising examples, that show the potential of this instrument for effective disaster aid and for setting incentives to support adaptation to climate change. Despite the promise of these new initiatives, insurance still reaches only a small fraction of vulnerable communities and governments.

24. Weather risks destabilize households and countries and create food insecurity. As a case in point, floods, cyclones, and droughts have been a major cause of hunger affecting more than 30 million persons since 2000 in the Southern African Development Community (SADC). Governments and donors only react to these shocks rather than proactively managing the risks. These emergency reactions have been criticized for being ad hoc and, at times, untimely. They are even credited with destabilizing local food markets. Similarly, many highly-exposed developing country governments do not have the means to finance the recovery costs of catastrophic disasters. These administrations could greatly benefit from adequate insurance contracts, co-financed by polluters. Least-developed countries can hardly afford the technical analyses and other start-up costs for insurance systems. Scaling up will prove costly, especially since disaster risks, unlike health or accident, affect whole regions simultaneously and thus require spatial diversification, reinsurance and/or large capital reserves. Thus, it is very important that risk management mechanisms – including innovative insurance mechanisms – play a role in the UNFCCC negotiations.

11.4 Response capacity at the local and community level

25. The literature on local and community-based adaptation policies is increasing, and several studies are available which provide a good overview of policy options for adaptation at the local level. One example is a case study carried out in Bangladesh. It has developed a useful typology to describe different policy measures and policy areas that need to be involved in local adaptation measures to climate change (FAO and ADPC 2006, 66f). The authors of that study show that successful local adaptation to climate variability and change is not an easy task. Rather, it requires multiple pathways with well planned and interrelated short- and long-term measures. The task ahead in designing meaningful adaptation policies at local levels is the need to find the right combination of these factors. This should give answers to the expected changes in the „geo-physical settings“ as well as the necessary adjustments in the „livelihood systems“.

26. To sum it up, adaptation policies need to be embedded appropriately in the local context and should be oriented towards the most vulnerable groups. One of the strengths of using a rights-based approach in the design of adaptation policies is that it helps to set up procedural guarantees for the affected communities and people for participation. This included having access to relevant information (transparency) and the right to complain. The second strength is that a rights-based ap-

proach requests a specific outcome. Governments have to prove that their policy and budget decisions are focused toward the most vulnerable groups and that no group is overlooked. Governments must prove that their own adaptation policies do no harm, i.e. deprive people of access to food or water. Therefore, it is very sensitive and meaningful to target those in most need when approaching adaptation policies, as many studies demand.

11.5 Response capacity at the international level

27. In discussing global food security and the response capacity of international aid and intergovernmental organisations, this study concludes that the availability of food is not an indicator explaining why people are hungry. The overall availability of food is dependent on many factors, including agricultural research and productivity. This chapter has shown that it is not only important to look into the high potential areas of production, because their relative advantage might suffer from climate change (less water, flooded fertile coastal zones affected by salt water intrusion etc.).

Productivity gains will be best achieved when smallholder farmers get more support and incentives to produce. Support must be directed at them in order to ensure that they can use it (linked with micro-credits and training etc). If this support is simultaneously directed to help them to adapt to climate change or cope with the consequences, then adaptation policies are becoming more oriented towards an integrated approach that includes poverty concerns. At the same time, smallholder farmers are still the biggest single group of hungry persons worldwide. If their income can be raised, the hunger situation will become better.

28. Development cooperation can play a crucial role in all stages of the adaptation policies. Different aid actors can play different roles in development aid. Bi- and multilateral aid can help integrate adaptation into policy development. Capacity must be built at all stages of the adaptation process in developing countries, from disaster preparedness and early warning to insurance schemes and policy design issues. Other stakeholders, such the scientific community and NGOs, should be integrated into adaptation planning. Each of these institutions can help to best design adaptation policies. Aid organisations are often those who are more in touch with other institutions than most vulnerable groups. They can help by using their experience in project management and implementation and also by mobilizing internationally available knowledge.

11.6 Climate change and development

29. Climate change will have an impact on the economy as a whole. The cost of importing food to low income, food deficit countries might increase substantially. Larger scale losses of fertile land will lead to sizable changes in the national economic structure. It will also influence the income governments receive, which will be one of the important sources to finance adaptation policies. Public budgets will not only face a potential decrease in income, but also potentially an increase in public expenditure for things like food and water supply. Public budgets could also be largely affected by the costs for financing infrastructure to cope with climate change, such as dam constructions etc.

The spread of additional diseases might create extra costs. As a result, less money might be available for the regular implementation of the MDGs. Money for adaptation – both internationally and nationally – should not come from the overall development budget. Otherwise, funding might shift from long term development investments to more short term adjustment projects to climate change.

30. The increasing environmental scarcity of resources in some regions might be one important factor triggering conflicts. The example of Darfur shows that the ongoing depletion and overuse of resources can become at least one of the reasons for conflict. Such situations, both environmentally-induced conflicts and existing conflicts that could be aggravated by climate change, will increase the number of refugees and cause migra-

tion. Migrants and internally displaced persons (IDP) are becoming one of the most vulnerable groups potentially affected by climate change, and they are without many coping capacities to deal with the new situation.

31. The financing of adaptation measures will need adequate international support. This study discusses current adaptation instruments, such as the National Action Plans for Adaptation that already exist under the UNFCCC. It also shows both the benefits and weaknesses of the new Adaptation Fund, a new instrument under the Kyoto Protocol. The governance structure has been finally agreed on in Bali in December 2007.

A key element under the UNFCCC to advance the understanding and practical approaches in assessing adaptation costs and benefits is the Nairobi Work Program on Impacts, Adaptation, and Vulnerability (NWP). The NWP has the main objective of helping all countries improve their understanding of the impacts of climate change and to make informed decisions on practical adaptation actions and measures. Thus, it is a good example of cooperative action and sharing of experiences among Annex-I and Non-Annex-I Parties. Many governments have stressed the need that further work on the NWP should contribute to the new considerations under the Bali Action Plan. Improved cost assessments will also be important for the work of the Adaptation Fund Board.

32. The Adaptation Fund (AF) is one of the most innovative funding instruments, and it is not fed by voluntary contributions but by a levy – actually the first international envirnonmental levy – on emissions reductions issued under the Clean Development Mechanism. The present forecasts of the resources that will flow into the AF will probably be much larger than the voluntary contributions to the Convention Funds.

However, it will still be insufficient to cover the needs. After Parties agreed upon the governance structure of the Adaptation Fund, with a non-Annex-I – synonymic for the developing countries – majority in the Adaptation Fund Board, it now has to work cut out for it in fully instituting the Adaptation Fund (AF).

It is important to note that the AF can not only finance projects, but also programs and activities. The Adaptation Fund has the potential to successfully demonstrate that effective international financing mechanisms with direct access for developing countries and independent from the conventional donor-recipient structures are possible. The better the AF serves the goal of advancing adaptation in developing countries, the better it is suited to play a key role in future adaptation financing beyond 2012. When developing its guidelines, it should address how to monitor project and program implementation to ensure effective disbursement of resources, and, more importantly, how to ensure that particularly vulnerable communities are prioritized target groups.

33. Once the large scale resources are generated, it remains to be decided whether one operating entity will strategically manage these funds, or if management will be disbursed among different sub-entities who have particular expertise in certain fields etc. Part of this strategic management must be assisting the implementation of frameworks based on incentives for adaptation within countries. The share of public investments may be higher in developing countries than in developed ones – and thus will be the share of adaptation costs. Nevertheless many actions relevant for adaptation are being undertaken by private actors (OECD 2008a). But this will in practice only work, especially for vulnerable groups, if governments create enabling environments as well as incentive structures and support those who can not afford private sector solutions.

11.7 Regional perspectives for climate change and food security (Africa, Asia, Latin America)

34. The chapter about regional effects of climate change on food security gives short summaries of more detailed regional studies, which were written in parallel to the main study. The chapters on Africa and Asia start with an overview of the research results about the effects of climate change on food production, agriculture and water availability. This is followed by an identification of key affected vulnerable groups and a discussion of the

available response capacity of governments and local actors in the regions.The Latin American study has not yet been available. So in chapter 12 we will give a short summary based on the newest IPCC results regarding Latin America.

11.7.1 Africa

35. In summarizing the Africa-related conclusions of the FAR, it becomes obvious that climate change has the potential to compromise the ability of many African societies to achieve the different Millennium Development Goals (MDGs) and to improve food security. The IPCC expects that the area suitable for agriculture and the length of growing seasons and yield potential, particularly along the margins of semi-arid and arid areas, will decrease. The yields from rain-fed agriculture are expected to decrease by up to 50 percent in some countries already by 2020 (IPCC 2007b, 13).

Also, the number of people under increased water stress will significantly increase from 75 to 250 million people in the next 15 years with a further increase until 2050. While the consequences of 2020 will be independent of the results of a worldwide mitigation strategy the consequences for the water situation in 2050 and even more 2100 will be largely determined by it. This will primarily take place in Southern and Northern Africa.

In addition, local food supplies are projected to be negatively affected by decreasing fisheries resources in large lakes. This result is due to rising water temperatures, which may be exacerbated by continued over-fishing. Lake Victoria, for example, represents an important food source for 30 million people in danger.

36. However, Boko et al. (2007, 457) also note that

> *„the contribution of climate to food insecurity in Africa is still not fully understood, particularly the role of other multiple stresses that enhance impacts of droughts and floods and possible future climate change. While drought may affect production in some years, climate variability alone does not explain the limits of food production in Africa. Better models and methods to improve understanding of multiple stresses, particularly at a range of scales, e.g., global, regional and local, and including the role of climate change and variability, are therefore required".*

37. In addition to the direct impacts of climate change on food security and the MDGs, recent research pays increasing attention to the role water scarcity or reduced food availability play in the emergence of conflicts, often through increased competition for scarce resources. These may further aggravate the livelihoods of people. Climate change already represents an important cause for existing conflicts, as several experts have concluded for the Darfur conflict, where a long-term decline in rainfall significantly contributed to the scarcity of available fresh water (Ban-Ki Moon 2007). In the southern part of Africa, climate change is expected to further weaken the agricultural potentials of countries belonging to the poorest societies in the world. This would worsen the state of human security and strain the governments' capabilities.

38. The most vulnerable groups include smallholder farmers who rely on rain-fed agriculture, pastoralists, and the fishing communities. Communities across the continent have developed ways of dealing with impacts of climate related events over time. Drought and floods are not new to many communities in Africa. However, the increasing frequency and intensity of these events are rendering some of the strategies that have served communities well in the past inadequate.

For farmers, mixed cropping served as insurance against total crop failure; rotational cropping allowed for the rejuvenation of soils sustaining production at reasonable levels. Pastoralists migrated to better areas in times of drought, traded animals for cereals and other products from neighboring communities, and kept animals with friends and relatives elsewhere as a form of insurance. With the rapid changes in climate in the recent past, some of the strategies are no longer viable, others might become ineffective in a quickly further changing climate. And there is evidence of erosion of coping and adaptive

strategies as a result of varying land-use changes and socio-political and cultural stresses.

39. Until recently, climate change adaptation hardly played a role in African politics. An analysis undertaken in 2007 on existing Poverty Reduction Strategy Papers showed that both adaptation and climate change were hardly mentioned (Harmeling, Burck and Bals 2007). However, at that time, the available PRSPs were some years old, and now the picture is changing. Adaptation has gained a lot of policy profile in the last two years, as can be seen in the Addis Abeba Declaration on Climate Change and Development in Africa, which was adopted by the African Union in 2007 (AU 2007), or the Joint Africa-EU Strategy (Africa-EU 2007). The NAPA process has helped governments to understand the challenge of adaptation, although it is only a first step.

40. The institutional capacity including that of political institutions is a key issue in developing comprehensive adaptation strategies. Recognizing that the needs for adaptation might exceed their abilities in terms of knowledge and resources, it is important that a combination of approaches, both technical and political, are used to ensure that the potential negative impacts are minimized.

This is especially true with regard to their assets and production systems. The focus should be on preventing impacts as much as possible rather than reacting to what has happened. Hence, this study recommends five guidelines.

(1) Awareness creation at all levels as a first step in sensitizing the global community and local communities on need to tackle climate change.

(2) The need to promote mitigation activities even in developing countries because the best way to adapt in future is to minimize the impacts.

(3) Everywhere, but especially for poor countries, adaptation must be implemented and strengthened as much as possible to avoid loss of assets and means of livelihood. Based on the UNFCCC principles of common but differentiated responsibility and respective capability, developed countries have a moral and legal obligation to support poor countries in the process.

(4) Reform the WTO and other trade regimes to ensure that it does not hinder vulnerable groups from being protected.

(5) There is need for coordination of efforts at the different levels (local, national, international) to ensure that limited resources are used optimally.

11.7.2 Asia

41. In Asia, an increasing trend towards a warmer surface air temperature has been observed during recent decades ranging between less than 1°C to 3°C per century. Moreover, a 2.0 to 4.5°C net global average surface warming is expected by the end of the present century (2090-2099). All of Asia will very likely have problems with this warming trend during this century (Christensen et al. 2007). Increases in the amount of precipitation are very likely in high-latitudes, while decreases are likely in most subtropical land regions, continuing observed patterns in recent trends (Christensen et al. 2007).

Glaciers in Central Asia, Western Mongolia, North-West China, and the Tibetan Plateau are reportedly melting faster in recent years than ever before (Pu et al. 2004). Consequently, glacial runoff and the frequency of glacial lake outbursts causing mudflows and avalanches have increased (Bhadra 2002; Rai 2005). Changes have also been observed in extreme climate events like frequent occurrence of more intense rainfall, increasing frequency and intensity of floods, drought, and tropical cyclones. Regions of Asia such as South Asia, East Asia, and South-East Asia will experience an increase in occurrence of extreme weather events (Cruz et al. 2007).

Based on regional HadRM2 simulations, Unnikrishnan et al. (2006) expect with rising greenhouse gases an increasing trend in the frequency as well as intensities of tropical cyclones by the 2050s in the Bay of Bengal. This

would cause more heavy precipitation in the surrounding coastal regions of South Asia during both southwest and northeast monsoon seasons. Furthermore, a general warming of 2 to 4°C in Sea Surface Temperature (SST) is projected to increase tropical cyclone intensities by 10 to 20 percent in East Asia, South-East Asia, and South Asia (Knutson and Tuleya 2004).

42. The FAR of the IPCC projects an increased risk of hunger in South Asia due to a 30 percent decline in cereal yields. That might cause the effect that 266 million Asians may face the risk of hunger in 2080. A decline of the net productivity of grassland and milk yields is predicted. The agricultural water demand will increase between 6 and 10 percent per 1°C rise in temperature. The water system might be strongly affected. Overall, there a decline in water availability is expected. Close to 1 billion people will be affected by that reduction in India and South Asia. The melting of the Himalaya Glaciers will change the pattern of river runoff in the region. In coastal areas, the water quality might suffer from the intrusion of salt water, which might then also affect fish larvae abundance. Bangladesh (3), Vietnam (4) and India (7) are 10 of the most affected countries by extreme weather effects in the decadal Climate Risk Index (CRI) for 1997-2006 (Harmeling 2007).

In the future, food scarcity projections for South and South-East Asia are highly vulnerable with high confidence, while East Asia is highly vulnerable with a very high degree of confidence (Cruz et al. 2007). The densely populated mega deltas of Asia and relevant megacities (e.g. Bangkok, Shanghai, Tianjin), are vulnerable to both direct effects of climate change and sea-level rise (Cruz et al. 2007). 2,500 km^2 of mangroves in Asia are likely to be lost with 1 meter of sea-level rise. Approximately 1,000 km^2 of cultivated land and sea product culturing area in Bangladesh are likely to become salt marsh (Cruz et al. 2007).

43. 37 countries, 10 of which are in Asia, are currently facing food crises and require external assistance (FAO 2008a). Those countries lack of ability to deal with critical problems of food security due to an exceptional shortfall in food production (Iraq), widespread lack of access (Afghanistan and Korea DPR), or severe localized food insecurity (Bangladesh, China, Indonesia, Nepal, Sri Lanka, Timore-Leste and Vietnam). Except in conflict prone Afghanistan, Iraq and Sri Lanka, natural catastrophes have played the most decisive role in undermining their food security. Recent high global cereals price have also generated widespread increases in domestic food prices of the Asian LFDC's. (FAO 2008a).

44. Reflecting knowledge on projected impacts of climate change on different sectors would allow to the identification of likely priority actions on adaptation from a top-down perspective. Initiated and supported by the UNFCCC process, LDCs in Asia and elsewhere have started or even finished elaborating on National Adaptation Programs of Action (NAPAs). The guidelines agreed upon under the UNFCCC specifically underline the objective to identify and address the most urgent adaptation needs and priority projects. In principle, these should be developed in a participatory process (UNFCCC 2001). However, these guidelines are much less concrete than the procedural elements from the FAO voluntary guidelines on the implementation of the right to adequate food as introduced above. Nevertheless, these NAPAs serve as the best and most recent starting point when looking at adaptation priorities. They also provide reference when assessing likely costs of adaptation, although it has to be repeated that they only concern the most urgent adaptation needs.

45. There are a number of barriers which still need to be removed to allow for better and faster increases in adaptive capacity. The prevailing level of poverty can be judged as the largest barrier to developing the capacity to cope and adapt. The poor usually have a very low adaptive capacity due to their limited access to information, technology, and other capital assets which make them highly vulnerable to climate change (Cruz et al. 2007). Adaptive capacity in countries where there is a high incidence of poverty will likely remain limited. Furthermore, Cruz et al. (2007, 492 conclude that

> *„insufficient information and knowledge on the impacts of climate change and responses of natural systems to climate change will likely*

continue to hinder effective adaptation particularly in Asia".

46. Easterling et al. (2007) infer with high confidence that smallholder and subsistence farmers, pastoralists, and artisanal fisher folk will suffer complex, localized impacts of climate change. Climate change may affect the poor through changes or depletion in common property resources, such as fisheries, rangelands, or forests, which they depend on for their livelihoods. Successful adaptation strategies have find strategies to support marginalized people most vulnerable to the impact of climate change. They are marginalized through all forms of discrimination i.e. by geographic, social, production specific, political, and gender processes.

47. The following recommendations for the situations in Asia are championed by this study.

(1) Most vulnerable countries like Bangladesh must develop policy coherence in the struggle to adapt to and fight against climate change. Therefore it is necessary to link climate change policy with all development sectors and sub-sectors (e.g. land, food, agriculture, trade, energy etc.) under a comprehensive National Climate Change Policy.

(2) Effective global mechanisms should be developed to ensure funds and incentive structures under the UN for climate-coping initiatives by poor countries.

(3) Global food production should be increased by using suitable technology, and potential agricultural lands should support smallholders and help them to increase their productivity.

(4) Vulnerable people should be empowered and enabled to adapt to climate change by building resilience through investments in social protection, health, education, insurance and other measures.

(5) In countries experiencing potential food deficits under climate change, local policy such as establishing social safety nets and associated programs aimed at the creation of access to food should be given priority. Propoor agricultural development should be given a very high priority.

(6) Food deficit countries should establish mechanisms, either individually or collectively, with neighboring countries to form an emergency food bank, which may be mobilized in case food is not available from international sources following a shock.

(7) Coastal infrastructure should be built in order to face onslaughts of extreme events (such as dams, cyclone shelters) with the support from emitting countries.

11.7.3 Latin America

48. As in other continents the yields of crops can increase in temperate climates, while in dryer regions it is expected that climate change will foster processes of salinisation and the available area for crop land as well as for grazing land will shrink (Magrin et. al 2007). Land use changes have occurred during the last years and have intensified the use of natural resources and exacerbate many of the processes of land degradation. The IPCC reports that almost three-quarter of the dry lands are moderately or severely affected by degradation processes.

49. Climate variability and extreme events have severely affected Latin America. The number of extreme events, be it hurricanes, flooding, or Amazonian drought (2005), has been high during the past few years. But the regular parameters are also changing. Increases in rainfall have been observed in South-East Brazil, Uruguay, the Argentinean Pampa, and some parts of Bolivia. While this has increased the flood frequency, it has also positively impacted crop yields. On the other hand, a declining trend in precipitation has been observed in southern Chile, South-West Argentina, southern Peru, and western Central America. As a consequence of temperature increasing, the IPCC notes that the trend in glacial retreat is accelerating, with the exception of the southern Andean region. This issue is critical to Peru, Bolivia, Colombia, and Ecuador, where water availability has already been compromised for both consumption or for hydro-power generation. It is expected (Magrin et

al. 2007) that the net increase of people experiencing water stress due to climate change is likely to increase from 7 to 77 million. The number of people experiencing water stress will increase more in the second half to the century.

50. Climate change increases the risk that major parts of the Amazon could change from tropical rain forest to savannas in coming decades. This risk is higher in the eastern Amazon and in the tropical forests of central and southern Mexico. This could go hand in hand with the replacement of semi-arid vegetation by arid vegetation in parts of North-East Brazil and most of central and northern Mexico. It would be a result of both land-use and climate change.

51. Support for smallholder farmers is reduced across Latin America. Many of these farmers have been moved to agricultural areas at the fringe of difficult environments, on steep hills, or in areas that might become totally dry. This group is likely to be very much affected by climate change, particularly because they are often missing household coping capacity.

Another group that will be affected are landless laborers. They must buy agricultural products on local and regional markets and will be affected by higher prices for basic staple foods. Latin America is the continent with the highest rate of urbanization. Urban squatters are directly dependent on food and water prices. Almost 13.9 percent of the Latin American population (71,5 million) has no access to safe water supply. 63 percent live in rural areas (Magrin et al. 2007, 597).

Many rural communities rely on limited freshwater resources. Many others rely on rainwater or use water-cropping methods which are vulnerable to drought. The number of people living in water-stressed watershed areas is going to increase by 12 to 81 million in 2020 and 79-178 million in 2050, depending on which IPCC emission scenario you choose. Other groups affected by climate change will be those living in cost-lines with mangroves, such as in Ecuador. Sea level rise is expected to affect particularly low coastal areas in Central America and the Caribbean.

52. The IPCC summarizes that a number of constraints of different natures are to be observed in this region related to the adaptation capacity. These constraints might dampen stakeholders' and decision makers' capacities to achieve policy efficacy and economic efficiency for adapting to climate change. Socio-economic and political factors compromise the limited availability of credit and technical assistance as well as the low public investment in infrastructure in rural areas. This hinders the implementation of adaptive options in the agricultural sector, particularly for small producers. In addition, the poor appreciation of risk, lack of technology, inadequate education, public health services, inappropriate monitoring, and incomplete information are important constraints to adaptation to current climate trends. The huge inequality in access to productive resources might lead to adaptation schemes that are oriented to support and help huge land entities and plantations adapt to climate change. The situation will not become easier for smallholder farmers and landless laborers. A rights-based adaptation policy could help to identify the vulnerable groups described above and to help focus national adaptation policies on those most in need. The role of safety nets for consumers in order to cope with increasing prices for food and water will be of particular importance in Latin America.

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Diakonisches Werk der Evangelischen Kirche
in Deutschland e.V.
for „Bread for the World"
POB 10 11 42
70010 Stuttgart
Stafflenbergstraße 76
D-70184 Stuttgart

Phone: ++49 (711) 2159-0
E-Mail: info@brot-fuer-die-welt.de
www.brot-fuer-die-welt.de

Brot für die Welt
www.brot-fuer-die-welt.de

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