Climate change and rural development

Climate change has major impacts on rural areas. It affects all components of humans' livelihood and food security, mainly through its impact on the ecosystems. People experience these impacts very directly as most ecosystems have a rural dimension. Activities in rural areas also contribute to climate change. What are the implications of climate change for rural areas and the options for rural people in developing countries to engage in mitigation of climate change as well as in adaptation to its foreseeable effects as integral components of rural ecosystem services?

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According to the Fourth Assessment Report (Climate Change 2007) of the Intergovernmental Panel on Climate Change (IPCC), the global average surface temperature is likely to rise by a further 1.8° to 4.0° Celsius until 2100. The sea-level may rise by 30 to 60 centimetres. Climate variability will increase almost everywhere. Rainfall will rise at high latitudes and decline in many subtropical regions. Runoff and water availability are expected to increase at higher latitudes and in some wet tropics, and decrease further at mid-latitudes and in the dry tropics. In 2002 the IPCC published a Special Report on Emission Scenarios (SRES), which are still the basis for impact projections. These scenarios cover a wide range of driving forces of future emissions, from demographic to technological and economic developments. They include the range of emissions of all relevant species of greenhouse gases. Depending on the scenario chosen, the prospected effects, in particular the shift of climatic zones will be more or less dramatic.

For example, scenario A1F1 describes a future world of very rapid economic growth, global population that peaks in mid-century and declines thereafter, and a rapid introduction of new and more efficient technologies, however still mainly based on fossil energy. The International Institute for Applied Systems Analysis (IIASA) has estimated the impact of this high emission scenario on the shifts of climate zones. Compared to the regional extension of climate zones prevailing in the second half of the 1990s, climate change under this scenario would cause a significant northern expansion of temperate zones in higher latitudes and an expansion of arid zones in lower latitudes (see figure on page 5). Practically the entire African continent would become tropical (all monthly average temperatures, adjusted to sea level, above 18°C) and most western and central Europe would become subtropical (winter rainfall, no frost).

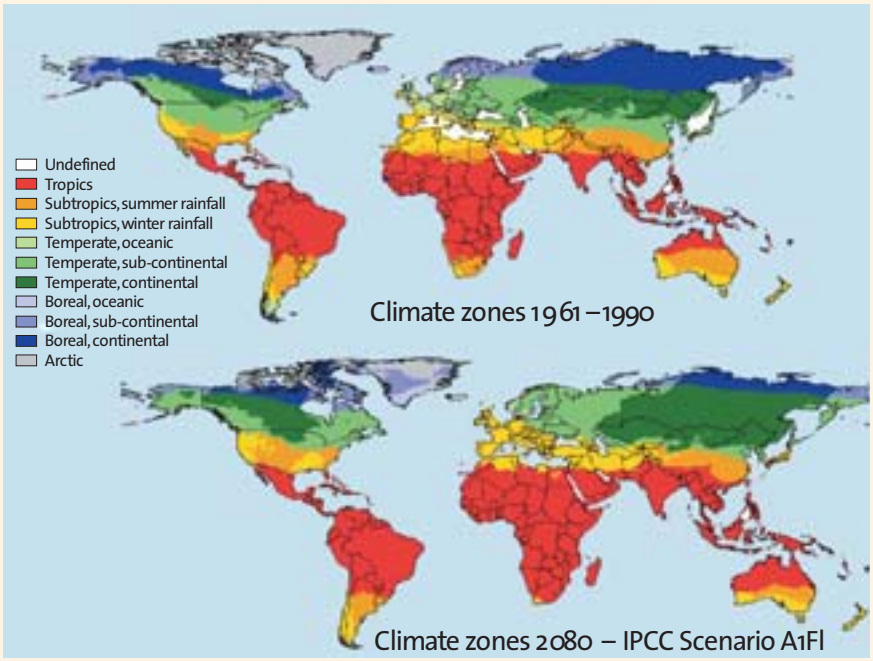
Climate change will have wide ranging implications for entire ecosystems and influence agriculture, forestry and fisheries. Temperate zones in higher latitudes will gain additional areas suitable for cropping, longer cropping periods, higher crop and pasture yields and wood growth. Lower latitudes, especially the seasonally dry tropics, will face a reduction of suitable crop lands and a lowering of crop yield potentials. On balance, developed countries, above all North America and Russia, may gain 160 million hectares of additional crop land, whereas the developing countries will lose 110 million hectares (G. Fischer, M. Shah and F. Tubiello, *Socio-economic and climate change impacts on agriculture: an integrated assessment*, 1990-2080, IIASA 2005).

Experts expect a significant increase in weather variability, contributing to a fourfold increase of material damage and a rising death toll from natural disasters, in particular floods, droughts and landslides, thus further aggravating a rising past trend. Particularly worrying is the fact that these natural disasters hit the poor disproportionately. More than 90 percent of natural disasters of all types and almost 100 percent of the death toll (70 000 per year, on average) occur in developing countries. Even within these countries the poor suffer most, because many of them live in disaster prone areas and lack the means of protecting themselves against the major causes of damage.

Climate change has also positive effects. Up to a certain temperature increase, the increased carbon dioxide concentration in the atmosphere will speed up photosynthesis and thus have a positive fertilization effect on many crop yields, although doubts remain about the magnitude of the effect.

IIASA has estimated the global effect of climate change on agriculture by comparing the estimated effects of SRES scenario A2 to those of scenario B1. A2 assumes high economic growth, high population growth and little progress in clean technologies, all resulting in high emissions. Scenario B1 assumes lower population growth, reduced material intensity and clean and resource-efficient technologies (Fischer, Shah and Tubiello, op. cited). Compared to scenario B1, scenario A2 would result in an annual loss of 25 to 35

Shift of Climate Zones under Climate Change (SRES Scenario A1FI)



Source: IIASA, 2002

billion US$ in global agricultural GDP by 2080. In other words, mitigation of climate change aiming at scenario B1 instead of A2 would generate a gain of this magnitude. Most of this gain would go to the geographical zones in lower latitudes which are most affected by climate change, hence to developing countries. Of particular importance is that scenario B1 would also result in much lower agricultural water requirements.

Climate change impacts in Africa

The effects on rural development in sub-Saharan Africa will be particularly dramatic. The various sub-regions are vulnerable to different combinations of risks, such as desertification, deforestation, loss of forest quality, sea level rise, reduced fresh water availability, cyclones and coastal erosion (see figure on page 6).

IIASA experts expect a drastic decrease in Africa's top prime agricultural land and an increase by 30 to 60 million hectares of land with severe constraints due to climate, soils or terrain factors. Land suitable for multiple cropping may decline by 15 to 30 million hectares. Agricultural lands in arid or semi-arid areas will increase by 10 percent and desertification will progress. Livestock and wildlife will suffer from increased heat stress. Some countries will gain, others will lose production potential. Extreme changes of climate and reduced water availability may potentially induce intra-national or even trans-boundary instability, migration and conflict and there could be an increased risk of disease, in particular malaria, and higher mortality.

It is realistic to expect that climate change may eventually increase food insecurity in many fragile areas. More specifically, it can result in reduced food availability, lower economic access due to higher food prices and reduced income and employment, greater instability of supplies and incomes and occasionally reduced food safety. However, it should be noted, that progress in reducing the number of poor and hungry depends much more on the type of socio-economic development than on climate change per se (Schmidhuber, J. and F.N. Tubiello,2007: *Global Food Security under Climate Change, Proceedings of the National Academy of Sciences,* forthcoming). Take Africa as an example. According to the most recent estimate by FAO, sub-Saharan Africa had 206 million undernourished people in 2001–03, up from 169 million in 1990–92. Projected numbers of hungry people in Africa by 2080 vary between an increase to 300 million under the high-emissions SRES scenario A2 and, on the other hand, a reduction to 40 million hungry under the environment-friendly Scenario B1 (Fischer, Shah and Tubiello, op. cited). However, of this gap between scenarios «only» a difference of 10 to 20 million hungry is due to climate change as various other factors such as different rates of population growth, economic growth, technology and policy impact significantly on the number of hungry people under the two scenarios.

Climate change impacts on ecosystems

Climate change affects rural people's livelihood. In poor countries of the tropics and sub-tropics it may have detrimental consequences for all components of food security: reduced access to food due to

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Vulnerability to Climate Change in Africa

Source: UNEP, 2002

income losses, lower and more unstable supplies and less effective utilization of nutrients due to health problems. Many of these effects occur through changes in the ecosystems. Agricultural ecosystems, including forestry and fisheries, are the largest managed ecosystems in the world. Through the management of these ecosystems, rural people contribute to the provision of ecosystem services which secure life on earth and maintain the sustainability of biodiversity and humans' livelihoods. Changes in surface temperature, precipitation, weather variability and water levels, all of which are influenced by climate change, can have significant effects on the functioning of these services.

Ecosystem services include inter alia provisioning of goods like food and water, regulating floods, disease control and supporting services such as nutrient cycling which maintains the conditions of life on earth. Some services, such as the supply of food and fibre, are subject to normal market forces of demand and supply and are the traditional source of rural income. Others such as watershed management or conservation of genetic resources generate public goods which tend to be under-supplied unless appropriate regulations or incentives are in place. Carbon sequestration to mitigate climate change belongs to the latter category.

According to the latest Millennium Ecosystem Assessment, 15 out of 24 ecosystem services under examination are being degraded more or less severely or used unsustainably (Millennium Ecosystem Assessment, *Ecosystems and Human Well-being,* 2005). Soil nutrient depletion, erosion, desertification, depletion of freshwater reserves, loss of tropical forest and biodiversity are clear indicators. Although by far not the only one, climate change is expected to be the dominant driver of ecosystem change for the current century. Any discussion of actions which rural populations can or should take to better cope with climate change should start from an understanding of the more complex reasons for the widespread degeneration of ecosystem services and the broader rural development strategies into which climate related measures should be integrated. Two causes of ecosystem service degeneration are of particular importance. The first is poverty and the second is institutional failure.

Regarding the first reason, rural people depend on ecosystem services more than any other segment of humankind. This is particularly the case for the majority (70 to 80 percent) of the world's almost one billion poor and more than 800 million hungry who live in rural areas and depend directly or indirectly on agriculture for their livelihood. Most of them draw a significant part of their daily sustenance from using land and water as farmers or fisher folks or from using forests and biodiversity for food, fodder, fuel and shelter. Rural people have shaped and conserved the rural ecosystems over thousands of years, but in more recent history, with increasing population pressure and lacking alternatives, the poor have often been forced to expand land use and livestock beyond the carrying capacity.

This vicious circle is only interrupted where adequate public and private investments are made in rural infrastructure, natural resources and smallholder productivity. There is now growing evidence that agricultural growth, which such investments generate, contributes more to hunger and poverty reduction than investments in other sectors (see references in World Bank, *World Development Report 2007*, forthcoming). Indeed, it can also be show, that zones with reduced prevalence of hunger show also lower rates of environment degradation. It is therefore difficult to understand why over the last ten to fifteen years governments of many of the poorest countries as well as donors have been neglecting the rural-agricultural sectors in public investments and development assistance.

The second reason why so many rural ecosystem services are degenerating is institutional failure. Many ecosystems or special services derived from them have a «common-pool» character, which means that there are inadequate sanctions for inappropriate use of a resource (e. g. pollution, deforestation or groundwater depletion) and lacking incentives for positive ecosystem services. The classical policy response to this failure is to clearly establish property rights and responsibilities, norms for good practices and taxation of harmful practices. Yet there are limits to the use of taxes and fines in poor countries. The more effective policy responses should also include rewards for well defined positive environmental services such as watershed management, biodiversity protection or carbon sequestration. More and more countries have recently institutionalized various forms of public or private payments for ecosystem services. Of special interest are those for which the rural poor have comparative advantages. Where this is the case, payments or other rewards for mitigation and adaptation can not only contribute to efficient provision of public goods but also to rural poverty alleviation and income diversification.

Der 4. Sachstandsbericht des Intergovernmental Panel on Climate Change – IPCC

Die Zwischenstaatliche Sachverständigengruppe über Klimaänderungen, englisch Intergovernmental Panel on Climate Change (IPCC), wurde 1988 vom Umweltprogramm der Vereinten Nationen (UNEP) und der Weltorganisation für Meteorologie (WMO) ins Leben gerufen. Hauptaufgabe der Sachverständigengruppe ist es, auf wissenschaftlicher Basis den Zustand des Klimasystems und seine Auswirkungen auf die menschlichen Gesellschaften festzustellen und Möglichkeiten des Gegensteuerns zu benennen.

Der 4. Sachstandsbericht des IPCC wurde im Laufe dieses Jahres veröffentlicht. Einige Zahlen zu seiner Entstehung zeigen auf, dass der Bericht einen breiten wissenschaftlichen Sachverstand widerspiegelt: 450 Hauptautoren, 800 beitragende Autoren und 2 500 Korrekturleser aus insgesamt 130 Ländern arbeiteten sechs Jahre an seiner Fertigstellung.

Der Bericht gliedert sich in vier Teile:

- Die physikalische Basis des Klimasystems und der Klimaänderung;
- Auswirkungen, Verwundbarkeit und Anpassung;
- Minderung des Klimawandels;
- Synthese.

Beobachteter Wandel

Die Zeichen der Klimaänderungen sind eindeutig. Die globale Oberflächentemperatur ist im 20. Jahrhundert um 0,74° Celsius angestiegen. Dabei hat sich der Anstieg in den letzten Jahrzehnten erheblich beschleunigt. Die Häufigkeit heftiger Niederschläge hat zugenommen. Gletscher und Eisschilde verlieren zurzeit deutlich an Masse. Der Meeresspiegel ist im letzten Jahrhundert um 17 Zentimeter angestiegen. All diese Veränderungen sind laut IPCC mit sehr hoher Wahrscheinlichkeit auf die anthropogen verursachten Treibhausgase (THG) zurückzuführen. Diese sind zwischen 1970 und 2004 um 70 Prozent gestiegen. Die Industrieländer, die lediglich 20 Prozent Weltbevölkerung beheimaten, sind zurzeit für 46 Prozent der globalen Emissionen verantwortlich.

Emissionsszenarien

Wie sehr sich das Klima in Zukunft verändern wird, hängt davon ab, wie treibhausgasintensiv der Entwicklungspfad sein wird, den die Menschheit einschlägt. Aufgrund der Trägheit des Klimasystems wird die Temperatur selbst bei sofortigem Emissionsstopp um weitere 0,6°C ansteigen. Als realistische Bandbreite erwartet das IPCC einen Anstieg von 1,8°C bis 4,0°C im Vergleich zu vorindustriellen Temperaturwerten. Um den THG-Gehalt auf 445 bis 490 ppm CO_2-Äquivalente zu begrenzen, was eine Temperaturerhöhung von 2,0°C bis 2,4°C bedeuten würde, müsste die Zunahme der Emissionen in zehn Jahren gestoppt und bis 2050 gegenüber 2000 weltweit um 50-85 Prozent reduziert werden. Die EU strebt ein Stabilisierungsziel von 2 Grad Celsius an, da jenseits dieses Schwellenwertes das Risiko irreversibler und möglicherweise katastrophaler Veränderungen des Planeten dramatisch zunehmen wird. IPCC geht davon aus, dass selbst das ehrgeizige Stabilisierungs-Szenario zu volkswirtschaftlich vertretbaren Kosten erreichbar ist. Die Kosten werden auf lediglich 0,12 Prozentpunkte des jährlichen Bruttoinlandsprodukts geschätzt.

Erwartete Auswirkungen

Die Intensität der Auswirkungen wird von der Temperaturerhöhung abhängen, so dass auch hier nur Bandbreiten angegeben werden. Der Meeresspiegelanstieg wird bis zum Ende des Jahrhunderts weitere 19 bis 58 Zentimeter betragen. Ein weiterer Anstieg über die kommenden Jahrhunderte ist aufgrund der Reaktionsträgheit des Systems nicht mehr zu verhindern. Dies ist besonders problematisch, weil viele Menschen in küstennahen Regionen leben. Dies gilt vor allem für die großen Flussdeltas Afrikas und Asiens und die kleinen Inselstaaten.

Mit regionalen Ausnahmen wird die Wasserverfügbarkeit bis 2050 in den höheren Breiten insgesamt um 10 bis 40 Prozent zunehmen, während sie in den Tropen und Subtropen um 10 bis 30 Prozent abnimmt. In vielen Entwicklungsländern wird dies insbesondere dort drastische Folgen haben, wo bereits heute Wasserknappheit herrscht.

Dem IPCC-Bericht zufolge wird die Intensität und teilweise auch die Häufigkeit von Extremwetterereignissen wie Dürren, Starkregen, tropische Zyklone usw. zunehmen.

Die Widerstandsfähigkeit vieler Ökosysteme wird durch die Kombination aus Klimaveränderungen, damit verbundenen Störungen wie Überschwemmungen, Dürren, Flächenbränden und Ozeanversauerung und andere Stressfaktoren wie Umweltverschmutzung und Übernutzung stark geschwächt werden. Besonders anfällige Ökosystemen sind dabei Korallenriffe und Feuchtgebiete.

Bei einer Temperaturerhöhung von 1,5° bis 2,5°C werden voraussichtlich 20 bis 30 Prozent der Arten auf dem Planeten vom Aussterben bedroht sein.

In der Kombination der oben genannten Faktoren prognostiziert der IPCC-Bericht, dass in den niederen Breiten die landwirtschaftliche Produktivität abnehmen wird und damit Hungersnöte zunehmen werden. Neben der erwarteten Mangelernährung wird sich der Klimawandel auch durch die Ausbreitung von Krankheitsüberträgern (Malaria, Dengue, usw.) und damit eine Zunahme von Erkrankungen negativ auf die Gesundheit auswirken.

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Foto: Petersen

Das IPCC rechnet mit einer weiteren Zunahme extremer Wetterverhältnisse.

Mitigation of climate change – new opportunities for rural development

Being one of the sources of climate change, rural areas can and should also contribute to mitigation. Examples of mitigation in rural areas may include bio-fuel generation from agricultural biomass or solar energy replacing power using fossil energy, afforestation and reforestation for carbon sequestration. Mitigation should also include the livestock sector. According to a recent study, «the livestock sector is a major player, responsible for 18 percent of greenhouse gas emissions, measured in CO_2 equivalents. This is a higher share than transport» (FAO/LEAD, *Livestock's Long Shadow,* FAO 2006). Mitigation projects in the livestock sector could aim for intensification, improved diets for ruminants to reduce methane emissions or improved manure management.

There are established official and various private mechanisms through which rural people can even be compensated for mitigation activities. The Kyoto Protocol provides a Clean Development Mechanism (CDM), through which industrialized countries (Annex I) can implement emission-reducing projects in developing countries (non-Annex I parties) in return for certified emission reductions. The market for carbon credits has recently grown rapidly, not only under the CDM. Many offsetting companies operate in developing regions and sell carbon credits to industries that need to fulfil reduction commitments or seek to be «emission-neutral» on a voluntary basis.

In order to be eligible for financial support under CDM, participants have to fulfil a complex set of rigid criteria. These are certainly needed to avoid misuse and ensure additionality of emission reduction. However, not surprisingly, small and poor countries find it difficult to comply with these criteria. For example, of the 696 registered CDM projects, only 20 (2.9 %) are in Africa, whereas the majority are in Latin America and Asia/Pacific. This is regrettable because low income countries miss a chance to receive support for sustainable development and transfer of environment friendly technologies, including from private sources. Rural communities need technical assistance in identifying potential emission-reducing projects.

Emission reduction through bio-energy investments has expanded rapidly in recent years. As crude oil prices continue to rise, more such investments will become profitable. However, the production of biomass for bio-energy competes with the production of food or animal feed for scarce land and water. This may cause food prices to rise and poor net buyers of food can be hit hard. With further growth of bio-fuel production, this may develop into greater hunger problems that will need policy responses.

Adaptation to Climate Change – Examples for Rural Areas

- Impact assessments, monitoring, early warning;
- Land use planning;
- Upgrading physical infrastructures;
- Adapting farming systems, for example:
  - expanding or improving irrigation systems,
  - diversifying production structures away from the emerging drought or moisture risks,
  - breeding plants and animals with greater pest resistance and tolerance to new stress factors.
- Insurance and new risk transfer mechanisms;
- Adaptations in rangeland and wildlife management.

Options for adaptation to climate change

The practical response to climate change has so far focused mainly on mitigation. In the long run, this is certainly the right emphasis. However, mitigation will not influence the effects of climate change already underway. Therefore, adaptation to the foreseeable changes must also be given priority.

The main aim of adaptation must be to reduce vulnerability of habitats, ecosystems and infrastructures; another aim should be to make the best of the changed climate by improving the responsiveness, in particular of the production systems. Comprehensive adaptation strategies should comprise impact assessments, monitoring and early warning; land use planning and upgrading physical infrastructures in disaster prone locations (see Box). Farming systems may need to be adapted by investing in new or enhancing existing irrigation systems, diversifying production structures away from drought or moisture risks and selecting plants and livestock with greater pest resistance and tolerance to new stress factors. The range of appropriate adaptation measures goes beyond physical investments and should include institutional reforms that help enhance resilience against weather shocks. It should even include modern risk transfer mechanisms such as catastrophe bonds, which allow borrowers to benefit from debt defaults when a defined catastrophe occurs. Special adaptations will also be needed in coastal low lands, in rangelands and in wildlife management.

In line with the provisions of the Kyoto Protocol, the international donor community is expected to provide support of adaptation efforts. Yet, most rural communities are not fully aware of the opportunities for investment in adaptation. A worldwide concerted effort is needed, including research and technology transfer.

Conclusions

The developing countries have so far contributed relatively little to the causes of global warming. Yet their people, in particular the poor, bear a disproportionate share of the costs, including loss of production potential and exposure to natural disasters.

Developed countries should therefore work with partners and assist rural people in developing countries, in particular the least developed countries, in their effort to include mitigation and adaptation to climate change in their development programmes. Naturally, such assistance can only be effective in countries whose governments have the political will to change priorities drastically in favor of the rural/agricultural sectors. The trend of under- and disinvestment in agriculture must be reversed especially in those areas where hunger is most prevalent and environmental degradation has been progressing.

Adaptation and mitigation should be well coordinated with other development activities, making use of existing synergies. In other words, promotion of agricultural and non-agricultural development in rural areas, food security policies, ecosystem management, climate change and disaster management should not be pursued in parallel, but be integral parts of one and the same rural development programme.

Instead of moving towards further ecosystem degeneration and increasing hunger and poverty in many fragile areas, such comprehensive programmes can be expected to mobilize positive ecosystem services, create greater resilience against the effects of climate change and reduce greenhouse gas emissions from rural areas. Inclusion of climate change mitigation and adaptation in payments for ecosystem services will give young people a perspective for their rural livelihoods and recognize rural women and men not just as producers of agricultural commodities, fish or timber, but as providers of multiple services that contribute a mix of private and public goods.

This article is a modified version of a key note address given by the author at the «Second European Forum on Sustainable Rural Development», in June 2007 in Berlin.