Adaptation to climate change in Africa – how to deal with uncertainty

Imme Scholz[1]

1 Introduction

Recent scientific analysis published in the last few years have made unmistakably clear that climate change is an unavoidable reality (Stern 2006; IPCC 2008). In order to keep the impacts of global warming within a manageable range, warming would have to be limited to a mean of 2°C. According to the IPCC, however, there is a high level of agreement and much evidence indicating that with current climate change mitigation policies and related development practices global greenhouse gas (GHG) emissions will continue to rise over the next few decades. GHG emissions at or above current rates would cause further warming and induce significant changes in the global climate system during the 21st century. The projected average surface warming at the end of the 21st century could reach up to 6.4°C relative to the last two decades of the 20th century. Alongside to a drastic reduction of GHG emissions, adaptation to the impacts of climate change is therefore an inevitable challenge, especially in developing countries that are highly vulnerable to the effects of climate change.

Adaptation to climate change is hindered by the fact that assessing future impacts of climate change is very uncertain, being the consequence of uncertainties in all aspects of projecting climate change. Until today, it is impossible to make clear predictions about future rainfall patterns at the local level, neither in Africa nor in Europe. At the same time, however, it is certain that climatic conditions will not remain the same as today. What are the sources of this uncertainty? What can still be said about the degree of climate change and its impacts? How shall investment and development planning deal with this new type of uncertainty? What implications does it have for development cooperation? Preliminary answers to these questions will be sketched out in this paper with the example of sub-Sahara Africa. For this purpose, the paper draws on several studies written at or commissioned by DIE in the last two years (Müller 2009, Horstmann 2009, Horstmann/Leiderer/Scholz 2009, Scholz/Klein 2008).

2 Uncertainty in projecting climate change: the case of sub-Sahara Africa[2]

Assessing future climate change is highly uncertain, due to the various dimensions which have to be considered in climate modelling:

- The various competing climate models can only represent the high complexity of the climate system in a reduced way: the single mechanisms of the climate system are not fully understood, and there are varying hypothesis on their workings which lead to the differing climate models. All models, however, are able to reproduce global annual mean temperature of the 20th century reasonably well; they diverge, however, with regard to precipitation, cloud cover and with regard to observed historic regional or local temperatures.
- Future changes in drivers of climate change are uncertain: drivers include greenhouse gas emissions, the concentration of aerosols, and land-use change. These drivers are influenced in turn by other variables which include population growth, economic and technological change, energy use, availability of fossil fuels, measures of economic,

[1] Dr. Imme Scholz is head of the department „Environmental Policy and Natural Resource Management“ at DIE, Bonn, Germany. imme.scholz@die-gdi.de, www.die-gdi.de.

[2] The following chapter is based on the main results of Christoph Müller (2009).

environmental and energy policy, land-use change and the degree of international cooperation. These linkages are addressed by employing different scenarios based on varying sets of hypothesis on these variables and drivers and which show how emission pathways may change (Nakicenovic / Swart 2000).

- Several feedbacks exist between climate change and its drivers which also lead to uncertainty: Warming leads to changes in soils (e.g. melting of perma-frost soils), in vegetation cover (forests turn into savannas) and in land use (forests turn into farmland). These changes, in turn, increase emissions and solar radiation (albedo) and thus reinforce climate change.

These statements refer to uncertainties with regard to the rate, the magnitude and the concrete impacts of global climate change.

Most global climate models are able to reproduce observed climate patterns in sub-Sahara Africa, but there are also deviations from observed historic climate:

- Half of all climate models underestimate temperatures; underestimations range between -2.8°C and 0°C in all four African regions.
- Deviations are even stronger in the case of annual precipitation; leaving out the Sahara, deviations range from an underestimation of -30% to an overestimation of +79%.
- Precipitation intensity is also not reproduced adequately; as a rule, models simulate too many days with low rainfall and too few days with strong rain.

These weaknesses also affect the projections of global climate models for sub-Sahara Africa. These projections are weak due to the inherent uncertainty of climate modelling and, in addition to that, to the coarse meteorological data base available for sub-Sahara Africa. There are hardly any complete historic data series, there are only few meteorological observation stations, and research on extreme weather events is limited. These factors lead to large differences between model projections even for the same emission scenario.

Model projections agree that the temperature trend in sub-Sahara Africa (+2-4.5°C) will be stronger until the end of the 21st century than the global average. Most models come to similar results with regard to the spatial pattern of temperature change, although the magnitudes of temperature change projections differ considerably. The Sahara and southern Africa are expected to warm up stronger than other regions of the continent.

Marked differences exist with regard to the expected changes in rainfall patterns. Even within one emission scenario there is always one model which projects increasing rainfall and one which projects decreasing rainfall for the same region. In addition to that, there are considerable differences even when there is agreement on the direction of change (decrease or increase). Differences in estimations for future annual rainfall range from +/- 1825 mm/year. For eastern Africa, 50% of all models project increasing rainfall by the end of the 21st century, while southern Africa and the Sahara will become dryer.

Uncertainty due to global *tipping elements*[3]

The uncertainty of projections of future climate change is increased by the possibility of abrupt and irreversible change. For this type of change, the term “tipping point” emerged in

[3] The following paragraphs are based on Lenton et al. (2008).

the natural sciences, which was then enlarged by the term "tipping element". Both terms are included in the following definition:

> *„(A tipping element describes) subsystems of the Earth system that are at least sub continental in scale and can be switched – under certain circumstances – into a qualitatively different state by small perturbations. The tipping point is the corresponding critical point ... at which the future state of the system is qualitatively altered"* (Lenton et al. 2008).

Further defining elements of a *tipping element* are related to its policy relevance:

- Human behaviour interfere with the system in a way that they determine whether the critical point is reached. Tipping points are thus accessible to policy decisions.
- Public attention: a significant number of people care about the fate of the subsystem in question because it can influence human welfare significantly or because it is considered to be of high value in itself. This feature makes it possible for the media to relate the fate of tipping elements to public responsibility and thus to politicize it.
- Time horizon: the authors who coined the term "tipping element" are convinced that it is necessary to account for the consequences of human behaviour and political decisions which occur within an "ethical time horizon" of 1,000 years. This means that cost-benefit calculations which mainly refer to the short term and ignore consequences in the long term are rejected for ethical reasons.

If these definition criteria are used, and further criteria such as uncertainty and sensitivity to global warming are added, the following examples of relevant tipping elements emerge:

- High sensitivity with smallest uncertainty: melting of the Greenland ice sheet and of Arctic sea-ice,
- Intermediate sensitivity with largest uncertainty: the collapse of the Amazon rainforest and of the El Niño-Southern Oscillation (ENSO),
- Low sensitivity with intermediate uncertainty: collapse of the Atlantic Thermohaline Circulation.

The shattering effect of these tipping elements lies in the irreversibility of the change, in its systemic character, i.e. the manifold linkages with the dynamics, magnitude and rate of climate change, and in the enormous impacts of the change which may comprehend the whole globe. If the Greenland ice sheet melts, global sea level may rise by seven meters and threaten low lying coastal zones not only in sub-Sahara Africa. If ENSO collapses, this will have stong impacts on the future climate in sub-Sahara Africa.

3 Estimations of impacts of climate change in sub-Sahara Africa[4]

Which impacts will the changes in temperature, precipitation and extreme weather events have on economy and society? Statements on the impacts expected with global warming are generally based on case studies. As yet, there are only few systematic quantitative impact studies (e.g. Alcamo / Flörke / Märker 2007, Howden et al. 2007, Kurukulasuriya / Mendelsohn 2007).

Statements on socio-economic change as a result of climate change depend on additional assumptions which refer to the adaptive capacity of the society in question. The IPCC defines adaptation as the "initiatives and measures to reduce the vulnerability of natural and human

[4] The following chapter is based on the paper by Christoph Müller (2009).

systems against actual or expected climate change effects. Various types of adaptation exist, e.g. anticipatory and reactive, private and public, and autonomous and planned" (Baede / van der Linden / Verbruggen 2008: 86). Adaptive capacity, in turn, is defined as "the whole of capabilities, resources and institutions of a country or region to implement effective adaptation measures" (ibid.). Most commonly cited examples for such measures include the raising of river or coastal dikes and the introduction of drought-resistant crops.

Vulnerability is defined by the IPCC as "the degree to which a system is susceptible to, and 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, its sensitivity and its adaptive capacity" (ibid., page 89). In the social sciences, some authors prefer a definition of vulnerability that guards some distance from the immediate impacts of climate change and rather focuses on the conditions which make a society vulnerable (Levina / Tirpak 2006; O'Brien et a. 2007; Horstmann 2008). Vulnerability is understood as the result of the interactions between socio-economic conditions (e.g. poverty, income distribution, existing infrastructure) and institutional settings (e.g. quality of public governance, rule of law, decentralisation). Particularly in developing countries, vulnerability is heavily influenced by poverty, because as a rule, the poor are more dependent on the direct use of natural resources and because they have less buffer capacity with regard to economic damages caused by natural disasters.

Adapting to climate change is, therefore, a great responsibility of the public administration: anticipatory measures for controlling risk and dangers require collective action and public expenditure, both with regard to infrastructure as to research, technology development and deployment, information and advice of various groups at risk, and changes in decision-making procedures in the public realm. In rich countries, local authorities, province administrations and the organisations of the private sector as a rule dispose of the necessary capacity for facilitating both public and private, planned and autonomous adaptation. In poor countries, the general fragility of public and private institutions becomes even more evident when dealing with future risks and dangers under conditions of increased uncertainty. Therefore, support from rich countries who caused most of climate change, will be paramount.

With regard to sub-Sahara Africa, the necessity of massive external support for adaptation to climate change has been emphasised already in the UN Framework Convention of Climate Change (UNFCCC) adopted in 1992, and has been repeated several times since, especially at the conference of the parties to the convention in Nairobi in 2006. Both perspectives on vulnerability (that of the IPCC and that of social sciences) are relevant here: Model projections agree on a stronger warming trend in sub-Sahara Africa than elsewhere, and the low level of human development in this region is likely to be equivalent to low levels of adaptive capacity.

In sub-Sahara Africa, more than half of the population lives in rural areas. Their food security depends on local food production. Agriculture is mostly rain-fed (less than four percent of arable land are irrigated) and subsistence-based (WRI 2005). Due to expected warming and precipitation changes, falling agricultural yields (Gitay et al. 2001) are expected and thus also losses in the gross domestic product (GDP) of sub-Sahara Africa. Even with adapting crops to climate change, average losses of agricultural GDP in Africa may reach six percent (Mendelsohn / Dinar / Dafelt 2000). The IPCC estimates that yields may decrease by up to 50 percent in rain-fed agriculture (Parry et al. 2007). The length of the growing season my decrease by more than 20 percent in the southern Sahara, in western Africa and in southern

Africa by 2050, while there are only a few regions in the Ethiopian highlands, in Kenya, Uganda, Zimbabwe and Mozambique where the length of the growing season may increase and yields may be higher (Thornton et al. 2006). These projections mostly depend on assumptions on future rainfall patterns which, however, are highly uncertain. There are no clear findings yet with regard to the impacts of CO_2 fertilization on plant growth.

Water availability is likely to further decrease in future, due to already existing overexploitation of water resources, a higher frequency and intensity of droughts and changes in precipitation patterns. Already today about 25 percent of the African population suffers from water stress, while one third is living in regions prone to droughts. Arnell (2004) estimates that by 2020 about 75-250 million persons will suffer from water stress in sub-Sahara Africa, while this number may increase to 350-600 million by 2050. Although climate change is an important additional stressor, some authors state that there is considerable adaptive potential to be liberated through water management reform, improved land-use regulation and better control of water pollution (Boko et al. 2007, Neubert et al. 2007).

4 Approaches for dealing with uncertainty and for elaborating adaptation strategies

Which possibilities are there for reducing the high degree of uncertainty inherent in simulations of climate models and thus make them accessible to political and economic decision-making? Müller (2009: 37-39) mentions four options:

- Reducing the number of modelled scenarios: this option requires to make decisions about plausible futures (which options are possible, which can be excluded? Which extremes do we have to consider?).
- Make specific assumptions on the magnitude of climate change: Kurukulasuriya and Mendelsohn (2007) build their calculations on the impacts of climate change on sub-Sahara African agriculture on four different assumptions (warming of +2.5°C and +5°C; precipitation decrease of -7 percent and -14 percent).
- Changing the starting point: identify hotspots of vulnerability by systematically analysing regional and local case studies instead of starting by simulating impacts of climate change.
- Vulnerability assessments: identify threshold values which lead to dangerous climate change with a view to maintaining food production; elaborate climate change scenarios for identifying the point in time when this dangerous climate change becomes likely.

Summarizing, we can state there are considerable methodological difficulties in making relatively safe and spatially precise quantitative projections of likely climate change. Therefore, it makes sense to focus on no-regret options when thinking about climate-resilient development planning and adaptation planning. In the case of sub-Sahara Africa, this includes in any case two options: (i) to reduce the immediate dependency of production systems from natural conditions, and (ii) to diversify livelihood strategies and income sources of households. These measures could contribute to strengthening the adaptive capacity of the African rural population as a whole. Some examples include:

- the construction of irrigation systems and rainwater harvesting in order to reduce rainfall dependency and secure water access over longer periods of time,
- the diversification of crops (food and cash crops, annual and permanent crops) and the use of off-farm income sources,

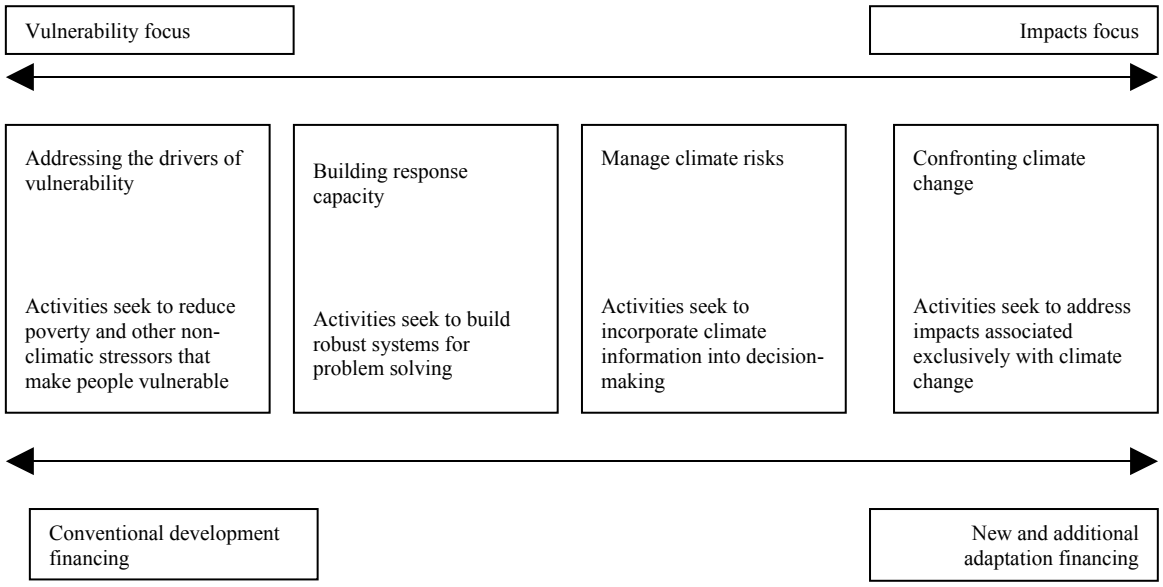
- the creation of insurance schemes for extreme weather events which help to avoid that the poor see themselves forced to sell their cattle, their house and land in case of droughts and floods in order to secure survival.

At a macro-economic level, development strategies should be designed in a way that they both consider climate risks and deliver benefits even if climate change does not occur in the expected magnitude. It is essential that these strategies work under a broad range of climatic and other environmental changes. This is true especially for strategies which refer to the rural and agricultural development and to the economic use of ecosystems (including tourism), natural resources and the enlargement of economic and social infrastructure in regions at risk, such as low lying coastal zones or arid and semi-arid areas.

In the coming years, adaptation to climate change will belong to the core of development planning and poverty reduction strategies. The more visible climate change becomes and the clearer the new temperature and precipitation patterns are, the easier it will be to describe and consider these new environmental conditions. This is an ambitious process, however, and it requires measures in four areas of action (see graph 1 from Klein / Persson 2008, based on McGray et al. 2007):

- confronting specific impacts of climate change (e.g. raising dikes),
- managing climate risks (e.g. changing technical parameters for dams, roads and bridges),
- building response capacity in public administration, in science, society and the private sector (e.g. by improving inter-departmental policy coordination, scaling-up research institutes, setting-up information campaigns, providing special credit lines and advisory services) and
- addressing the drivers of vulnerability for climate change (e.g. reducing poverty, strengthening participation, particularly on local level, improving access to water, health and education services).

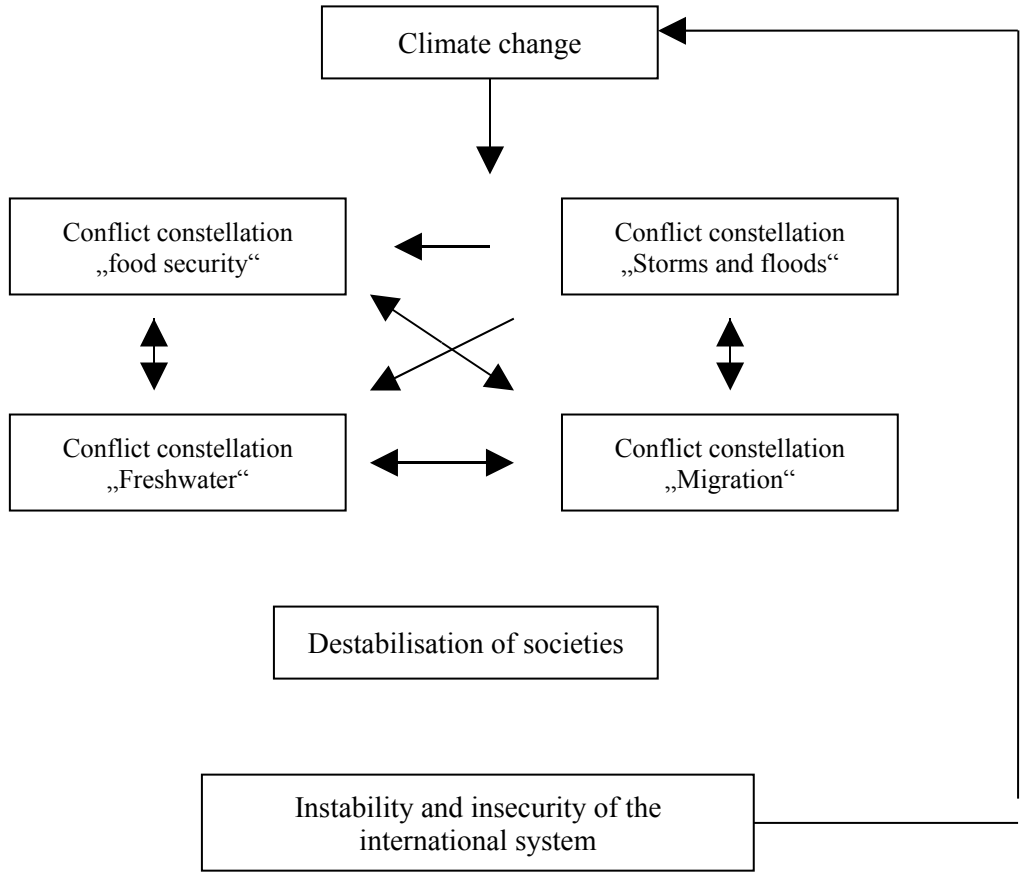
Graph 1: Adaptation as a continuum between vulnerability reduction and dealing with impacts of climate change (Klein / Persson 2008)



Many adaptation researchers in developing countries see reducing vulnerability to the impacts of climate change as the most important area of action (O'Brien et al. 2007). Poverty, exclusion from political decision-making, reduced access to land, water, health services, to information, marginalisation due to gender or ethnical reasons – these factors make poor people and communities vulnerable to climate change. In rich countries, most people are protected by insurance schemes, public protection measures or simply by the fact that they are less immediately dependent from natural conditions.

If these drivers of vulnerability are not addressed, the likelihood of internal or even cross-border conflicts increases as well (see graph 2 from WBGU 2007).

Graph 2: Climate change worsens existing conflict constellations (WBGU 2007)



Adaptation to climate change is an important area of action of the UN Framework Convention on Climate Change (UNFCCC). Under the convention, rich countries have committed to 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 (Article 4.4). All parties to the Convention agreed to include adaptation to climate change into domestic strategic planning, and to cooperate in preparing for adaptation to the impacts of climate change, particularly in Africa (Article 4.1e). At the 2006 Conference of the Parties to the UNFCCC, the Nairobi Work Programme (NWP) specified that developing countries need assistance in order to improve their understanding and assessment of impacts, vulnerability and adaptation and to make informed decisions on practical adaptation actions and measures to respond both to climate change and climate variability. At the 2007 Conference of the Parties to the

UNFCCC in Bali, enhanced action on adaptation was re-iterated as a major building block of the post-2012 climate regime.

This means that decisions on financial support to adaptation measures will also have to be made at international level, in the context of climate negotiations. In order to make efficient and effective decisions, even under conditions of uncertainty, which react to the needs of particularly vulnerable population groups and the poor, at least three questions will have to be answered: where shall funds be invested (priorities with regard to country groups), when shall be invested in which sectors (sequencing and areas of action) and who should invest (coordination among actors of international cooperation)?

(1) Priorities with regard to country groups: The UNFCCC states that countries particularly vulnerable to the adverse impacts of climate change, e.g. small island states and countries with low lying coastal zones, and poor countries with low adaptive capacities should be targeted. The needs of these country groups are very different and cover the whole range of actions mentioned above. Here, how to deal with residual costs occasioned by climate change impossible to adapt to will also become relevant. This includes impacts such as the loss of national territory which will lead to massive migration flows and to questions of international law (loss of territory = loss of statehood?).

(2) Sequencing and areas of action: As climate change is uncertain, anticipatory investment has to be carefully planned in order to use funds efficiently. Project Catalyst[5] proposed to consider two periods of action, 2010-2020 and 2020-2030.

- Reducing uncertainty and getting prepared (2010-2020): the main tasks in this phase would be improving the information base through the elaboration of local scenarios for climate change, developing early warning systems for natural disasters and strengthening research; tasks to be started with include the elaboration of adaptation strategies, introducing instruments for flexible and integrated policy coordination and cooperation and implementing the National Adaptation Programmes of Action (NAPAs). In this phase, it would be necessary to start thinking on how to strengthen adaptation capacities at the household level (poverty reduction, avoiding maladaptation) and to introduce instruments for managing climate risks.
- Public and private investment in adaptation (2020-2030): Work on local climate scenarios, early warning systems and research has to be continued, while investment in anticipatory public adaptation programmes will start with the aim of strengthening public and private adaptive capacities. In this phase, regional and local programmes (e.g. insurance on country level, support for migration flows, emergency aid) have to become operational.

(3) Coordination among actors of international cooperation: The areas of action mentioned before in this section show that a broad range of capacities and considerable financial resources will be needed in order to give adequate support to adaptation action in developing countries. This means that in rich countries, development and international cooperation will need to be coordinated in an integrated way that is based on common aims and a clear division of labour between all actors in the rich countries and on participatory procedures with partner countries in order to agree on common objectives, areas of action and measures to be supported. In Germany, there are some approaches for coordinated action

[5] Project Catalyst is an initiative by US American and European foundations (www.climateworks.org) which commissioned McKinsey with elaborating a proposal for a deal to be reached at the conference of the parties in Copenhagen 2009. The proposal was discussed in working groups comprising negotiators, researchers and practitioners. The author participated in the adaptation working group.

among the departments for environment and for international development, but the department for science and research is missing completely, as well as the department for transport which is responsible for the meteorological services. Possible measures in developing countries which would benefit from an improved coordination between these departments include

- Improving the database and regional climate models and scenarios through research cooperation and the strengthening of meteorological services;
- Using adaptation as a window of opportunity for strengthening national and global environmental regulation (reducing market failure);
- Strengthening emergency and humanitarian help as well as peacekeeping forces;
- Establishing innovative financial instruments for the provision of additional finance.

One controversial issue is how additional funds will be distributed: is it better to rely on existing institutions of bi- and multilateral development cooperation, including a reformed GEF (Global Environmental Facility)? Or should new funds be created under the UNFCCC which distribute additional funds in a complementary way to development cooperation? Should other departments in rich countries benefit from these additional funds? How should coordination procedures be designed in rich countries in order to avoid that transaction costs increase in developing countries and to realise the benefits of such an enhanced cooperation? These questions already rose with regard to the question of how to shape international cooperation with the major economies in the South, e.g. India and China (see Altenburg / Leininger / Scholz 2009). With regard to adaptation to climate change, the urgency of finding viable answers increases.

5 Recommendations to German development cooperation[6]

Development cooperation has to find an answer to the question of how to deal with adaptation to climate change. On the basis of the areas of action and the dimensions of decision-making mentioned in the previous section, we will present three complementary approaches which should be applied in development cooperation: protection against climate risk (climate proofing), addressing the drivers of vulnerability, especially of the poor, and improving policy coordination.

Climate proofing: Sectoral and project-based planning will have to integrate climate information in order to consider the risks of climate change are anticipated and to internalize the additional costs of adaptation. This is information with a high degree of uncertainty. This means that decision-making will have to learn to act under these conditions of uncertainty, especially in the case of costly and long-living infrastructure projects. Line ministries, planning agencies and banks in rich and poor countries have to cope with this complex task. UNDP (2007) estimates that the costs in OECD countries for climate-proofing development cooperation will be 44 billion US$ by 2015, i.e. about 0.1 percent of OECD GDP. Information gaps in developing countries are large which increases the uncertainty of cost calculations and decisions.

Reducing vulnerability: Climate-resilient development strategies will have to give an answer to the question how socio-economic and political vulnerability to climate change can be reduced and how individual as well as collective adaptive capacities in partner countries can be increased. (i) Adapting to climate change encompasses technical investments, e.g. in infrastructure for rainwater harvesting, in order to increase access to water in regions with

[6] This section is based on Scholz / Klein (2008).

short but heavy rainfall. (ii) Beyond that, measures in order to change social and political factors that determine vulnerability will also be needed: investment in education, in improved access to health, to land, to credit, to information, in the rule of law, in improving political participation as well as transparency. The focus on reducing vulnerability means that rather than looking at environmental changes as the driving force one analyses social factors that affect both individual and collective capabilities in order to manage the consequences of climate change. Important areas of action are integrated water resource management, primary health care, combating deforestation and desertification and promoting good governance and decentralisation. (iii) Finally, there is a third area: preventing development programmes that reduce adaptive capacity in the mid-term, called maladaptation. One example: From an economic perspective, it makes sense to induce peasants to specialise on products and market niches in order to use the comparative advantages of the division of labour. From the perspective of adaptation to increasingly uncertain climatic conditions, it makes more sense to diversify income sources in order to have alternative options in case of bad yields. Another example comes from public administration reform: From the perspective of increased efficiency it makes sense to reduce overlapping areas between administration areas and levels. From the perspective of increased needs for policy coordination and of securing coping capacities under stress, maintaining redundancies may make sense as well, in order to be able to cooperate at interfaces and to improve communication channels.

(3) Improving policy coordination within development cooperation and with other departments: Adaptation to climate change requires improved policy coordination within bilateral development cooperation and between bi- and multilateral agencies in order to guarantee an efficient use of resources, funds and capacities. Integrating adaptation adequately into bilateral cooperation will require to consider climate change not anymore as an environmental problem, but rather as a general challenge that will affect development opportunities of all partner states. Within the EU, coherence and complementarity of the division of labour (between the Commission and the member states) has to be ensured. The Development Assistance Committee of the OECD is a forum in which donors can debate the conceptual and strategic questions that have been broached here. A strategic view on the role of bi- and multilateral development cooperation (complementary to the Adaptation Fund and possibly new funds to be agreed in Copenhagen) when financing adaptation is urgently needed. Transaction costs of development cooperation have to be reduced, and the Accra Plan of Action for increasing aid effectiveness has to be implemented swiftly. Other actors beyond development cooperation need to be integrated in the efforts to support adaptation action in developing countries, e.g. from energy, environment, science and technology.

Options for action in the short term

The following proposals for action allow to integrate adaptation to climate change into bilateral development cooperation in the short-term while the debate on the more fundamental questions is still ongoing:

1) Enhance effort: A fundamental step is a gradual increase of funds in bilateral development cooperation in order to strengthen adaptive capacities in developing countries. In this way, learning processes on the donor as well as partner side could begin, with regard to how adaptation measures in the three areas mentioned at the start can be planned and implemented (climate proofing, adressing vulnerability and improving policy coordination). The targeted amount should match the volume given to the support of mitigation activities in developing countries.

Parallel to this, a certain number of partner states could be selected for a pilot process on how adaptation to climate change can be integrated into bilateral cooperation, and how adaptation measures can be sensibly combined with mitigation measures, for example in the area of promoting renewable energies, protecting biodiversity and combating deforestation. This process could also be used to test in how far budget financing or program-based funding are suitable instruments for an integrated approach that is based on interdepartmental measures to strengthen adaptive capacities.

2) Build partnerships: Expanding cooperation between the development department and other departments is sensible in many respects. A joint strategy for addressing adaptation to climate change in international cooperation could help to develop a long-term funding strategy and to gather various competences for strengthening adaptive capacities. One example is to combine support for scientific cooperation in the area of natural resource management and urban and regional planning with funds geared to the application of the new approaches or best practices identified by research.

3) Increase visibility: The first step is to identify and enhance activities conducive to promote adaptive capacity in developing countries. In Germany, the implementing organisations of development cooperation are already working on finding such approaches and instruments within their bilateral portfolios. It is also important to support the World Bank and the regional development banks with regard to the implementation of their climate strategies within the field of adaptation in order to be able to utilize funds and resources of a larger scale.

4) Generate knowledge: In order to accelerate the learning processes in the field of adaptation, development agencies and research organizations should be supported when it comes to systematically analyzing their experiences and to mutually reflect on these against the background of the scientific research that has been carried out to date. Integrated approaches of financial and technical cooperation will be important in order to enable quicker learning processes to take place. Cooperation with India in these two areas would be very helpful: India started comparatively early with undertaking research into the impacts of climate change and the socioeconomic vulnerability at the federal state as well as local levels. Proposals for the integration of adaptation into investment plans for rural development and the use of microinsurance for small farmers offer starting points for technical assistance as well as for financing. The experiences made in the rural areas of India could also be relevant for the cooperation with LDCs and for the design of financial instruments. In addition to this, mutual learning processes of bi- and multilateral development cooperation should be organized through workshops and joint studies, for example through the reactivation of the Vulnerability and Adaptation Resource Group (VARG).

Long-term and significant progress in the fight against poverty will be impossible if the challenges of climate change are not managed adequately. In order to avert this, it is not only necessary to significantly reduce greenhouse gas emissions but also to support developing countries now in adapting to climate change.

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