

# CLIMATE CHANGE AND LAND TENURE

## THE IMPLICATIONS OF CLIMATE CHANGE FOR LAND TENURE AND LAND POLICY



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IIED (International Institute for Environment and Development) and  
Natural Resources Institute, University of Greenwich

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*The views expressed in this publication are those of the authors and do not necessarily reflect the views of the Food and Agriculture Organization of the United Nations (FAO).*

## List of abbreviations

|        |   |
|--------|---|
| AD     | Avoided Deforestation                                       |
| CBNRM  | Community-Based Natural Resource Management                 |
| CC     | Climate Change  |
| CDN    | Clean Development Mechanism                                 |
| ECOWAS | Economic Community of West African States                   |
| FACE   | Forests Absorbing Carbon Dioxide Emissions                  |
| FAO    | United Nations Food and Agriculture Organisation            |
| FPCF   | Forest Carbon Partnership Facility                          |
| FPIC   | Free, prior and informed consent                            |
| ICZM   | Integrated Coastal Zone Management                          |
| IFPRI  | International Food Policy Research Institute                |
| IIED   | International Institute for Environment and Development     |
| IPCC   | Inter-governmental Panel on Climate Change                  |
| IUCN   | International Union for the Conservation of Nature          |
| LULUCF | Land Use, Land Use Change and Deforestation                 |
| MDGs   | Millennium Development Goals                                |
| NAPA   | National Adaptation Programme of Action                     |
| NGOs   | Non-Governmental Organisations                              |
| NLUP   | National Land Use Plan (Bangladesh)                         |
| NRI    | Natural Resources Institute (University of Greenwich)       |
| ODI    | Overseas Development Institute                              |
| OECD   | Organisation for Economic Cooperation and Development       |
| PES    | Payment for Environmental Services                          |
| RED    | Reduced Emissions from Deforestation                        |
| REDD   | Reduced Emissions from Deforestation and forest Degradation |
| UNFCCC | United Nations Conference on Climate Change                 |
| WGCCD  | Working Group on Climate Change and Development             |
| WRM    | World Rainforest Movement                                   |
| WWF    | World Wide Fund for Nature                                  |

## TABLE OF CONTENTS

|   |           |
|---|-----------|
| <b>Summary</b> .....  | <b>1</b>  |
| <b>1. Introduction and background</b> .....   | <b>4</b>  |
| 1.1 Objectives, scope and methodology of the study.....   | 4         |
| 1.2 Key concepts and relevant climate change projections.....   | 5         |
| 1.3 Existing literature on land and climate change.....   | 7         |
| 1.4 Structure of the paper.....   | 8         |
| <b>2. Climate Change and land issues: linkages</b> .....  | <b>9</b>  |
| 2.1 Framework for understanding the linkages between climate change and land, and<br>the land tenure / policy implications..... | 9         |
| 2.2 Regional impact scenarios.....  | 11        |
| <b>3. The land related impacts of climate change and adaptive challenges</b> .....  | <b>14</b> |
| 3.1 Sea level rise and impacts on low lying coastal and delta areas.....  | 14        |
| 3.2 Impacts on human settlement in coastal cities.....  | 23        |
| 3.3 Climate change impacts on agriculture in Africa's drylands.....   | 30        |
| 3.4 Increased glacial melt and impacts on irrigation schemes and tenure arrangements<br>for irrigation.....                     | 36        |
| 3.5 Land tenure implications of avoided deforestation and carbon offset forestry.....   | 39        |
| 3.6 Climate change, land and indigenous peoples.....  | 44        |
| 3.7 Gender, climate change and land.....  | 48        |
| <b>4. The implications of climate change for land policy</b> .....  | <b>52</b> |
| 4.1 Critical issues.....  | 52        |
| 4.2 Land tenure related measures.....   | 54        |
| 4.3 Integration of land into climate change adaptive planning.....  | 54        |
| 4.4 Priorities for further research.....  | 56        |
| <b>Bibliography</b> .....   | <b>58</b> |
| <b>ANNEX: Developed country adaptation to sea level rise</b> .....  | <b>62</b> |



## Summary

This document analyzes the implications for land tenure and land policy of climate change. It assesses the implications of ongoing anthropogenic climate change resulting from greenhouse gas emissions for land tenure and the role that land policy can play in climate change adaptation planning in the developing world; it also sets out a simple framework for tracing the linkages between climate change, impacts on land use systems, and the land tenure implications, including those which result from adaptation and mitigation responses to global warming.

Although the linkages between climate change and land tenure are complex and indirect, the effects of climate change and variability are felt through changes in natural ecosystems, land capability and land use systems. Increasingly, these changes will place diminishing supplies of land under greater pressure, for both productive use and human settlement. As a result land issues and policies should be key considerations for adaptation planning, so as to strengthen land tenure and management arrangements in at risk environments, and secure supplies and access arrangements for land for resettlement and changing livelihood demands.

The central chapter of this paper explores the implications of climate change scenarios in more depth to identify the requirements and practical scope for land policy related interventions in developing appropriate adaptive responses. The cases examined include low lying coastal areas and river deltas affected by sea level rise and increasingly frequent and severe storm events, especially in South Asia, major coastal cities (again in South Asia), semi arid areas of sub-Saharan Africa facing increased aridity and climate variability threatening the sustainability of agriculture (specifically, exploring adaptations to existing climate variability in the Sahel), and irrigation systems supplied by glacial melt-waters.

Moreover it explores the land tenure implications of carbon emissions reduction through avoided deforestation and reforestation schemes, together with the implications of climate change for indigenous people's and women's land rights. The paper finds that climate change reinforces the urgency of scaling up the delivery of secure land tenure over land and natural resources, using low cost, decentralised systems of documentation and building where possible on functional informal systems. Adaptation also requires increasing emphasis on land use regulation, the governance of land resources, and the delivery of land in safe and secure sites for informal urban settlements, and both temporary and in some cases permanent resettlement for populations that have to move.

There are three critical problems which cross cut the range of at risk areas in developing countries, and which land policies need to address:

- i) Land use and settlement in areas facing significant direct risks from climate change - notably low lying coastal areas, including cities and river deltas, and particularly in those areas at serious risk in South Asia.
- ii) Accelerated provision of secure land tenure arrangements to enhance households and communities capacities to adapt to climate change impacts on livelihoods and food security.

iii) Measures to protect the poor and vulnerable from loss of livelihood resources and develop the opportunities available for them to gain direct benefits as a result of climate change mitigation measures

In conclusion, the paper makes recommendations on integrating land policy measures with wider adaptive planning, also identifying gaps in understanding of region and country specific climate change impacts and the scope for land tenure and land use adaptations.

In relation to land policy, the paper recommends strengthening existing efforts to:

- *Provide tenure security for all through a diversity of forms of tenure*, to improve land access for the poor, and to strengthen their negotiating position
- *Improved land and natural resource information*: including improved inventories of land occupation in urban and rural areas including the informal sector; improved analysis and mapping of natural hazard risks for informal settlements; better inventories of land available for resettlement or temporary relocation
- *Strengthen land administration*: including increasing capacity for low cost land survey and registration and for comprehensive, socially inclusive land information systems; devolving land administration responsibilities to more local levels; safeguarding against corruption in land administration

In addition, national and regional climate adaptation initiatives should incorporate important land and resource tenure dimensions including:

- *Resettlement planning* for populations at risk of displacement and loss of livelihoods
- *Integrated land and water resource management*
- *Special programmes for land and natural resource tenure in semi arid areas subject to climate change*: pastoralist custodianship of rangeland areas, territorial plans for water resource management are high priorities
- *Effective regulatory frameworks, standards and monitoring arrangements for carbon mitigation schemes* which threaten to undermine land access and use rights of poor and vulnerable groups, such as market based avoided deforestation / reforestation programmes and biofuels development

Practically oriented research can make potentially important contributions in strengthening adaptive planning. Research should combine case-by-case regional climate modelling with assessment of the quality of available information about land occupation, use and tenure conditions, and the capacity of land institutions on the ground. Research priorities identified include:

- *Regional impact modeling*: to understand the likely land use impacts at regional and sub-regional scales in the developing world



- *Country and area studies*: in depth using 2050 impact scenarios; existing land policies, tenure systems, institutional and governance frameworks, available land for new settlement and productive activities, demographic features and the links with national adaptation plans, strategies and capacity issues, focused on priority areas
- *Thematic research to inform specific aspects of adaptation planning*: including climate proofing land policies so they can better address climate change risks, integrated land and water management and opportunities for the poor in developing countries to benefit from carbon mitigation and low carbon economic development

Given the increases in mobility, migration and land competition that are likely to result from climate change, and the fact that the poor will be disproportionately affected, there is a general need to strengthen the governance arrangements over land based natural resources on which the poor and vulnerable depend. This means not only paying attention to lands issues in climate change mitigation planning but ensuring that land tenure and land use management have central places in sustained efforts to improve the governance frameworks for both rural and urban development.

## **1. Introduction and background**

The direct impacts of climate change on human land use systems and land occupation could potentially have a range of impacts on land access and tenure, with both direct and indirect negative repercussions on human livelihoods, welfare and prosperity. Yet despite the wide publicity given to climate change, there is still very limited understanding of the relationships between the impacts of climate change, social and policy responses, and land tenure. Accordingly, FAO has identified a need for scoping studies to partially address this knowledge gap and thereby build a basis for sound policy making.

This paper aims to identify key issues related to land tenure in the context of ongoing climate change and current climate variability. The paper draws extensively on IIED's and NRI's existing stocks of knowledge and field research relating to climate change adaptation and to land tenure and land policy, as well as on more widely available published information on climate change and climate change adaptation.

### **1.1 Objectives, scope and methodology of the study**

The terms of reference for the study ask for a review relevant literature and of IIED's own stock of field research and knowledge to identify key issues related to land tenure in the context of climate change and variability, including the effects of climate change and variability on existing land tenure arrangements, and appropriate changes to land tenure policies and practices to mitigate climate change and variability. The review is intended to cover key concepts and relevant forecasts, players, drivers and significance of effects, also addressing gender considerations.

Because of the diversity of land tenure conditions and land policies across the globe, as well as the likely divergence in climate change impacts across countries and major regions, it is necessary to examine specific regional impact assessments explicitly in order to understand the possible implications for land tenure and land policy. However only limited assessment of regional impacts in the developing world is currently available (see IPCC Working Gp 1 2007, Warren et al 2006). Moreover, this concentrates on the impacts of biophysical systems impacts, with some consideration of the implications for land use systems, rather than detailed examination of social and economic impacts and possible adaptive responses in specific country cases. Nevertheless these assessments provide the starting point for the analysis of land tenure and land policy implications in this paper.

Accordingly, the paper:

- Sets out a conceptual framework for understanding and examining the linkages between climate change impacts and lands issues, summarising the principle types of climate change impacts on biophysical systems, the likely consequences for land use and land occupation, drawing on the existing literature.
- Summarises the main anticipated impacts of climate change in major global regions
- Identifies a series of key thematic issues relating to the main land related impacts of climate change, and discusses people's vulnerabilities to these impacts in particular types of environment and parts of the world, and the scope for adaptation, highlighting the roles that secure land tenure and forward looking land

policies can play. The paper also considers the land tenure implications of carbon emissions mitigation in forest environments and identifies appropriate policy responses.

- Draws together the main implications of climate change for land policies, together with gaps in knowledge and research priorities, and considers how land issues can be better integrated into climate change adaptation planning.

Rather than presenting an explicit literature review, this paper refers to relevant work and its findings in the course of outlining possible implications for land tenure and land policy in specific regions and for particular social groups.

### 1.2 Key concepts and relevant climate change projections

This paper uses the following working definitions:

- *Climate change* refers to ongoing changes in the global climatic system resulting primarily from anthropogenic global warming as a consequence of the increased and continuing emissions of greenhouse gases due to energy production and consumption, industry, agriculture and the loss of vegetation cover and other Carbon sinks.
- *Climate variability* refers to established cyclical variations in aspects of the world's climate and weather patterns over wide areas originating from variations in the earth's rotation and cyclical changes induced by variations in ocean currents and other factors. The best known of these established cycles is the El Niño Southern Oscillation. The impacts of climate change are superimposed on the ongoing effects of climate variability and in general can be expected to accentuate, complicate or disrupt observed patterns of variability.
- *Climate change impacts* refers to the direct impacts of the changing climate on key variables such as ocean and atmospheric temperatures, precipitation, sea levels and frequency of storm events, together with the impacts these changes are expected to have on biophysical systems, human land use and productivity, social and economic systems
- *Climate change adaptation* refers to spontaneous or organised processes by which human beings and society adjust to changes in climate by making changes in the operation of land and natural resource use systems and other forms of social and economic organisation
- *Climate Change mitigation* refers to organised processes whereby society seeks to reduce the pace and scale of climate change by reducing the rate of Carbon and other greenhouse gas emissions use and increasing the rate at which atmospheric Carbon is sequestered through absorption by natural vegetation or other forms of carbon sink
- *Land tenure* refers to the terms under which land and natural resources are held by individuals, households or social groups
- *Land policy* refers to the set of rules, regulations, laws and strategies adopted by governments to govern land tenure, land holding, land access, land distribution, and land resource utilisation, land occupation, land related planning processes and the settlement and management of land disputes and land conflicts.

Reports of the International Panel on Climate Change (IPCC) indicate that the probable bounds of climate change expectations will have significant impacts across a wide range of geographical areas and human societies and look at the prospects for and implications of mitigation. The Stern Report (2007) has drawn together scientific expectations of some of these broader impacts and the associated challenges for human adaptation and carbon emissions mitigation. The impacts include:

- Declining crop yields, especially in Africa, could leave hundreds of millions without the ability to produce or purchase sufficient food. At mid to high latitudes, crop yields may increase for moderate temperature rises (2-3°C), but then decline with greater amounts of warming. At 4°C and above, global food production is likely to be seriously affected.
- Rising sea levels will result in tens to hundreds of millions of people more flooded each year with warming of 3 to 4°C. There will be serious risks and increasing pressures for coastal protection in South East Asia (Bangladesh and Vietnam), small islands in the Caribbean and the Pacific, and large coastal cities, such as Tokyo, New York, Cairo and London. According to one estimate, by the middle of the century, 200 million people may become permanently displaced due to rising sea levels, heavier floods, and more intense droughts.
- Melting glaciers, increasing flood risk and subsequently reducing water supplies, eventually threatening one sixth of the world's population, predominantly in the Indian sub-continent, parts of China and the Andes in South America
- Worldwide increases in deaths from malnutrition and heat stress. Vector-borne diseases such as malaria and dengue fever could become more widespread if effective control measures are not in place.
- Ecosystems will be particularly vulnerable to climate change, with around 15-40% of species potentially facing extinction after only 2°C of warming. And ocean acidification, a direct result of rising carbon dioxide levels, will have major effects on marine ecosystems, with possible adverse consequences on fish stocks.

The damages from climate change will accelerate as the world gets warmer as a result of unpredictable and irreversible effects.

Higher temperatures will increase the chance of triggering abrupt and large scale changes.

- Warming may induce sudden shifts in regional weather patterns such as the monsoon rains in South Asia or the El Niño phenomenon – changes that would have severe consequences for water availability and flooding in tropical regions and threaten the livelihoods of millions of people.
- A number of studies suggest that the Amazon rainforest could be vulnerable to climate change, with models projecting significant drying in this region. One model, for example, finds that the Amazon rainforest could be significantly, and possibly irrevocably, damaged by a warming of 2-3°C.
- The melting or collapse of ice sheets would eventually threaten land which today is home to 1 in every 20 people.”

These impacts of climate change can be expected to have a range of direct impacts on land use systems, with both direct and indirect repercussions for land access and land tenure. Shifts in climatic regions, rising sea levels and increases in extreme climatic events are likely to reduce the availability of land suitable for human settlement and agricultural production, as a result of temperature increases, sea level rise and associated flooding, and restrictions in water supply, leading to population migration and displacement and the need to adjust livelihood patterns to new circumstances. These changes will involve increased competition for land and are likely to trigger changes in access to land and land tenure arrangements.

In this paper we make no assumptions about continuing levels of carbon emissions, levels of warming and the effects on biophysical systems and on land use, or which of the various IPCC emissions scenarios is likely to obtain, given the uncertainties surrounding these. Rather than considering possible longer term impacts and how land policy might need to adapt to these, we focus on the likely range of impacts in the medium term, up to 2050, which reflect a possible 1–3° C temperature rise, considering specific regional impact information where this is available. We take this approach for a number of reasons:

- A temperature rise within this range is now regarded as virtually certain as a result of past and current emissions (and is most likely to fall in the range of 1–2°C by 2050 under the different IPCC continuing emissions scenarios).
- 2050 represents the limit of scenarios which can be addressed by current generations of policy makers and practitioners, and there is a need for policy to begin adapting now to incremental changes and impacts
- Near future climate trends and impacts within this period can more easily be extrapolated and anticipated from current knowledge, representing more tangible scenarios for which policy can grasp and prepare for.

### **1.3 Existing literature on land and climate change**

The available climate change impact studies which address questions of land use under likely and possible future scenarios of cumulative carbon emissions provides an important starting point for this review. In addition there is a growing literature on agricultural impacts although tends to focus on specific crops, in particular those of greatest economic significance in developed countries, with less emphasis on the impacts on agricultural production systems, farming peoples and livelihoods in the developing world. There is also considerable discussion of the likely and possible impacts of climate change induced sea level rise and increasing frequency and intensity of extreme weather events on low lying coastal areas and islands, and some analysis of possible changes in flood regimes in major river systems, relating to increases in the rate of melting glaciers, as well as to rainfall and storm events and sea level rise. The implications of climate change for urban areas including settlement, housing and the requirements for improved urban land use planning is another topic on which a research based literature is emerging. To date however no research has addressed directly and systematically the land tenure related impacts of climate change, and only a very limited range of literature is available on the topic. Some empirical evidence is available which illustrates the impacts of existing climate variability on certain types of land use and tenure systems and for particular groups such as pastoralists and indigenous groups, as well as the gender impacts. Finally there is a growing body of policy related literature generated by development agencies

and NGOs which addresses the broader overall social and economic impacts of climate change for the poor and in developing countries and the implications for international and national adaptation planning.

Inevitably, given the uncertainties about climate change impacts in specific regions and the rate at which these will be played out and the complexity of the implications for production and livelihood systems, much of the emerging literature is forward looking and speculative in nature. At the broadest level, as the World Bank notes<sup>1</sup> *“the need to promote poverty reduction in a carbon constrained world may lead to fundamental shifts in the way development is understood”*. On the other hand, however: *“Adapting to current climate variability is already sensible in an economic development context, given the direct and certain evidence of the adverse impacts of such phenomena”* (IPCC Working Group 2 Ch 17).

#### **1.4 Structure of the paper**

To consider how land policy may need to respond to climate change requires more detailed consideration of impact scenarios in particular regions and land use systems, and evidence about how human land use and the institutions which manage and regulate it respond to current changes and variability.

- First, Section Two, below sets out a general framework / model to help in tracing through and understanding the complex linkages between climate change and variability, land use change, human adaptation and the tenure and land policy implications. It then summarises by way of a table the main anticipated impacts of climate change on biophysical systems and land use, and the types of implications these may have for land policy, with some indication of the global regions which are likely to be particularly affected in each case.
- Section three considers the principal climate change impacts with on human settlement and land use, illustrated by discussion of specific themes in relation to vulnerable countries and regions, the adaptive options they face and the land tenure and land policy implications.
- Section 4 considers the issues of “climate proofing” land policies and integration of land policy into adaptive planning, and outlines a research agenda to inform this process in relation to the main land related risks and impacts in different regions.

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<sup>1</sup> *Exploring the social dimensions of climate change: a proposal for a program of work*, World Bank Social Development Department August 2007

## **2. Climate Change and land issues: linkages**

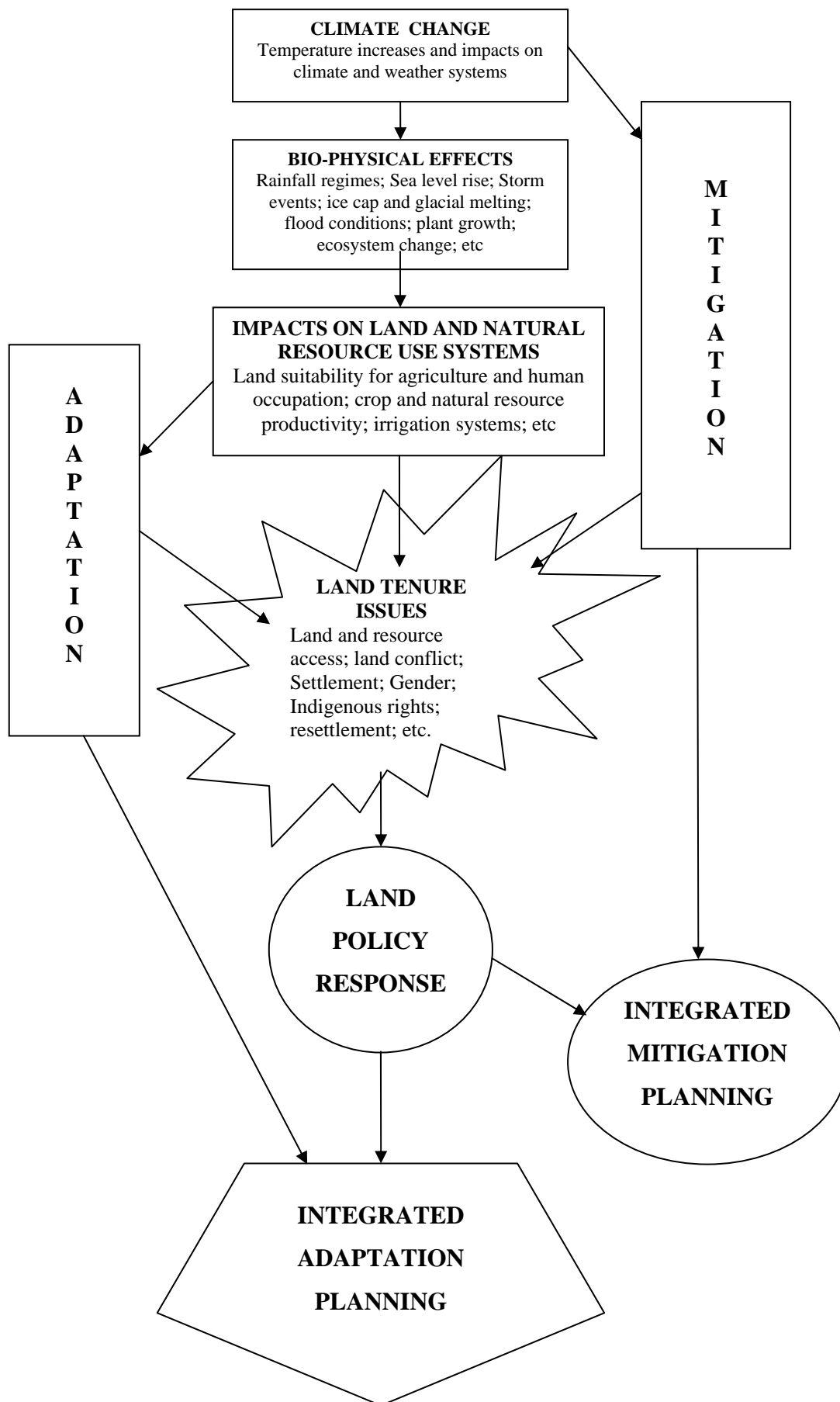
The linkages between issues of climate change and variability and questions of land tenure are multiple, complex and indirect. However, the effects of climate change and variability are felt through changes in natural ecosystems, land capability and land use systems. Increasingly, these changes will place diminishing supplies of land under greater pressure, for both productive use and human settlement. As a result land issues and policies are key considerations for adaptation planning, which will need to strengthen land tenure and management arrangements in at risk environments, and secure supplies and access arrangements for land for resettlement and changing livelihood demands.

This, in fact, is the key argument of this paper. We therefore begin here by setting out an overall framework whereby the linkages between climate change and land can be traced through and understood.

### **2.1 Framework for understanding the linkages between climate change and land, and the land tenure / policy implications**

- i. The starting point is to identify the main elements of climate change and its effects on the land and natural resource use systems where the impacts will be felt most directly.
- ii. The next is to consider the implications for land occupation and systems of land holding and land tenure of climate induced changes to land and natural resource systems, including both abrupt changes result from increased extreme weather events and more gradual changes. The land tenure implications may be direct, in that abrupt or long term changes in land use will displace or significantly disrupt human settlement and land based production systems, or indirect, in so far as land use changes in agriculture and natural resource utilisation may drive changes in tenure systems over time.
- iii. Thirdly climate change will lead to spontaneous adaptations by land and resource users, and generate requirements for systematic adaptation planning by society at different levels, which may affect land tenure systems. These adaptations include agricultural change including changes in cropping zones, intensification of production systems, greater competition for access to land, water and pasture, economic diversification from dependency on affected resources, urban and rural migration, and policies for improved land use, resettlement, better environmental regulation of land based resource use, and for protection of natural resources and human settlements.
- iv. Tenure implications of mitigation measures should also be considered, including policies avoided deforestation, and development of additional carbon sinks and alternative energy sources including biofuels, which involve significant commercial opportunities for existing and also for new land users.
- v. Finally the implications for land policies of anticipated Climate Change – land use impact – adaptation and mitigation – land tenure causal chains for specific types of impact and countries / sub-national regions need to be considered, together with the matter of better integration of land policies with adaptation and mitigation plans and broader national development frameworks.

**Figure 1. Framework for assessing land and climate change linkages**





Such a framework can be applied to help assess the general land tenure and land policy implications of climate change impacts but can also be applied to specific regional, country or local cases according to the specific climate change effects and impacts predicted under different emissions scenarios. Impacts will remain uncertain because of uncertainty as to continuing levels of emissions and the temperature rises these will provoke. However the principal constraint in understanding the impacts of existing and continuing emissions and the 1 – 3° C warming range that is virtually certain to occur up to 2050 results from the lack of detailed regional impact studies for the developing world based on existing models.

The likely effects of climate change on land use, land occupation and settlement demand that the mainstreaming of climate change adaptation into national and supra-national planning and policy frameworks should include land policy. Land policies are currently widely debated and subject to ongoing processes of reform, presenting opportunities to ensure that land policies are adequately “climate proofed” as part of the reform process, so as to anticipate the future demands of climate change. The likely requirements for resettlement, changes and relocation in cropping systems, government land acquisition, improved land use regulation and environmental protection as part of national adaptation strategies mean that land policy itself needs to be clearly mainstreamed within national planning and adaptive frameworks. Governments and international agencies should seek to develop and adapt land tenure policies incrementally so as to better address the impacts of climate change over time, beginning with the climate events and changing patterns of variability which can currently be observed.

Although the linkages between issues of climate change and variability and questions of land tenure are however complex and indirect, it is certain that land use change and adaptive interventions by the state will have a variety of tenure implications. Broadly speaking land policy and tenure systems need to deliver adequate tenure security, so as to provide incentives for good land and resource management and reduced vulnerability, but also display sufficient flexibility to allow land rights to be reassigned to cope with increasing land use change and the human displacement and migration, and associated growth in land competition and land use conflict that can be expected to resulting from climate changes and intensified extreme events.

Climate change raises questions for land policies as a whole and not only for questions of tenure security, but also wider issues of land access and redistribution, urban settlement, the governance of land resources, reform and development of land institutions, management of common property resources, land use regulation and environmental protection, land conflict and the potential demands for settlement generated by mass displacement resulting from the growth of natural calamities, and potentially, civil conflict, to which climate change is contributing.

### **2.2 Regional impact scenarios**

This section summarises the broad regional implications of existing climate models for 1-3° C warming scenarios up to 2050

### **Africa**

Most studies agree that Africa will be hardest hit by the effects of temperature rises, decreases in moisture availability and changing rainfall patterns and on crop production because of the high dependence (approximately 70% of Africa's population) on agriculture. 95% of cropland is devoted to rainfed agriculture (FAO cited by IFPRI 2007). Whereas some areas may benefit from increases in rainfall, much larger areas will face severe moisture limitation (80,000km<sup>2</sup> and 600,000km<sup>2</sup> respectively according to UNFPCC cited in IFPRI 2007). Temperature and rainfall predictions indicate a risk of agricultural collapse in North Africa where crop failures, desertification, and water resources stress could be expected to cause climate-induced migration of people from the region (Warren et al 2006) and overall trends for drying and reduced food security in southern Africa. In both West and Southern Africa maize yields are likely to fall resulting from the combinations of increased temperature and lower and more variable rainfall, possibly leading to increased famine and malnutrition in the absence of shifts to more drought tolerant crops. Existing model projections vary for the Sahel where there are possibilities of the emergence of a more humid rainfall regime, or of greater rainfall variability with more frequent localized and seasonal flood events.

### **Asia**

In coastal areas of South Asia livelihoods and lives are at risk from flooding, land loss and salinisation due to salt intrusion, with a potentially massive impact on human settlement and livelihoods. Bangladesh and other parts of the Gangetic plain are likely to be affected by increased seasonal flooding and changes in flood regimes as a result of increased melting of Himalayan glaciers. Semi arid areas of south Asia and Central Asia dependent on rain fed farming are likely to see increased crop failures which may destabilize the Central Asian region politically (Warren et al / Tyndall Centre 2006).

### **Latin America**

Water resource stress is expected to increase and crop yields to decrease, particularly in the dry Andean *altiplano* and in Northeast Brazil. The Amazonian region may be subjected to a drying trend, with large biodiversity loss (Warren et al / Tyndall Centre 2006) compounding deforestation risks and feeding back to heightened CO<sub>2</sub> concentration. Glacial fed hydrological and irrigation systems in Andean regions are likely to be affected by accelerated glacial melting resulting in increased water availability in the short term with longer term declines.

### **Oceania / Island states**

Small island sub-regions in the Pacific and Indian Oceans are highly threatened by flooding and submergence due to sea-level rise. The economy of the Caribbean whose economy will be affected by sea level rise combined with damage to coral reefs and associated fisheries due to increased acidification resulting from marine CO<sub>2</sub> absorption.

**TABLE 1. Land-related impacts, risks and policy implications of 2050 1-3° C emissions scenarios**

| <b>IMPACT TYPE</b>                                   | <b>Specific Land Use Impacts</b>   | <b>Human impacts with tenure implications</b>   | <b>Regions affected</b>  | <b>Land tenure and policy issues</b>   | <b>State of knowledge and research needed</b>   |
|--|--|---|--|--|---|
| Temperature rise                                     | initial increases followed by reductions in crop yields  | reduced food production and food security (in tropical regions); changes in land suitability for different crops; increased land competition and exits from agriculture   | All regions but with greatest impacts in arid and semi-arid regions                        | Tenure security for retention of land holdings investment in improved land use; land reallocation and access due to changes in land suitability  | More detailed impact studies for main developing country arable crops and associated livelihood / production systems  |
| Reduced rainfall and greater rainfall variability    | Lower moisture availability for agriculture  | reduced food production and food security (tropical regions); increased land competition and exits from agriculture; competition for water use  | Semi arid farming regions: Sahel, Southern Africa, South Asia, Andean region and NE Brazil | As above; need for improved water resource management and strengthened governance of remaining productive areas  | More detailed region / country impact studies and analysis of: existing adaptive systems; changing requirements for food security, research & extension, migration; options for diversification |
| Possible increases in rainfall                       | Possible increases in land and NR productivity   | unpredictable, with flood risks; may lead to new opportunities involving in / out migration and resource competition  | Sahel, parts of NE Brazil on some models   | Formal and informal institutions to manage mobility, land use / tenure change, and regulate conflict where new opportunities emerge  | Impacts highly uncertain. Analysis of existing adaptive systems to variability in dry-sub-humid regions; systems for dryland water and flood management   |
| Sea level rise / increased frequency of storm surges | Coastal and inland flooding; salinisation of coastal lands   | Urban and rural displacement and migration; declines and losses of coastal and riverine resource and livelihood systems   | Coastal, deltaic and low lying areas, especially S and SE Asia, island states              | Greater tenure security to facilitate adaptive management; resettlement and facilitated migration; compensation for land loss; improved land inventory; land sharing and release schemes | More detailed country / regional impact studies; assessment of land availability, resettlement and policy options   |
| Increased glacial melt                               | Initial greater and earlier seasonal volume of melt waters with heightened flood risk; longer term declines in melt waters | Short run implications for management and seasonal use of glacial melt waters. Longer run declines in productivity and sustainability of glacial fed irrigation systems. Risks to settlement in sub-glacial areas | Arable lowlands fed by Andean and Himalayan glacial systems (Indus / Ganges basins)        | Dam construction for seasonal water / flood management, some short term displacement and resettlement; better land and water management in irrigation systems                            | More detailed impact studies on specific hydrological and irrigation systems  |
| Biodiversity loss                                    | Extent and diversity of natural ecosystems   | Threats to hunting & gathering / extractivist livelihood systems Increased pressures on particular species and ecosystems   | All major biomes, especially arctic, coral reefs, tropical forest, other hotspots          | Better governance of common lands; conservation of genetic resources and indigenous knowledge  | More detailed impact studies linked to assessment of socio-economic / livelihoods impacts for NR dependent groups   |

### **3. The land related impacts of climate change and adaptive challenges**

Based on the main anticipated impacts on land use systems (summarized in Table 1), and the available literature on vulnerability and adaptation, this section illustrates the implications for land tenure and the likely adaptive requirements for land policy by exploring these in greater depth by way of a series of thematic case studies. The first four of these address the major land use impacts with reference to particular regions, countries and types of environment which are likely to be particularly affected:

1. Impacts of sea level rise on land, natural resources and human populations in low lying coastal regions and deltaic floodplains, utilizing the example of Bangladesh
2. Human settlement in coastal cities (using mainly but not exclusively Asian examples)
3. Dryland agriculture and pastoralism, and how adaptation can build on existing adaptations to climate variability in the Sahel and other semi-arid regions of Africa
4. Irrigation systems fed by glacial melt waters and possible land tenure implications of accelerated glacial melt (Andean region and South Asian lowlands).

Using a similar logic, we also consider

5. Land tenure impact of climate change mitigation through avoided deforestation and attempts at Carbon sequestration forestry (using various examples)

We then consider two cross cutting sets of possible land and resource tenure impacts and the role of land policy adaptive measures:

6. Indigenous peoples
7. Gender

#### **3.1 Sea level rise and impacts on low lying coastal and delta areas**

The areas most affected by sea level rise will be low lying coastal regions and deltaic areas where urban settlements, large population concentrations, productive agricultural areas, natural ecosystems and coastal fisheries will be at risk. The land related impacts include the likelihood of increased migration from rural areas where agriculture and natural resource based livelihoods will be undermined into urban areas and other rural areas which may be less affected where greater land competition will occur. There is a likelihood of increased displacement of urban residents particularly in coastal areas, and there will be a need for enhanced systems for land delivery and resettlement in both urban and rural areas. These regions will require improved systems for land use planning, flood risk management, drainage, and coastal protection but also for land access for resettlement and to facilitate both planned and spontaneous migration, including both temporary and permanent displacement as a result of high impact flood events.

According to the Tyndall Centre (Warren et al 1996) the bulk of the population currently exposed to coastal flooding is in South Asia and East Asia, and these regions continue to dominate when predicting future risks, although Africa increases in its relative contribution. Actual experience of flooding (as opposed to risk) depends not

only on sea-level rise, and on other climate related factors including frequency of storm events and storm surges, precipitation levels and rates of glacial melt feeding major river systems but also on population, socio-economic scenarios, and most especially assumptions about protection. Small islands and deltaic areas appear most vulnerable, but contain less people. Greater numbers are at risk everywhere under the high population IPCC A2 scenario, under which sea level rise and frequency of extreme coastal storm events would be greater, but coastal populations would have grown more rapidly and more people would be exposed to the risks.

To summarize the findings of IPCC Wkg Gp 2(Ch 6) large land losses are predicted due to sea level rise is projected if current global, regional and local processes continue. Projected increase in tropical storm intensity would exacerbate these losses and much of this land loss would be episodic, due to storm events, as demonstrated during the landfall of Hurricane Katrina

Sea-level rise poses a particular threat to deltaic environments, especially with the synergistic effects of other climate and human pressures. This is particularly important since many of the largest deltas are home to large urban and rural farming populations and providers of important environmental services. The impacts of sea level rise and increased storm surges on these areas must be seen in the context of the existing and ongoing impacts of human induced land changes. Whereas present rates of sea-level rise are contributing to the gradual diminution of many of the world's deltas, most recent losses of deltaic wetlands are attributed to human development. An analysis of satellite images of fourteen of the world's major deltas<sup>2</sup> indicated a total loss of 15,845 km<sup>2</sup> of deltaic wetlands over the past 14 years. Every delta showed land loss, but at varying rates, and human development activities accounted for over half of the losses.<sup>3</sup>

It is estimated that nearly 300 million people inhabit a sample of 40 deltas globally, including all the large mega-deltas (Ericson et al. 2006). The average population density is 500 people / km<sup>2</sup>, with the largest population in the Ganges-Brahmaputra delta, and the highest density in the Nile delta. Many of these deltas are associated with significant and expanding urban areas. Model projections of the impact of sea level rise and increased flooding indicated that by 2050 more than 1 million people will be directly affected by sea level rise in three mega-deltas alone: the Ganges-Brahmaputra delta in Bangladesh, the Mekong delta in Vietnam and the Nile delta in Egypt. More than 50,000 people are likely to be directly impacted in each of a further 9 deltas, and more than 5,000 in each of a further 12 deltas. 75% of the population likely to be affected lives in Asia, and a large proportion of the remainder live in Africa. Many people in these and other deltas worldwide are already subject to flooding from both storm surges and seasonal river floods, and therefore it is

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<sup>2</sup> Danube, Ganges-Brahmaputra, Indus, Mahanadi, Mangoky, McKenzie, Mississippi, Niger, Nile, Shatt el Arab, Volga, Huanghe, Yukon and Zambezi

<sup>3</sup> In Asia, for example, where human activities have led to increased sediment loads of major rivers in the past, the construction of upstream dams is now seriously depleting the supply of sediments to many deltas with decreased land formation and increased coastal erosion a widespread consequence. Large reservoirs constructed on the Huanghe River in China have reduced the annual sediment delivered to its delta from 1.1 billion metric tons to 0.4 billion metric tons (Li et al., 2004, cited in IPCC Working Gp II, 2007, Ch6).

necessary to develop further methods to assess individual delta vulnerability (IPCC Working Group 2 2007 Ch 6)

The IPCC (2007) report goes on to note that effective policies for coastal development are sensitive to resource use conflicts, resource depletion and to pollution or resource degradation, and that this requires an integrated holistic approach to policy-making. Debate about response to sea level rise in developed countries concentrates on the relative costs and benefits of different combinations of managed retreat and provision of long-term sustainable coastal defenses, the need to increase public awareness, scientific knowledge, and the provision of land and transfer of property rights in lesser developed areas, anticipating encroachment by the ocean, loss of land inland, and migration of wetlands and beaches. Developed country adaptation measures to the threat of sea level rise (see Annex for examples) all involve and direct intervention by the state to bring land into public ownership, undertake increased coastal protection, manage retreat from the coast, regulate coastal land use more carefully and to release land for resettlement inland. Existing property rights and land use practice can make it difficult to achieve such goals.

Adaptation to sea level rise in developing countries are also constrained by lack of resources for effective coastal defenses, limited capacity for land delivery, and in some cases as, limited availability of resettlement land due to high population densities. Intensive land use in delta areas often under informal and undocumented property rights, and where the poor are dependent on seasonal availability of fertile agricultural land and the fisheries and other natural resources deltas provide makes preventative planning particularly difficult.

Although there may be lessons for developing countries, the financial costs of coastal protection may inhibit protection of even the most valuable land, and the benefits to the state of intervening in this way may be minimal since coastal and deltaic land may not generating real value as a result of informal occupation and subsistence. Given that widespread coastal land protection and reclamation are effectively impossible in these areas, the greatest challenge facing developing countries is that of resettlement and provision of alternative livelihoods, if not emergency relief owing to the generally unforeseen nature of high impact flooding and storm events.

The main land policy implication is intensified resettlement planning and a stronger role for the state in land use planning of areas at risk and available for resettlement. This requires investment in land inventory and land occupation surveys in both potential resettlement areas and areas at risk of loss, which in turn requires development of dedicated land information systems. Public land acquisition may be needed both to impede occupation in at risk areas and for resettlement, but this is also likely to require schemes for land sharing or release from private ownership and to promote land rentals and the good use of available public land. In many cases provision of small scale house and garden plots may be the only options, given high population densities and intense competition for land, and resettlement will need to be accompanied by employment generation and diversification out of farming and dependence on natural resources.

## **Vulnerability and adaptation to coastal and inland flooding in Bangladesh**

Bangladesh is at enormous risk from increases in both coastal flooding (from sea and river water) and inland flooding (from river and rain water), as a result of climate change threatening to displace and undermine the livelihoods of tens of millions of people. The country's economy is highly dependent on agriculture and thus highly sensitive to climate variability and change.

Most of Bangladesh lies on the deltaic flood-plain of three major rivers and their numerous tributaries. The low lying coastal zone in Bangladesh is located between the extensive drainage network of the Ganges-Brahmaputra-Meghna river system on one side, and tidal and cyclonic activity from the Bay of Bengal on the other. Most of the country is less than ten metres above sea level, with about ten per cent less than one-metre above the mean sea level. One-third of the country is vulnerable to high tides and coastal erosion, and at present between thirty to seventy per cent of the country is normally flooded each year. The huge sediment loads brought by these Himalayan Rivers, coupled with a negligible flow gradient add to drainage congestion problems and exacerbate the extent of flooding. Bangladesh also lies in a very active cyclone corridor that transects the Bay of Bengal.

The flood risks to Bangladesh under climate change result from the threat of sea level rise compounded by higher precipitation and increases in the frequency and severity of monsoons, with accompanying tidal surges, and by higher levels of annual flooding resulting from increased glacial melt in the Himalayas, which feeds the Ganges / Brahmaputra river systems (Agrawala et al 2003)

### **Climate Change Scenarios for Bangladesh**

The IPCC expects sea-level rise during the early part of the twenty-first century to be an average of two to three millimetres per year due to global warming, although this varies by area. Erosion, coastal land subsidence, siltation of river estuaries, reduced sedimentation, waterlogging, and saltwater intrusion will all increase as a result. (NEF and IIED 2005a). Mean tidal levels on the Bangladesh coast are already showing higher than average global increases, attributed to coastal subsidence. According to Ali (1999) About 2,500, 8,000 and 14,000 km<sup>2</sup> of land (with a corresponding percentage of 2%, 5% and 10% with respect to the total land area of the country) would be lost due to potential sea level rises of 0.1m, 0.3m and 1.0m respectively. Other studies estimate even greater potential land losses. IPCC and other studies put the likely range of sea level rise at anything between 9 and 100 cm by 2100. Higher mean sea levels are likely to compound the enhanced storm surges expected to result from cyclones with higher intensity. (Agrawala et al 2003). IPCC projects a 5-10% increase in intensity (wind-speed) that would contribute to enhanced storm surges and coastal flooding and a 20-20% increase in intensity of associated precipitation that would contribute to flooding both in the coast and inland as the cyclone makes landfall.

Back water effects as a result of monsoons and tidal surges which cause flood water inside the country to accumulate, inundating more areas and increasing the length and depth of flooding in areas already inundated will also increase if climate change causes an increase in intensity of the monsoon. Even a slight increase in the frequency and intensity of extreme events will make them even more destructive, while sea level

rise will bring more coastal area under inundation. Saline water intrusion, already reaching 100km or more inland, will also accelerate, increasing salinity of soils and of ground water aquifer, with negative impacts on agriculture (Ali 1999).

Annual mean maximum temperatures can be expected to increase by at least 0.400C and 0.730C by the years 2050 and 2100 respectively, which is likely to increase precipitation by 295.94 mm and 542.55 mm respectively, and lead to higher rainfall during the monsoon period and more severe flood situation in summer. (Ali 1999, citing various sources)

Major vulnerabilities to climate change can be ranked according to certainty, severity and timing of impact and the value of the resources affected. The greatest risks are the direct impact of flooding on human populations and on coastal resources in the Sundarbans, followed by the impacts on agriculture.

### **Human settlements**

Bangladesh has a total population of over 133 million people a population density of more than 1,209 persons per km<sup>2</sup>, and 75% of the population lives in rural areas. More than one-third of the people in Bangladesh live in poverty; and 40% in rural areas, it is 40%. Higher population density increases vulnerability to climate change because more people are exposed to risk and opportunities for migration within a country are limited. About one-quarter of the population lives in the coastal area, where rural population densities are around 800 persons per square kilometre and population could reach 40-50 million by 2050, The remainder of the country depends in some way or other, on the activities in the coastal region. Both the magnitude and aerial coverage of seasonal inundation will likely be increased under climate change. Under a sea level rises of one metre, Bangladesh could lose up to 18 per cent of its landmass, including half of its rice land, directly threatening 11% of the country's population: as many as 30 million Bangladeshis could become climate refugees. The densely populated area around Dhaka would be affected but there are also pockets of population density in the Khulna region, which is most vulnerable to sea level rise. The major port of Mongla would be at risk, as would one-eighth of the country's agricultural land and 8,000 km of roads (Ali 1999).

The whole process is likely to lead to enhanced sedimentation and further gradual declines in river gradients, causing increased drainage congestion and compounding the flood risks for coastal areas. Since over two-thirds of the country is less than 5 m above sea-level and densely populated, storm surges and increased rainfall will contribute to flooding and loss of life and livelihoods far beyond the coast. In addition, the backwater and increased river flow from sea level rise could affect 60% of the country's population (Agrawala et al 2003).

### **Impact on natural ecosystems - mangroves**

Change in climate will also have serious impacts on the mangrove forests (known as Sundarbans), already affected by diversion of fresh water upstream in India. The Sundarbans may be completely inundated by a 1m rise in sea level, but gradual sea level rise will cause inland intrusion of saline water during winter when rainfall is less, threatening less salt tolerant mangrove species. Dense human settlements just outside the mangrove area will restrict the migration of the mangrove areas to less saline areas inland. Industries which depend on raw materials from the Sundarbans



will be threatened with closure, increasing unemployment calculated that a 25 cm sea level rise would result in a 40% mangrove loss (Agrawala et al 2003).

Traditional lifestyles were reasonably well adapted to the unique characteristics of the Sundarbans. Human dwellings were built on raised platforms, and farmers cultivated salinity and flood tolerant rice during the monsoon in land protected by temporary dykes when the abundance of freshwater had greatly reduced salinity levels. The dykes were dismantled post-harvest, opening the land to tidal movements. Meanwhile fishing of salt tolerant varieties was the principal source of livelihood during the dry season when salinity levels were high.

These lifestyles and livelihood patterns have however been altered in recent decades, as a result of population growth, increased poaching of wildlife and illegal felling of timber and industrial and infrastructural development in the region. Increases in inundation and salinity changes have also created ideal opportunities for shrimp farming which exploded as an export oriented cash industry starting in the mid-1980s. Shrimp farming has also encouraged farmers to artificially inundate lands with brackish water during periods of low salinity, causing severe damage to the forest cover. The depletion of forests in water logged shrimp areas has increased pressures in other parts of the Sundarbans for fuel wood and timber, enhancing the rate of forest depletion. Ultimately, increases in salinity are likely to jeopardize the lucrative business of shrimp farming. Sea level rise, by reducing available fresh water will cause reduction in fish production from inland fisheries and aquaculture.

### **Impacts on agriculture**

Coastal lands are used for agriculture and livestock grazing throughout the year and sea level rise and higher dry season salinity levels will also adversely affect agricultural production. Sea level rise and potentially higher storm surges would result in over-topping of saline water behind the embankments (constructed since the 1960s to protect low lying lands from tidal inundation) flooding lands that are currently protected and highly valued and home to productive economic activity. Sea level rise will threaten hundreds of thousands if not more than a million hectares of agricultural land (Huq et al., 1995), including the richest and most productive region of the country. For example, Islam et al. (undated) estimated that in eastern Bangladesh alone 14,000 tons of grain production would be lost to sea level rise in 2030 and 252,000 tons would be lost by 2075. Increased flooding from glacial melt, more intense monsoons, or more intense cyclones could also adversely affect agriculture in the near term by periodically inundating much agricultural land. Finally, it is estimated that several hundred thousand tons of grain production could be lost as a result of increased salinization from sea level rise. (Agrawala et al 2003)

### **The scope for adaptation**

There are three main adaptation options: retreat, accommodation and coastal protection. As a result of high population density and shortage of land, retreat is not possible. Possible options include raising of forest all along the coast, protection of mangrove forests, changing cropping pattern and variety in the coastal area, construction of embankments where feasible, construction of 'safe shelters' for emergency situations like extreme events, etc.

*Migration:* In the long run, sea level rise could displace tens of millions of people. However, mass resettlement, even if affordable would not easily be achieved in practice. Migration of people inland from the coastal area further inland will doubtless occur, putting pressure on non-coastal area as well. Because of scarcity of land and high population density, the scope for northward migration will be limited. (Ali 1999) Traditional adaptation via seasonal migration to less vulnerable areas within the Indian subcontinent was curtailed significantly half a century ago with the creation of a discrete geopolitical entity (East Pakistan), which subsequently became Bangladesh. The increase in environmental stress due to climate change may further raise the conflict potential and might eventually lead to international tensions and regional instability. (Agrawala et al 2003)

*Physical adaptations to flooding:* A first order adaptation to climate change would therefore to build or maintain appropriate drainage infrastructure along coastal embankments. The participation of local communities would be critical for the effective monitoring and maintenance of coastal embankments and flow regulators. Another family of physical adaptation measures could revolve around enhancing the drainage and/or conveyance capacity of the coastal rivers. This could involve excavation and dredging of silting rivers to unclog their waterways. Controlled flooding to enhance sedimentation and thereby raise the floodplain further upstream is another adaptation measure that could enhance drainage by increasing the flow gradient.

Other adaptation measures involve the use of lifting pumps to take out excessive water flushing of saline affected lands by freshwater but these involves high costs and would only be applicable to high value properties or urban zones. Possible adaptation measures for the Sundarbans include reducing risks of permanent inundation and of increased salinization by increasing fresh water flows while seeking to understand how to increase sedimentation.

Achieving more effective disaster early warning and response in Bangladesh is also essential as an adaptation strategy to the projected flood risk under climate change. Increased Construction of cyclone shelters in coastal areas – already a massive programme – will also be needed.

*Forest conservation and reforestation:* The National Land Use Policy (NLUP) does not make direct reference to climate change. NLUP however aims to bring 25% of the land under forest cover and highlights mangrove plantations in *char* lands, and coastal green belts more generally as a priority. It also advocates conservation of existing forest lands, including the Sundarbans, as does the National Forest Policy (NFoP) that which could increasing their resilience to the impacts of climate change. Policies to develop coastal green belts would also reduce the vulnerability of the coastline to cyclones and storm surges, both under current conditions as well as under climate change. Forest and tourism policies however also advocate eco-tourism and development of tourist infrastructure in the Sundarbans (including for Khulna which is the most vulnerable region in Bangladesh to sea level rise) which could add to the stresses on the fragile ecosystem and could therefore lower its resilience.

### **Land Issues**

Large numbers of Bangladeshis suffers landlessness, and despite land reform legislation and the abolition of intermediary landlords, land distribution has become more unequal in recent years, as a result of substantial problems of poor governance and corruption in the management of public land. Under the law, land holdings of former feudal landlords and private land holding above certain ceilings are intended to become public land – known as *khas* land – intended for redistribution to the poor and landless. In practice however *khas* land is subject to extensive land grabbing by rural elites and former landlords, often closely associated with the political class, utilising fraudulent documents, social connections with bureaucrats political leaders and the judiciary, and forcible land occupation (Barkat, Zarman and Raihan, 2001).

The occupants of inundated land, which can disappear temporarily or permanently owing to changes in river flow, suffer instant loss of homestead and livelihood, without right to compensation. In addition to the direct impacts in coastal areas sea level rise and other climate change related factors are likely to cause might result in increased flooding of the chars in the Upper and Lower Meghna rivers as well as the Padma River. Riverbank, island and floodplain land subject to regular disappearance and reformation and a result of recurrent flooding and alluvial accretion, known as *chars* land, is a prime source of *khas* land; under 1972 legislation all land inundated for more than 20 years or newly formed land became public land, and former occupants lost the right to retain it; although under a 1994 amendment they were to be entitled to preferential allocation of the land by the state. However the reversion of inundated *chars* land to the state makes it particularly subject to land grabs. Settlement and ownership rights over newly accreted *chars* land have always been complicated by the difficulty in ascertaining ownership of new land, whether it should belong to the state or to some other riparian proprietor upstream or even to somebody on the other side of the river. While the complex bureaucratic procedures for land allocation are already inaccessible to the landless, spontaneous land grabs occur before official surveys can take place. Land grabs of *char* land are frequently organized by powerful landlords (*jotdars*) under a neo-feudal system using dependent peasants (*lathiyals*), frequently people made landless by flooding, who may be formed into "cooperatives" registered under the patronage of the *jotdars* and given preferential treatment in subsequent land allocation by the landlord. Disputes with other claimants of the land often lead to violent conflicts (Haque et al 2003, Chadwick). *Chars* water bodies are also an important resource for fisher-folk, but under present policies newly appearing water bodies are subject to auction by government, a process to which rural elites have privileged access.

### **The place of land in adaptive planning**

The balance of expert opinion favours a combination of improved accommodation increased flooding including improved disaster relief, provision of flood shelters and physical works, given the difficulties of accomplishing managed retreat and mass resettlement owing to high population densities and intensive competition for land. In this context it is essential that full use is made of available land for resettlement within coastal and floodplain Bangladesh.

Regular and effective Khas land allocation to the poor including *chars* land would provide an important safety valve for displaced people affected by climate change. However success of redistribution depends upon enforcement of land reform

legislation and the ability of the relevant government machinery to conduct survey and prepare maps immediately after appearance of the *char* and to take over possession of the same notwithstanding political pressure from local elites.

In order to cope with the present situation as well as the additional threats posed by climate change, major step changes both in the quality of governance of public land and the efficiency of land administration will be needed. Without improved information, policy reform and public sector accountability, environmental governance is set to deteriorate.

Increased physical works for flood protection will involve increased public land take, although under present legislation those losing land for public works are already entitled to compensation, unlike those displaced by floods. Better inventory and registration of existing land occupation would facilitate this process, and could be used to facilitate access by the displaced to streamlined land allocation procedures.

According to IFAD, policy should pay particular attention to protecting the livelihoods and settlements of the moderately poor, who constitute 21% of rural households, to ensure that they are not thrown back into poverty by crisis shocks, particularly natural hazards, in addition to safeguarding the extremely poor. Greater tenure security for this group would help sustain the economy of impacted areas, by promoting investment of labour in measures such as improved, elevated house building techniques public works schemes to improve flood defences and drainage, and in collective tree planting and mangrove management.

Although the present National Land Use Policy recognizes the far higher levels of land conflicts in the coastal area and on *chars* land it does not contain effective prescriptions for their resolution. Nor does it contain specific contingencies for the extremely rapid levels of land erosion and accretion and the problems associated with land tenure and land rights found in coastal areas, which are all likely to increase under climate change (Chadwick).

Greater coherence between land policy and other areas of sectoral policy such as Forests and Tourism will also be required, and more effective controls on development of coastal and floodplain land including for shrimp farming. Under forest legislation newly accreted land is in the first instance be planted with mangroves (to improve land consolidation and provide protection from cyclone damage). Although initially intended to be temporary, the Forestry Department regards any such mangrove plantations as permanent, meaning that there is even greater uncertainty over the rights of coastal communities to officially acquire newly accreted land.

In view of the scale of the threats of displacement due to coastal and riparian flooding, migration will be inevitable and there may be a need to develop regional migration and adaptation programmes, including cooperation in resettlement policy (NEF and IIED 2005a).

### 3.2 Impacts on human settlement in coastal cities

A substantial body of literature has identified the likely impacts of climate change on coastal urban settlements, these being: tropical cyclones and storm surges, extreme rainfall and riverine floods, heat- or cold-waves and drought, sea-level rise, and saline intrusion. Climate change impacts will compound existing infrastructure backlogs and poor provision of public services, disproportionately affecting the poor and marginalized communities, who often settle in inter-tidal or low-lying areas prone to flooding.

The immediate effects of climate change on coastal zones involve changes of both extreme and mean tidal levels. The former set of changes includes the effects of tropical cyclones and storm surge, extreme rainfall and riverine floods, as well as heat- or cold-waves and drought, compounding the effects of increases in mean sea level rise and associated saline intrusion, together with changes in mean levels of precipitation, and temperature. (Satterthwaite et al 2007).

The direct impacts of sea level rise will be felt primarily in the so-called Low Elevation Coastal Zone (LECZ) which can be defined as “the contiguous area along the coast that is less than 10 metres above sea level.” This area comprises only 2% of global land area but contains 10% of the world’ population, and 13% of the world’s urban population. (McGranahan et al 2007).

IPCC Working Group II considers “the near coastal zone” defined as within 100m elevation or 100km distance from the coast, and estimate that it contains between 600 million and 1.2 billion people, or 10% and 23% of the world’s population respectively (IPCC 2007 Working Group 2 Ch 6; McGranahan et al., 2006) who could potentially be affected directly or indirectly by sea level rise. The LECZ will be the focus of direct impacts however, since sea level rise is not expected to reach anything like 10 metres above the current mid-tide elevations, at least in the foreseeable future. Even with storm surges, the 10 metres elevation leaves a large margin of safety regarding direct flooding (McGranahan et al 2007).

Existing and predicted sea-level rise, increase frequency and intensity of extreme events and changes in precipitation patterns point to urban flooding as the main effect of climate change on urban settlements. The greatest danger comes from the compound effects of storm surges and high-tides. (Satterthwaite 2006). The IPCC Working Group II (2007, Chapter 6) reported that climate change impacts could, by the 2050s decrease the return period of the flood associated with the 100-year storm to 19 to 68 years on average, endangering low-lying urban settlements and transportation systems. Even in the absence of major storm events, rising sea levels may also mean rising water tables that undermine building foundations and increased saline water intrusion into valuable groundwater sources (Satterthwaite 2006).

The economic importance of coastal zones is also huge: \$1 trillion worth of assets are contained on coastal land less than 1-m elevation above current sea level, and 22 of the world’s 50 largest coastal cities are vulnerable to coastal surges including Tokyo, Shanghai, Mumbai, Calcutta, Buenos Aires, New York and London (Stern 2007). Almost two thirds of the world’s mega cities with populations greater than 5 million fall at least partly within the LECZ. Urban settlements, coastal infrastructure,

populations and economic activities in India, China, South America and the East Caribbean are particularly vulnerable to sea-level rise, which will affect the land use and physical infrastructure of coastal cities. The Stern Report estimated that globally 2 million Km<sup>2</sup> of land and \$1 trillion worth of assets at less than 1 metre elevation above current sea level.

### **Impacts on the urban poor**

A total of 634 million people – 10% of the world's population, are estimated to live in the LECZ, 360 million of whom are in urban areas – 13% of the world's urban population (McGranahan et al 2007, using year 2000 data). Globally, the LECZ has a higher level of urbanisation than inland areas, at around 60%, compared to an average level of urbanisation of 50%. In poor countries, the LECZ tends to be more urbanised still, demonstrating strong tendencies for the location of high density informal urban settlements in low lying coastal areas.

In the South, the poor are most vulnerable because they are frequently located in informal settlements, floodplain and riverine areas vulnerable to flooding, which generally suffer from poor drainage, infrastructure and sanitary conditions, and because of inadequate housing conditions. An estimated total of 900 million poor people live in poor quality housing in urban areas across the South (Satterthwaite et al, 2007), and given that the majority of urban dwellers in the South are poor, very high proportion of the 360 million urban residents of the LECZ can be assumed to live in these conditions.

IPCC Working Group II (2007, Chapter 7) found that climate change will compound existing “baseline” stresses in urban areas. Climate change coalesces with other stresses, such as inadequate drainage and sanitation, scarcity of water, congestion, poverty, political and economic inequity, insecurity unmet resource requirements and weak governance structures involving institutional and jurisdictional fragmentation, limited revenue streams for public sector roles, and inflexible patterns of land use that are inadequate even in the absence of climate change. Any significant additional stress could be the trigger for serious disruptive events and impacts, and these are likely to be particularly acute in coastal cities.

Climate change will also affect the urban poor in more indirect ways as a result of changes in temperature, precipitation and humidity which increase the threats to public health such as extremes in heat stress, respiratory distress stemming from changes in air quality, and water- and vector-borne diseases which pose a particular risk in flood situations, notably in densely settled areas with poor sanitation and drainage (IPCC Working Group II 2007).

### **Greatest impacts of sea level rise in Asia**

Of the world's urban population living in the coastal zone, two-thirds is in Asia. 18% or 238 million of Asia's urban population is located in the LECZ, two thirds of the global total (McGranahan et al 2007), and the urban population is set to increase dramatically in coming years.

The flood risks arise from anticipated sea surface temperature rise of 2 to 4°C, in the Indian Ocean over the 21st century, which is expected to induce a 10 to 20 percent

increase in cyclone intensity (IPCC Working Group 2, 2007), in addition to the sea level rise resulting from expansion of the ocean induced by temperature rises.

Asia is currently experiencing increasing urbanisation and migration to coastal areas, along with more frequent and intense cyclones and storm surges and is already highly vulnerable to flooding, with much of the poorer urban population in coastal South and Southeast Asia housed in large extra-legal settlements. In Bangladesh and China between 1990 and 2000, the population in the LECZ grew at almost twice the national population growth rate. In both countries, the urban populations in the LECZ grew particularly rapidly, and the urban population growth in China's LECZ, enhanced by the creation of special economic zones in coastal areas) was more than three times the national rate" (McGranahan et al 2007).

Asia has also been the location of the vast majority of deaths from flooding, demonstrated dramatically with the Mumbai floods in 2005, when almost one metre of rain fell in a single day. The impacts included the death of some 500 people, in the city, many of them from Mumbai's overcrowded slums, a further 72 deaths of people living in slums at the foot of a hill in the western suburb of Andheri following a landslide, the flooding of the metro system and the almost complete breakdown of transport and communications for several days. Outside Mumbai, at least 60,000 villagers had to move into temporary camps because their homes were flooded (NEF and IIED 2005a).

In Bangladesh, the capital Dhaka, currently a city of 13 million people, already suffers serious water-logging and drainage problems during the monsoon season. Climate Change will affect Dhaka in two primary ways: through floods and overstretched drainage systems, and through heat stress. Temperature rises in the Himalayas causing the melting of glaciers and snowfields, together with increased precipitation will lead to more frequent flooding, compounding the effects of sea level rise and more intense and frequent storm events (NEF and IIED 2005a).

Between 1994 and 2004, about one-third of the 1,562 flood disasters, half of the 120,000 people killed, and 98 per cent of the 2 million people affected by flood disasters were in Asia, where there are large population agglomerations in the flood plains of major rivers including the Ganges–Brahmaputra, Mekong and Yangtze, and in cyclone-prone coastal regions such as the Bay of Bengal, South China Sea, Japan and the Philippines (McGranahan et al 2007). Two-thirds of all disasters in India are climate or weather related, mainly due to drought, flooding, and storms, damaging infrastructure and affecting millions, especially those already weakened by poverty and disease. The number of strong tropical cyclones has continued to increase over the past three decades (NEF and IIED 2005a).

### **Land issues**

The risks faced by the urban poor in coastal areas in the face of sea level rise relate substantially to problems of inadequate land use planning and in addition to the lack of secure land tenure.

Poorer residents and urban migrants are often forced to settle in low lying or otherwise hazard prone areas (such as unstable hillsides) which are more vulnerable to the impact of flooding and coastal storms, because of the lack of any affordable

alternatives. Land in less vulnerable areas is of higher value and tends to be zoned for residential or commercial development for better off urban residents. Better located plots and dwellings with formal tenure are generally unaffordable to the poor in the absence of targeted schemes for low cost housing and tenure upgrading. Vulnerable areas may be less subject to building controls and regulations, resulting in the dense proliferation of informal dwellings.

Urban governments fail to make provision for land availability for poor people's settlement, or to provide adequate infrastructure in areas zoned for poor people's housing. In low lying, poorly drained areas it may be particularly costly to do so, and the risks of damage and loss to expensive infrastructure may be too great.

The absence of secure tenure arrangements creates disincentives for people to invest in better quality dwellings better protected from the effects of flooding. The more affluent are better able to relocate to less vulnerable areas, and to use better quality building materials and take protective measures against flooding.

### **Adaptation in coastal urban areas**

The risks faced by low lying coastal cities suggest that an intensive and incremental programme of adaptation will be required over the coming years, most particularly in Asia. Official climate change reports identify the adaptation measures required only in very schematic ways, however. The Stern report (2007) notes that possible adaptive measures include resettlement and facilitated migration; compensation for loss of assets; improved land inventory; and land sharing and release schemes.

Adaptation planning is not well developed in the South however, and the majority of large cities are yet to integrate climate change adaptation to their public works programmes and land-use plans. Most coastal cities in the South face very large backlogs in the provision of drainage and other infrastructure needed for protection against sea level rise. Given the scale and nature of the challenge, integrated planning for adaptation at governmental, state, city and neighbourhood levels (Revi 2007). However city governments are often weak and under-resourced. Even when they have progressive policies they often lack the capacity to ensure best practice in urban design and service delivery. This will demand more support to, and capacity at, the appropriate institutional level, whether a town council or the regional government covering, for example, river-basin areas. There is also great scope to develop adaptive planning at community-level (NEF and IIED 2005a).

Land policy related measures have much to contribute to successful adaptation to climate change and sea level rise in coastal cities. The urban poor are most at risk from sea level rise in coastal cities because they cannot afford to buy, build or rent secure housing in safe areas free from flooding and related risks. The progressive ingredients of urban land policies to *upgrade informal settlements*, improve *tenure security*, increase *delivery of appropriate land through public-private collaboration*, simplify and *strengthen planning arrangements*, and *extend popular participation* therefore all have a significant role to play by improving the incentives and flexibility for individuals, small businesses and communities to adapt to the risks of sea level rise.



In general, *mass relocation should be avoided* wherever possible, because of its high cost, logistical problems, and the difficulties in identifying suitable land for resettlement. Moving whole cities or large parts of cities is virtually unprecedented, however relocation of particular urban settlements which are located in highly vulnerable areas and are difficult to protect may be required in a number of cases.

In most cases it will be more appropriate to combine preventative planning – ensuring that poor people can access land and housing in areas at less risk from flooding, and redirecting economic activity out of vulnerable zones – with adaptive measures – upgrading infrastructure, housing and tenure conditions in large informal settlements facing flood risks. Adaptive planning and good urban design needs to be proactive and anticipate future growth of coastal cities and take place as informal settlements become established, rather than waiting until they are very large, when improving infrastructure, land use planning and settlement will be more expensive and complex.

Outright prohibition or forced removals of settlements in flood prone areas are unlikely to work or risk of simply transferring the problem to other vulnerable hazard prone sites where prohibitions are not in force. Whether informal settlements are to be relocated or upgraded, city governments need to work directly with their occupants. Low-income groups may be prepared to move from hazardous sites, but only if they are involved in decisions about where to move and how the move is organised. This means a fundamental change in practice, since most city governments tend to move people who live in the path of new infrastructure investments, pushing them into peripheral areas, destroying their homes, asset base, social networks, and their incomes. And if climate change adaptation is to benefit the urban poor, they should be fully involved in plans to combat flooding and other risks through schemes to provide of better drainage, sanitation, waste management, housing land and building materials (Satterthwaite 2006).

Successful adaptation requires competent local governments with a commitment to working with all those living in informal settlements. Although climate change mitigation may be a national agenda driven by international agreement, adaptation is intensely local. Yet many cities' local governments still refuse to work with the population living in informal settlements resulting in a lack of infrastructure and services in these areas. Current international funding mechanisms show little capacity to address this.

“Part of what needs to be done does not require additional government expenditure but is achieved by changing frameworks that influence individual, household, community, company and corporate investments – for instance *adjustments to building regulations, land use plans, land subdivision regulations*, pollution control and waste management.” (Satterthwaite 2006, our emphasis). Changes to urban and peri-urban *land use zoning*, and introducing *planning requirements*, building standards, tax incentives and subsidies to *facilitate settlement and industrial development in areas less exposed to flooding* and promote *good practice in building design, drainage, and infrastructure provision* can also play important roles.

Satterthwaite et al (2007) note however that “There are some particular worries in regard to the impact of the needed measures on housing and basic services for low-income groups: higher building and infrastructure standards and land-use restrictions

(including avoiding new constructions on floodplains) could mean rising land and housing prices and much reduced supplies of cheap accommodation”. In this context special measures need to be taken to ensure sufficient supplies of well-located, serviced land for new housing, and a comprehensive approach, linking better environmental management and provision with *expanded provision for low cost housing* is essential to ensure that adaptive planning creates benefits for urban populations as a whole.

The scale and nature of the risks need to be better understood in order to motivate and target timely measures. Much of the information required for this is local (McGranahan et al 2007). A fundamental measure is for city governments to *survey all extra-legal settlements as well as available settlement land, and identify any that are in areas subject to environmental hazards* (for example floods or landslides) or required for strategic public purposes, with a view to planning for upgrading and preventive measures, or if necessary re-location. In many cities (such as Johannesburg, Cape Town, Kisumu in Kenya, Phnom Penh, and Karachi, federations of slum/shack dwellers and local NGOs have undertaken surveys and mapping of all informal settlements at a citywide scale. The advantage of these initiatives is that they not only identify risk but also focus on populations that are particularly vulnerable. In many cities, the federations and their support NGOs have also undertaken *surveys of vacant land to identify safe and appropriate sites for relocation*, when in-situ upgrading is not possible (Satterthwaite et al 2007).

In some cases, housing federations and their support NGOs have also undertaken many *detailed household surveys in informal settlements* – covering every household and producing very detailed maps showing plot boundaries and existing infrastructure provision. These improved inventories of land occupancy in informal settlements can facilitate tenure or housing upgrading and / or payment of compensation or provision of resettlement for those who may be required to move.

Increased and improved availability of land for low cost housing is critical. This requires not only land improved use planning zoning, and inventory, and *better use of available public land* but also *innovative collaboration with private and traditional land owners*, involving for instance land pooling and land sharing for public allocation, as practiced in some Indian cities.

A good example of a proactive strategy is provided by the city of Ilo in Peru. Here, the population increased fivefold during 1960–2000. Yet, no land invasion or occupation of risk-prone areas by poor groups looking for housing has taken place, because local authorities implemented programmes (such as the acquisition of an urban-expansion area) to accommodate Ilo’s growth and to support the poor in their efforts to get decent housing conditions. Similarly, in Windhoek in Namibia, the city government changed the land development regulations on minimum plot sizes and infrastructure standards (previous regulations reflected a colonial model based on the requirements of better off residences) which considerably reduced the prices of the legal plots (Satterthwaite et al 2007).

Perhaps the most important experiences in making poorer groups less vulnerable to climate change in cities are those that have successfully improved housing conditions and infrastructure and services within low-income settlements. A variety of major

cities now have some 40 years of experience of upgrading “slums” and informal settlements and, although the extent of success is very varied, where it works, it certainly reduces poorer groups’ vulnerabilities to flooding and extreme weather events. By focusing on *provision and quality of basic community and household level infrastructure* so as to reduce vulnerability to everyday environmental hazards, squatter upgrading programmes build resilience and extend the adaptive capacity of communities to the more frequent and higher level risks posed by climate change. Tenure regularisation with provision of more certain, secure property rights, and community mobilisation to drive upgrading have been key elements of these schemes (Satterthwaite et al 2007).

In addition to adaptive and policy-led measures taken by governments, the urban poor show significant capacity to take autonomous measures to improve their resilience so as to protect themselves and their property from flood risks, through small scale investments such as building community flood shelters on higher ground, raising the level of buildings, digging local drainage channels, provision of sandbags, using more resistant but also removal materials and locating wiring and more valuable household goods well above ground level (Satterthwaite et al 2007). Such autonomous adaptations are however constrained by insecure land tenure which creates disincentives for people to invest scarce resources in risk reduction. For both new and existing settlements *more secure land tenure is required* so as to improve resilience to sea level rise related risks by promoting investments in better housing and community infrastructure. Therefore improving tenure security – although not a *prima facie* priority adaptive measure - is another important area of action for city governments, to facilitate adaptation by the people most at risk themselves.

Given the high cost of land titling schemes involving full cadastral surveys of large numbers of small plots, and often complex administrative procedures, *low cost methods of land survey and registration* need to be introduced, together with a diversity of tenure arrangements, and *intermediate forms of secure tenure which fall short of full title*. This is likely to involve the *legal recognition of existing informal and customary land occupation*, and provision of *simple documentation*, and the *involvement of local community and customary leaders* in the process. It is also important to *work with the private landlords* who operate in many large informal settlements, to improve existing practice and improve existing rental contracts. *Formalizing informal or extra-legal rental markets* can help improve the supply of land for low cost housing, provide greater certainty of tenure arrangements and offer incentives to both landlords and tenants to invest in better quality shelter (Satterthwaite et al 2007). Securely registered and documented land and housing rights in areas with known and potentially manageable levels of risk, and some presence of protective infrastructure can also facilitate people’s access to insurance against the effects of flooding (it being unlikely that insurance could become commercially available at large scale in dangerous areas completely unprotected).

The challenge of effective urban adaptation to the risks of sea level rise reinforces the need for improved urban land policies pursued by progressive city governments and reflected in policy development campaigning by urban civil society groups, international agencies such as UN Habitat and global partnerships such as the Cities Alliance. On the one hand adaptive measures to the threat of sea level rise need to be integrated into urban land management and planning programmes. On the other hand

these programmes need to be expanded. Although initiatives for improved practice urban land delivery, land tenure and land use planning have been subject of widespread experimentation and advocacy, they are not yet widely implemented due to limitations in city budgets, frequent domination of city governance by vested interests in commercial development, political resistance to legalizing and working with informal settlers and inadequacy of present international mechanisms to provide financial resources and mobilize relevant expertise on the scale required. All of the adaptive measures identified require not only increases in resources but also considerable improvements in the capacity of city governments to respond, in which skills, systems and human resources for better land management play a central role.

In addition to these land policy related measures, there are likely to be important areas of overlap between adaptation to climate change, other forms of disaster preparedness, emergency relief and measures to address local environmental health issues such as improved water, sanitation, waste disposal and drainage systems (McGranahan et al 2007). Good urban management can help meet multiple goals including for instance, MDG targets on poverty reduction, health and slum improvement as well as adaptation to climate change. Although additional finance is needed, new separate programmes are not. Instead, existing good practice and sound policies need to be implemented on a massive scale in a coordinated, cross sectoral way, by committed national and city governments.

In practice however, the speed with which city systems change to reflect the new “risk map” of climate change and sea level rise is likely to be slow, in relation to how rapidly this map is likely to change – especially in the absence of international agreement on reducing global greenhouse gas emissions, and financing of effective adaptation.

### **3.3 Climate change impacts on agriculture in Africa’s drylands**

Climate change will impact on agriculture directly through a combination of temperature rises, changes in precipitation and moisture availability and intensification of patterns of rainfall variability and the frequency of extreme weather events. In addition, indirect impacts discussed in other sections of this paper include the effects of salt intrusion into agricultural land due to sea level rise and of seasonal and long term changes in water availability and flood regimes as a result of accelerated melting and recession of glaciers and snow fields.

The effects on agriculture will differ from region to region, according to the regional changes in climate. In the North, agricultural land suitable for cereal crop cultivation could expand significantly in North America (40%), northern Europe (16%), the Russian Federation (64%), and East Asia (10%), due to longer planting periods and generally more favourable growing conditions under warming (Fischer et al, 2005; IPCC 2007 Working Group 1 Ch 11).

In the tropics however, environmental constraints on agriculture are most likely to increase as a result of climate change, causing decreases in crop production, as a result of rising temperatures and reductions in rainfall in many regions. Cereal crop production considered highly sensitive to temperature rises and therefore food insecurity in the tropics is expected to increase. African agriculture is more vulnerable

to climate change and variability than is farming in other developing regions, due to the high reliance on rainfed agriculture, which constitutes 95% of agriculture in sub-Saharan Africa (IFPRI, 2006).

In this section we discuss the challenges for agricultural adaptation in tropical regions and the possible land tenure and land policy implications, focusing on semi-arid areas and drawing on examples of successful adaptation to existing climate variability, especially in the Sahel.

In Mali, for example, only 3% of arable areas are fed by irrigation (Butt *et al.*, 2006). In Sudan, traditional farming (including nomadic, transhumant and sedentary agriculture) is widespread throughout the northern and southern parts, with livestock being the main insurance against uncertainty. Approximately 90% of Sudan's cultivated areas depend exclusively on rainfall and the traditional rainfed sector supports 1.7 million households. Recent droughts (1983-85 and 1990-93) have resulted in severe food shortages and famine among dependent populations (various sources, cited in Orindi and Murray 2005).

Temperatures across Africa have increased by 0.7°C in the twentieth-century and models predict a further rise of between 0.2°C and 0.5°C per decade in the twenty-first century (Case, 2006). Although there is a generally anticipated longer term association of declining rainfall and increased aridity with these temperature increases in semi-arid regions of Africa (Stern 2007, IPCC Working Group II Ch8, Warren et al 2006), there are considerable uncertainties in modeling crop production under temperature increase scenarios, due to the CO<sup>2</sup> fertilization effect through which increases in CO<sup>2</sup> concentration can stimulate crop yields, below certain temperature thresholds and given adequate moisture availability, and difficulties in linking climate models to crop production models (IPCC 2007 Working Group II Ch 5).

Despite an anticipated overall long term drying trend in many tropical regions, climate models for the Sahel show substantial divergence: while some predicting a potential 10% increase in vegetation cover in dryland areas per decade, due to medium term increases in rainfall (Brooks 2004), the overall implications for Sahelian rainfall regimes remain highly uncertain, (Warren et al 2006). Increases in rainfall may create some new opportunities for arable production in some regions, but these may well be temporary, since drier scenarios become more likely as CO<sub>2</sub> concentrations approach 550 to 600ppm (Brooks 2004). Any short and medium term increases in rainfall may also be reflected in changes in the, seasonal, geographical, inter-annual and inter-decadal range and pattern of temperature and rainfall variability, already quite pronounced in semi-arid regions, and increases in extreme weather events, such as the extensive flash floods that occurred in Northern Ghana in 2006. In August 2003, 75mm of rain fell on normally arid areas of northern Mali and Mauritania and increased vegetation cover across parts of the Sahara, yet large areas of northern Senegal and southern Mauritania did not receive increased rainfall (Brooks 2004).

The situation in East Africa is somewhat similar to that in the Sahel, with predictions that rainfall will increase by 5-20% in the wet season and decrease by 5-10% in the dry season (Case 2006), but with likely overall decreases of rainfall in semi-arid areas (IPCC 2007 Working Group 2 Summary for Policy Makers and Chapter 9, Stern 2007, Warren et al 2006). This will increase agricultural vulnerability to extreme

events such as floods and droughts. Increases in temperature in mountain regions may open up new farming zones, while also affecting their suitability for production of certain crops well adapted to existing temperature regimes, such as coffee in the upland areas of East Africa.

### **Land tenure issues and adaptation in dryland Africa**

Some of the recent climate change literature examines issues of vulnerability and adaptation (Eriksen et al / NORAD 2001) including the challenges and opportunities for support to collective action to improve land use systems and livelihoods resilience (IUCN et al 2003). Current assessments of the challenges of adaptation however focus on the scope for substitution of existing crops with more drought tolerant species and varieties, adaptive research for dryland crops to develop more suitable varieties, land use management and agroforestry to improve water retention and promote crop diversification, wider development of s and the scope to improve credit availability, crop insurance, improved weather forecasting and introducing payments for avoided deforestation / reforestation by small farmers to substitute for loss of farm income (IFPRI 2007). Secure land rights for dryland farmers provided either on a farm household or community basis, are likely to increase the incentives for investment and people to invest in and take advantage of these types of adaptation.

The land tenure implications of climate change impacts on agriculture are also difficult to predict. Although not a simple consequence of climate change, but of development and population pressures and political economy, increasing scarcity of good quality agricultural land will increase land pressure and competition, further weakening the asset base of the poor in the absence of guarantees of tenure security. Combined with decreases in crop productivity this would hasten the exit of the poor from agriculture. Thus in addition to facilitating adaptations to changing rainfall conditions, another set of challenges for land policy is to facilitate migration, diversification and exits from agriculture, and how best to secure the tenure rights, or provide alternative settlement and compensation for those affected. Here we concentrate on how to strengthen resilience on situ, building on existing adaptations, including established strategies involving seasonal mobility.

Problems of increasing climate variability are already currently experienced by Africa's farmers, The IPCC Working Group 1 (Ch 11) found that in the Sudano-Sahel region of Africa, persistent below-average rainfall and recurrent droughts in the late 20<sup>th</sup> century have constricted physical and ecological limits by contributing to land degradation, diminished livelihood opportunities, food insecurity, internal displacement of people, cross-border migrations and civil strife. Some impacts of climate change may already be visible. Precipitation has fallen by 50-150mm per season from 1996 to 2003 in East Africa, which has brought on a subsequent fall off of long-cycle crops (Funk et al., 2005 cited in Case, 2006).

Africa's dryland farmers and pastoralists face serious implications including the decreased viability of rainfed dryland farming, changes in the geographical ranges within which arable farming and cattle raising are feasible (including possible increased opportunities as well as constraints for pastoralists in some regions), and overall increased land and water competition in drylands. These are all issues for which Africa's dryland farmers have already been adapting to some degree to current and recent patterns of climate variability, which under climate change, are likely to be

exacerbated. However the adaptive responses required to future climate change should not in principle be very different from existing adaptations to climate variability except in scale and pace at least in the medium term and excepting extreme climate change impact scenarios. In view of this much can be learnt from understanding how farming populations and the formal and informal institutions which shape and regulate land and resource use have responded and adapted to these changes – and in practice the changes have surely gone wider than the agricultural systems.

*Crop varieties and land use practice:* Some of the recent climate change literature examines issues of vulnerability and adaptation (Eriksen et al / NORAD 2001) including the challenges and opportunities for support to collective action to improve land use systems and livelihoods resilience (IUCN et al 2003). Current assessments of the challenges of adaptation however focus on the scope for substitution of existing crops with more drought tolerant species and varieties, adaptive research for dryland crops to develop more suitable varieties, land use management and agroforestry to improve water retention and promote crop diversification, wider development of s and the scope to improve credit availability, crop insurance, improved weather forecasting and introducing payments for avoided deforestation / reforestation by small farmers to substitute for loss of farm income (IFPRI 2007). Secure land rights for dryland farmers provided either on a farm household or community basis, are likely to increase the incentives for investment and people to invest in and take advantage of these types of adaptation.

*Risk spreading:* African farmers have traditionally spread their risks by planting a variety of crops in different types of location or agro-ecological niches. However, growing populations, increasing competition for land and in some cases policy pressures for land consolidation and tenure individualisation are eroding farmers' opportunities to pursue these strategies. In southern Mozambique, farmers from Nwadjahane community who have reduced their vulnerability to inter-annual climatic variations, flooding and drought through planting crops in both low-lying valleys and more elevated dryland areas successfully formalised their customary tenure arrangements over both land areas after forming a producers' association and petitioning local authorities and the provincial land registration office. In times of flood when the valley crops are damaged, the higher dryland areas produce a good yield of maize and cassava, and in times of drought the lower fertile soils perform better. The producers' organisation has also shared information about drought-resistant crop varieties and promoted their uptake by community members (NEF and IIED, 2005).

*Village land titling:* Mozambique's Land Act (1997) facilitates the granting of secure tenure rights to village communities according to customary rights and occupation in good faith, and a variety of communities have succeeded in gaining security over substantial areas comprising a variety of types of agricultural land, pasture and woodland areas. Tanzania's Village Land Act (1999) includes similar provisions allowing for community-based resource management through the granting of village land titles.

*Land use intensification:* Literature on farming systems changes in northern Nigeria and Niger, illustrates cases of successful adaptation practiced in high population density areas despite decreases in rainfall and population growth. Farmers have been

able to preserve soil fertility and yields through, more intensive small-scale farming practices involving higher livestock densities, soil and water conservation, crop diversification and integrated farm management approaches (Brooks 2004). Reasonable confidence in tenure security appears to be an important underlying condition for these sorts of sustainable intensification.

*Small scale irrigation:* In East Africa local adaptation involving small-scale irrigation have long been carried out by certain ethnic groups and is a proven coping strategy to cope with climate variability. In order to sustain these strategies the rights of the poor to access these water resources needs to be recognised and incorporated into national or local natural resource arrangements. However, in areas where access arrangements to water resources have been formalised, low-income groups have been marginalised due to their inability to afford water access fees (Maganga et al. 2003, cited in Orindi and Murray 2005).

*Decentralisation and CBNRM:* Since 1990s the decentralisation policies pursued by certain countries (see below) has increased possibilities of establishing community-based natural resource management (CBNRM), as an adaptation strategy, offering alternative sources of income to arable farming, including wildlife and forest utilisation, and in some cases, small scale eco-tourism ventures. Devolution of rights and responsibilities to local people needs to be strengthened to ensure sustainable use of natural resources and effective adaptation measures to climate change conditions. In particular, women's participation in decision-making and planning processes should be sought (Orindi and Murray 2005).

*Farmer herder interactions:* Customary arrangements, between transhumant pastoralists and agriculturalists who exchange a right to access resources against fertilising soil through manure. Reciprocal relationships between pastoralists and agriculturalists could play a key role in future development: just as pastoralists may grant farmers the right to engage in agriculture on their lands in wet periods, so agriculture in less marginal areas might provide temporary employment to pastoralists during dry periods, reinforcing their food security (Brooks 2006).

*Pastoralist land tenure:* Pastoralism has provided food security for African populations for over seven thousand years. Cattle pastoralism enabled people to track increasingly elusive water and pasture, increasing flexibility through an enhanced ability to respond to a rapidly changing, and increasingly unpredictable environment. Archaeological evidence indicates overwhelmingly that pastoralism in Africa developed in direct response to long-term climate change and variability, and spread throughout northern Africa as a means of coping with an increasingly unpredictable and arid climate (Brooks 2006). Pastoral livelihoods in the Sahel historically were underpinned by systems of negotiated access to water and pasture that did not assign exclusive rights, and by reciprocal arrangements between pastoralists and agriculturalists. However, the mistrust of mobile populations by both colonial and independent governments, and the beliefs that their livelihoods are ill-adapted to the demands of development and effects of drought have led however to long standing attempts to settle pastoralists in confined areas through ranching and farming schemes. On the whole these have exacerbated pastoralists vulnerability to drought by denying them the opportunity to exploit resources flexibly over wider areas in a



highly variable environment, which has been central to pastoralists' survival and adaptation over the centuries (Thebaud 2004).

The primary adaptive strategy of pastoral peoples remains mobility. Mobility is one of the most effective strategies of exploiting diverse and shifting natural resources, and securing mobility through local, national and regional mechanisms can therefore help build on pastoral peoples natural adaptive capacity. The formation and reinforcement of pastoral associations is also an important tool to strengthen their voice and take advantage of decentralisation policies in certain states that offer the opportunity for enhanced community-based natural resource management.

*Progressive pastoral legislation:* Since the early 1990s, rural or pastoral laws and charters have been passed in a number of West Africa countries which set out innovative land tenure arrangements, for example Niger's *Code Rural* (1993) and Mali's *Charte Pastorale* (2001). Niger's *Code Rural* brings together in one document the different laws and regulations relating to the transfer and tenure of agricultural and pastoral lands. It gives pastoralists the right to freely access natural resources and introduces the concept of '*terroirs d'attache*'. A '*terroir d'attache*' is a place where a community of herders spend most of the year and where they return after periods of transhumance. The *Code* does not give pastoralists the exclusive right to the '*terroirs d'attache*', nor ownership of the land, but it gives the community priority access to the resources whilst these must remain open to other users. The *Charte Pastorale* gives pastoralists the right of mobility across agricultural and pastoral areas in Mali and access to natural resources. Similarly Mali's *Charte* protects pastoralists' right to priority usage of defined natural resources, but not ownership of the land. Both pieces of legislation support a network of livestock corridors and impose on pastoralists some obligation to develop the pastures that they claim priority access to through traditional and modern infrastructure improvements (Thébaud, 2004).

*Decentralisation and Conventions Locales:* The successful implementation of progressive laws such of these is closely bound up with decentralisation that entrusts greater powers to local governance structures in place of the state. Decentralisation in the Sahel has been actively pursued not only by Mali and Niger but also by other states including Benin, Burkina Faso and Senegal). This may involve the transfer of competence over local infrastructure development and resources. To take another example from Mali, the local *collectivités territoriales* have the power to impose a tax on access to certain resources (Thébaud, 2004).

A patchwork of customary host of reciprocal arrangements amongst different pastoralist and farming groups in the Sahel have helped to regulate access and control utilisation of scarce natural resources. In a number of cases these have been developed to provide negotiated frameworks for land and resource access and management formalised as *Conventions locales*, sanctioned by the local authorities. These local conventions involve the development of *shared arrangements* access and management arrangements for shared natural resources over wide areas negotiated between the full range of interested stakeholders including pastoralists themselves (Gueye and Tall 2004). These approaches can help to overcome the deficiencies of more localized *gestion de terroir* approaches which focused on individual settled village communities and tended to exclude mobile herders, or the simple devolution of management rights and responsibilities to individual pastoral groups without

addressing the claims and interests of other users on the same set of resources (Gueye and Tall 2004).

*Cross-border mobility:* Policy initiatives at the regional level are also important in sustaining adaptive strategies involving mobility over wide areas to exploit the natural geographic and seasonal variability of dryland environments. Most significantly, the introduction by ECOWAS of Certificates of Transhumance (1998; Decision A/DEC.5/10/98), enables pastoralists to cross national borders of ECOWAS states.

*Pastoralism and regional adaptive strategies for the Sahel*

Brooks (2006) discusses the expansion of agriculture in the Sahel and Saharan fringes during the relatively wet 1950s and 1960s pushed pastoralists into more marginal regions and led to a breakdown in the networks connecting herders and farmers, also contributing to conflict between these groups. As a result of these changes, and ensuing regulation and restrictions in access to pasture and water resources, pastoral communities became more vulnerable to drought when rainfall returned to more “normal” conditions in the late 1960s. As a result of the dramatic decline in rainfall culminating in the severe droughts of the early 1970s, the overextension of agriculture and the marginalisation of pastoralists had catastrophic effects including massive loss of life and livestock, the destruction of communities and livelihood systems, violent conflicts, and societal disruption on a regional scale. Various modelling studies indicate a possible intensification of the African monsoon in coming decades the African Monsoon, and a greening of the Sahel and southern Sahara is a plausible consequence of anthropogenic global warming. Although the Sahel might benefit from these changes, continuing rises CO<sup>2</sup> and consequent temperatures up to the mid-21<sup>st</sup> century, indicate the probability of a return to drought. If the predicted future greening of the Sahel and southern Sahara were to lead to another wave of extension of settled agriculture beyond its present environmental limits, the droughts and famines of the 1970s could be repeated on a massive scale (Brooks 2006).

Brooks proposes that significant control of historically marginal areas in the Sahel could be ceded to pastoral groups, to help safeguard against the risk of agricultural overextension during a future wet periods. Pastoralists could “lease” land in these areas to agriculturalists during humid periods, when there is a surplus of resources. In drier periods the control of potentially marginal areas by pastoralists would prevent pastoral populations being pushed into extreme marginal environments, minimising the potential for famine and conflict. Pastoralism could thus provide a buffer zone between more reliable agricultural areas and the extreme desert margins, maximising the use of a variable resource base while reducing large-scale vulnerability to drought and climatic desiccation.

### **3.4 Increased glacial melt and impacts on irrigation schemes and tenure arrangements for irrigation**

Decreases in rainfall regimes and water availability and increased competition for water resources are also likely to impact on irrigation systems, responsible for large proportion of crop production in arid and semi arid countries. In addition increases in the pace of glacial melting in mountainous regions (such as the Himalayas and the Andes) will affect the volume and timing of seasonal flooding on which organized irrigation and flood recession farming are dependent, with short term increases

followed by longer term declines in water resources, posing challenges to the management of irrigation land. These developments will have a bearing on land tenure arrangements in irrigation systems, as well as on supplies of water for human consumption and agriculture. At present there are no studies of specific cases of glacial fed irrigation systems available which might indicate the sort of adaptations that are likely to be required. The exact nature of the impacts is complicated and difficult to foresee, depending on the rate of glacial melt, the changing on seasonality of water flows and the effects of temperature rise on precipitation in mountain regions. The impact on irrigation systems are likely to include decreases in the capacity of irrigation systems, or in some cases their complete collapse, creating the need for resettlement as well as better management of water resources and adaptation of crop varieties and production systems to changes in seasonality and overall availability of water supplies, together with likely concomitant needs for reorganization and readjustment of land holdings according to the changing requirements and capacities of the users. This section summarizes the known impacts on glacial systems on which people depend for water supply and livelihood, drawing on available regional assessments of climate change impacts in two regions at risk, Asia and Latin America.

### **Asia**

Accelerated glacier melt is likely to cause increase in the number and severity of glacial melt-related floods, slope destabilisation and a decrease in river flows as glaciers recede (IPCC Working Group 2, 2007, Ch 10). In drier parts of Asia, melting glaciers account for over 10% of freshwater supplies. Glaciers in Asia are melting faster in recent years than before, as reported in Central Asia, Western Mongolia and North-West China, particularly the Zerafshan glacier, the Abramov glacier and the glaciers on the Tibetan Plateau. As a result of rapid melting of glaciers, glacial runoff and frequency of glacial lake outbursts causing mudflows and avalanches have increased. Tibetan Plateau glaciers of 4 km in length are projected to disappear with 3°C temperature rise and no change in precipitation. If current warming rates are maintained, glaciers located over Tibetan Plateau are likely to shrink at very rapid rates from 500,000 km<sup>2</sup> in 1995 to 100,000 km<sup>2</sup> by the 2030s.

Climate change-related melting of glaciers could seriously affect half a billion people in the Himalaya- Hindu-Kush region and a quarter of a billion people in China who depend on glacial melt for their water supplies (Stern, 2007). As glaciers melt, river runoff will initially increase in winter or spring but eventually will decrease as a result of loss of ice resources. Consequences for downstream agriculture, which relies on this water for irrigation, will be likely unfavourable in most countries of South Asia. The thawing volume and speed of snow cover in spring is projected to accelerate in North-West China and Western Mongolia and the thawing time could advance, which will increase some water sources and may lead to floods in spring, but significant shortages in wintertime water availability for livestock are projected by the end of this century.

Himalayan glacial snowfields store about 12,000 km<sup>3</sup> of freshwater. About 15,000 Himalayan glaciers form a unique reservoir which supports perennial rivers the lifeline of millions of people in South Asian countries (Pakistan, Nepal, Bhutan, India and Bangladesh). The Gangetic basin alone is home to 500 million people, about 10% of the total human population in the region. Glaciers in the Himalaya are receding

faster than in any other part of the world and, if the present rate continues, the likelihood of them disappearing by the year 2035 and perhaps sooner is very high if the Earth keeps warming at the current rate. Its total area will likely shrink from the present 500,000 to 100,000 km<sup>2</sup> by the year 2035 (WWF, 2005).

In the longer term decreasing supply of irrigation from snowcaps will be felt particularly in the Indo-Gangetic plain (IPCC Wkg Gp 2 Ch 7). Moreover increasing amounts and earlier timing of irrigation are important adaptive measures to avoid crop stress due to increased temperatures and decreased rainfall. Although glacial warming will increase meltwaters in the shorter term, this will be felt mainly in spring rather than coinciding with peak irrigation demand, leading to summer shortages of irrigation water. The current trends of glacial melts suggest that the Ganga, Indus, Brahmaputra and other rivers that criss-cross the northern Indian plain could likely become seasonal rivers in the near future as a consequence of climate change and could likely affect the economies in the region. The Himalayan glaciers which feed these river systems, together with those in China, ensure a year round water supply for domestic and agricultural purposes to two billion people. In the Ganga, the loss of glacier meltwater would reduce July-September flows by two thirds, causing water shortages for 500 million people and 37% of India's irrigated land (WWF 2007).

In Kashmir, the impact of faster melting glaciers on agriculture is already evident, and a switch from irrigated rice production to rainfed crops is underway in many areas, undermining food security and exposing farmers to greater levels of risk. This trend has also been fuelled by the fragmentation of land holdings which are now frequently below the minimal size required to make paddy production viable. Lower water availability combined with rising temperatures has also affected the viability of valuable alternative cash crops, such as fruit tree crops, and field crops, notably saffron (Talib 2007).

In North China, irrigation from surface and groundwater sources will meet only 70% of the water requirement for agricultural production, due to the effects of climate change and increasing demand. Water saving schemes and alternative crop varieties for irrigation schemes are recommended (IPCC Working Group Two 2007) but the land management implications are not clear.

### **South America**

The Glaciers of the Andes have been steadily receding in Peru, Ecuador, Colombia and Venezuela, at an accelerating rate, attributable to climate warming in the high Andes (Hulme M and Sheard W / WWF Tyndall Centre 1999). An anticipated 3° C warming in the Northern Andean region Andes by 2050 under B1 low to A2 high emission scenarios, is expected to bring about rainfall changes rather more rapidly in the Andean plateau than on the coast. Predictions of various climate models differ but on balance likely increases rainfall in central Andes significant under higher emissions scenarios, but with drying in the North. Reduction of rainfall in lowlands and Andes, combined with increases in deforestation, are likely to impact on biodiversity.

Changes in El Nino behaviour will have a big impact on the region but how the region's natural climate variability will respond to global warming is highly uncertain.

As a consequence of temperature increases, the trend in glacier retreat reported by IPCC is accelerating. This issue is critical in Bolivia, Peru, Colombia and Ecuador, where water availability has already been compromised either for consumption or for hydropower generation. These problems with supply are expected to increase in the future, becoming chronic if no appropriate adaptation measures are planned and implemented. Over the next decades Andean inter-tropical glaciers are very likely to disappear, affecting water availability and hydropower generation. Peru already suffers declining irrigation water supplies as a result of glacial retreat

### **3.5 Land tenure implications of avoided deforestation and carbon offset forestry**

Land use change, in particular deforestation, has been a significant source of greenhouse gases. Deforestation is a major source of carbon accounting for some 18-20- % of global CO<sup>2</sup> emissions (Stern 2007), and in some countries, such as Indonesia and Brazil, for the greater part of their emissions (75% in the case of Brazil). As a result, the avoidance of deforestation, together with measures to improve land use planning and protection of natural ecosystems and to promote afforestation and the restoration of degraded forest all offer important CC mitigation strategies.

These strategies primarily involve developing countries, where important tracts of natural forest remain and substantial land resources are often assumed to be available for tree planting. However these means of mitigation have significant implications for property rights and tenure systems. Given existing land policies, including the insecurity of customary rights and the land requisitioning powers of governments, demands for land for avoided deforestation and other climate change mitigation schemes (including afforestation, but also, significantly, increased biofuels production) from the state and private investors are ironically likely to further undermine land access by the poor, already under threat from numerous development pressures, unless mitigation schemes can provide them with new opportunities which safeguard their existing land holdings.

#### **Types of scheme**

The so called LULUCF (Land use, land use change and forestry) projects promoted under the CDM (Clean Development Mechanism) of the Kyoto Protocol include Carbon sequestration through forestry to offset carbon emissions, whereby polluting and high energy consuming countries, private companies and individuals finance tree planting and the purchase of forest land as a means to guarantee its conservation.

LULUCF projects have been based on both public funds and market mechanisms. Available evidence suggests that the pressures may be particularly acute when they originate from market based schemes for the purchase and exchange of carbon credits and for delivery of Carbon offsets to corporate customers in the North. To increase their uptake and anticipated impact in terms of net reductions in carbon emissions, these programmes seek to deliver land for carbon mitigation for high volume planting and rapid growth of trees at lowest possible cost. In a context in which forest dwellers land rights are frequently unrecognized this creates tendencies to ignore the stake that they have in the land and tree planting schemes - which potentially raises the costs and reduces the scale and pace of the carbon sequestration being purchased - or at worst to exclude them completely from land earmarked for mitigation or avoided deforestation.

A variety of independently organized market based projects have also emerged whereby Carbon offset companies or voluntary organizations facilitate the investment of private funds in carbon offsets, to compensate for emissions produced from air travel, industry and high consumption lifestyles.

Forest conservation or avoided deforestation (AD) projects were not accepted under the first commitments period (2008-2012) of the CDM, because of difficulties involved in verification. In principle however, and given the evidence from existing carbon offset afforestation projects, forest conservation projects are less demanding of new land for tree planting, less threatening to community livelihoods (except where forest dwellers are excluded in drives for forest protection) and also more effective in reducing net Carbon emissions.

Since Kyoto, a new generation of projects has emerged, on the principles of RED (Reduced Emissions from Deforestation) or REDD (Reduced Emissions from Deforestation and Degradation of forests) with considerable debate about where the balance of emphasis should lie. Proponents of RED want incentives for forest conservation to be part of the Kyoto Protocol's Carbon trading instruments during its next phase (post-2012). Private companies involved in Carbon markets, and countries which have already degraded their forest cover and are now seeking to restore it argue that REDD approaches are needed to enable them to capture a share of AD funding (Griffiths 2007). Whereas RED projects alone, may be more difficult to verify than creating new plantations, forest degradation and rehabilitation is also difficult to define and measure. Moreover, a focus on rehabilitation of degraded forests through tree planting may fail to prevent continuing deforestation, providing lower benefits in terms of reduced Carbon emissions. RED schemes would use a national country level Carbon accounting approach, rather than project level accounting, in order to enable effective cross sectoral land use planning and reduce monitoring costs (Griffiths 2007).

For both RED and REDD approaches, it is proposed that developing countries should pay for avoided deforestation and forest restoration schemes using public resources, through aid budgets, or alternatively that Southern countries should sell the carbon locked up in forests to the North to allow industry and society to carry on polluting under a global system of Carbon trading (Griffiths 2007). Some southern countries, such as Brazil, are opposed to linking RED schemes to carbon trading and propose that they should be financed by a combination of international (aid) and national (taxation) public funds. The Stern report (2007) proposes public financing supplemented by Carbon trading, with action to ensure large scale AD as soon as possible. The World Bank, UK government and others take the view that while public finance may be fundamental, a market approach is necessary to deliver finance on the scale required, and change the incentives for developing countries to control deforestation effectively.

The major recent development is the Forest Carbon Partnership Facility (FCPF) announced by the World Bank in October 2007 would pay developing countries hundreds of millions of dollars for protecting and replanting tropical forests, which store huge amounts of carbon that causes climate change. The facility would cover both RED and REDD proposals and would feasibility test and pilot different methods

of financing and management, while supporting developing countries to monitor levels of deforestation and emissions reduction related to forest cover. The FCPF has already attracted interest from more than a dozen developing countries including Indonesia, Brazil and several in Africa's Congo River basin. By creating economic value for tropical forests, the facility can help developing countries such as Liberia, Democratic Republic of Congo, Guyana, Suriname and others generate new revenue for poverty alleviation while maintaining the natural benefits such as fresh water, food and medicines that the forests provide local populations.

However the whole range of schemes for LULUCF and AD (or RED and REDD) schemes have important implications for how forests are managed, who manages them, and what may or may not be allowed to happen in them (Griffiths 2007). In other words, they have implications for tenure and property rights, and the institutional governance arrangements over forest resources.

### **Lands issues**

Unspecified property rights over forest areas and the allocation of forest land to commercial users by governments have led to widespread deforestation as a result of uncontrolled logging and conversion of forest land to other uses. More secure property rights for forest dwellers, together with better systems for valuing and pricing forest resources to include their environmental and carbon mitigation functions thus have important roles to play in safeguarding forests as stores of carbon and in reducing carbon emissions.

However the growing interest in purchasing forest land in developing countries as a means to offset carbon emissions, and in payments to governments to safeguard forest cover creates pressures to override existing tenure systems and exclude forest users including indigenous groups. As a result the poor face serious risks as well as potential benefits from avoided deforestation and carbon offset schemes.

The Stern report (2007) does recognise the need for AD schemes and projects to address tenure issues: *'At a national level, defining property rights to forestland, and determining the rights and responsibilities of landowners, communities and loggers, is key to effective forest management. This should involve local communities, respect informal rights and social structures...'* (page xxvi). It is also stressed that *'Clarity over boundaries and ownership, and the allocation of property rights regarded as just by local communities, will enhance the effectiveness of property rights in practice and strengthen the institutions required to support and enforce them'* (page 541). Stern also notes the risks of perverse incentives created through incorrect baselines, corruption, rent-seeking behaviour and the capture of benefits by national elites (pages 549-550), but proposes few concrete measures to avert or minimise these risks. (Giffiths 2007 on the Stern Review)

Where incentives for AD accrue directly to governments "in their scramble to receive compensation payments by showing satellites overhead that forest clearance and burning has stopped, over-zealous forest protection agencies may be tempted to evict shifting cultivators and to cordon off forests completely against any use by traditional forest dwellers and other forest-dependent communities" (WRM 2007). At worst, entire communities may be evicted from land designated for tree planting or as forest based carbon stores (Reid and Roe 2007). The additional resources available from

REDD financing could promote an unjust and outdated “guns and guards” approach to forest protection (Griffiths 2007).

The record of existing Carbon offset afforestation projects and top-down large scale PES (Payment for Environmental Services) projects in countries such as Bolivia and Brazil in delivering real benefits to forest dwellers is not encouraging (Griffiths 2007). For example in a tree planting project in Mount Elgon National Park, in Uganda (Lang and Byakola 2006) and similar projects operated in the Ecuadorean Andes by the same Dutch carbon offset company, the FACE Foundation (Granda 2005), have been found to be highly problematic from the point of view of community land rights and participation. In both cases local people were not properly informed, consulted or advised of the real net benefits they could expect, subjected to manipulative contracts and had their own access to land and natural resources curtailed, with some communities becoming indebted through failure to meet their obligations, or even removed from their land. Experience of similar projects in India has shown that they tend to increase state control rather than local people’s influence over forest resources, and lead to unwanted government interventions. Since the cheapest and most rapid way of acquiring Carbon credits would be through the plantation of large tracts of land with monocultures of fast-growing tree species, Carbon sinks pose serious threats to the livelihoods, territories and cultural survival of indigenous peoples and rural communities” (Carruso and Reddy 2005).

Carruso and Reddy (2005) go on to explain how, in India, following heightened protest by Adivasis (indigenous people) and support organizations in late 2004, the Central Government agreed in early 2005 to introduce the *Scheduled Tribes and Forest Dwellers (Recognition of Forests Rights) Bill* before parliament. The Bill would provide Adivasi communities with legal recognition of their forest resource and access in areas traditionally used and occupied by them. This law would facilitate the regularization of lands being cultivated by Adivasis, the conversion of so-called forest villages<sup>21</sup> to revenue villages (with title deeds), and the settlement of disputed land claims. However, by creating a market for carbon which impinges on Adivasi land and resource use, Carbon sink projects will engender change in the relationship between Adivasis and their lands and resources, undermining livelihoods, food security, indigenous cultural identity, and ultimately contribute to a crisis of survival.

Whether through plantation or protected area projects, carbon forestry projects present potential problems for indigenous peoples. The first threat is to indigenous peoples’ lands and territorial security. In India, and elsewhere government agencies still refer to large areas of land constituting important livelihood bases for many indigenous and forest-dependent peoples as “wasteland” or “degraded land”, even though much of this land is subject to customary ownership by indigenous Adivasis and other forest dependent communities, unrecognized by the government, and therefore at risk of expropriation through CDM plantation projects. (Carruso and Reddy 2005).

In contrast to these approaches, in order to ensure community benefits and prevent evictions, there is a need for implementation of CDM and AD projects through village self help groups, farmers associations and indigenous people’s organizations, rather than by forest departments or directly by carbon offset companies. Ownership rights over land, over the carbon sequestered, and the management control of the project are the most critical elements to be accounted for in small scale RED or REDD projects



which need to be established prior to implementation in order to avoid conflict and ensure that local people and forest dwellers can benefit.

According to Griffiths (2007) there are real risks that governments, companies and conservation NGOs will ‘zone’ (or carve up) forests by demarcating protected areas, biological corridors, forest reserves and sustainable forest management zones (certified logging) to receive AD payments to the exclusion or disadvantage of indigenous and traditional communities, and that RED schemes will drive the expropriation of customary lands. “*The same potential problems of top-down land use planning and forest zoning exist with RED schemes as they do with other approaches that depend on land-use zoning and land classification – like the application of the High Conservation Value or ‘critical forests’ concepts. Given the potential earning capacity of standing forests, some States may become even more reluctant to recognise indigenous and local community customary ownership rights over forest lands. RED (reduced emissions from deforestation) compensation payments to governments may create a disincentive for forest and conservation and other government authorities to resolve long-standing land disputes in forest areas (Griffiths 2007)*”. Griffiths also identifies other dangers: that relatively lucrative compensation rates per hectare of forest might drive land speculation on forest frontiers and even in more remote forest areas; that government agencies will capture the benefits; that people will be subjected to unjust contractual arrangements; and that without careful measures to ensure equitable benefits, AD payments might create rifts between those communities or households receiving payments and those that are excluded, which may include those without formal legal title to their lands and ‘landless’ people.

In this context *tenure regularization for existing forest dwellers and collective titling for indigenous groups* are essential measures to ensure that avoided deforestation schemes respect their rights and reduce land use pressure and need for resettlement in other areas. In addition to improving the provisions of land policy itself in respect of indigenous peoples and forested land, countries may need to *address the consistency of their land and forest policies* – even where land policies acknowledge the need to protect customary rights and facilitate formalization, forests themselves may remain the preserve of the state, refusing to recognize the rights of forest dwellers and undermining forest and livelihoods so as to substitute AD revenues for logging revenues.

At present there are no *legal frameworks for CDM and AD projects* in place – these need to be devised taking into account provision for communities’ and indigenous people’s land rights. In addition, even where state institutions guarantee the rights of forest dwellers, unless the preferences and livelihood priorities of these groups involve maintaining forest cover, then *mechanisms to ensure that indigenous groups and forest dwellers can benefit directly from the payments and incentives provided by AD schemes* will be needed. And the benefits of these will need to exceed the opportunity costs of foregoing the returns from deforestation (e.g. from logging, charcoal extraction and conversion to agriculture).

Monitoring and enforcement of AD schemes is difficult if land ownership in forests areas is not clearly defined with rights fully specified (Peskett et al 2006). Part of the management costs of AD schemes thus need to be devoted to *improved land*

*information and registration systems.* In addition communities will require active encouragement and technical assistance for forest conservation and sustainable management and the *development of standards for AD schemes should encompass land ownership issues* and provide of support to forest land users to conserve forest.

Avoiding deforestation while safeguarding the livelihoods of the forest dependent people calls for a *strong focus on the legal and institutional arrangements for forest governance*, including the *nature and distribution of property rights in forest areas* and *mechanisms to protect the land rights of the poor.*

### **3.6 Climate change, land and indigenous peoples**

Climate change will have a substantial impact on the lifestyles and livelihoods of indigenous peoples because of the effects on the variety of wild and remote areas where they live and the natural ecosystems. These include: polar areas, where melting ice sheets affect fish and wildlife populations; mountain environments, where glacial melt creates particular hazards such as glacial lake outbursts, and affects alpine ecosystems and water supply; remaining tropical forests, threatened with long term drying trends causing changes in natural resource availability and utilization; dryland environments, where pastoralist groups are reliant on mobile access to fragile grazing and water resources spread over wide distances and highly dependent on rainfall availability; and coastal wetlands and low lying island threatened by sea level rise.

Indigenous groups can be particularly vulnerable to climate change hazards because they face widespread discrimination and exclusion from and degradation of land and natural resources on which they depend, often as a result of government failures to recognize the legitimacy of their land and territorial rights. In this context in which indigenous people's livelihoods and cultural survival are already under threat, they also face the direct and indirect impacts of climate change on the ecosystems which have formed the traditional basis of their livelihoods.

Best documented are the effects of melting polar ice sheets on biodiversity and its utilization by indigenous peoples of the Arctic Circle, where the impacts on the Inuit in Canada are discussed by IPCC (2007, Working Group 2 Chapter 17). Major biodiversity losses are predicted in tundra, wooded tundra (taiga), cool conifer forest and temperate deciduous forests. With a 3°C rise in temperature, these biomes would lose variously between 7 and 74% of its extent such that 22% of their total land surface is transformed, these areas supporting low biodiversity. The major world ecosystems at greatest risk of complete loss due to climate change are coral reefs, Arctic ecosystems, and other ecosystems in biodiversity hotspots where losses of species due to climate change could number into the thousands or tens of thousands of species. Of serious concern is that acidification of the ocean, a direct consequence of increased carbon dioxide concentrations, has the potential to disrupt the marine ecosystem (Warren et al 2006) although these changes will not only impact on indigenous groups they are likely to be particularly affected because of higher dependencies on biological resources.

#### **Forest dwellers**

In addition to the direct effects of climate change, indigenous peoples are also at risk of further losses of land and resource access as a result of carbon emissions mitigation

projects, notably those involving avoided deforestation and forest restoration in tropical forest environments. Forest dwellers are already being affected by carbon offset forestry, and they are likely to be affected by avoided deforestation schemes, as discussed above in section 3.4.

Although under international law and best practice, all development projects must account for indigenous land and resource rights, the Clean Development Mechanism has not highlighted these, nor has it sought to ensure the free, prior and informed consent of indigenous peoples and fully inclusive social baseline assessments as fundamental requirement for climate change mitigation or carbon emissions offsetting projects on indigenous lands. Moreover, the carbon offset markets and financing mechanisms for avoided deforestation may provide further incentives for governments not to recognize indigenous land and territorial rights the incentives, so as to capture the benefits for themselves and make land freely available for afforestation projects.

There are urgent needs to ensure that global climate change mitigation policies on avoided deforestation are formulated with the full and effective participation of indigenous peoples and other potentially affected rights holders, and for measures to involve indigenous groups and their partner organizations in identifying and implementing sustainable, decentralised solutions to climate change mitigation and adaptation (Griffiths 2007).

An Indigenous Peoples' Statement made at the 9th Conference of Parties to the UNFCCC in Milan in 2003 summed up their demands in relation to these types of projects:

*“The Clean Development Mechanism (CDM) and Joint Implementation (JI) must incorporate principles which address transparency, free, prior and informed consent and equitable benefit sharing with Indigenous Peoples in order to accomplish the objectives of lowering greenhouse gas emissions and achieving sustainable development in developed and developing countries All development projects within indigenous ancestral territories must respect our fundamental rights to lands, territories, self-determination and ensure our right to our free, prior and informed consent. Sinks projects do not contribute to climate change mitigation and sustainable development. The modalities and procedures for afforestation and reforestation project activities under the CDM do not respect and guarantee our right to lands, territories, and self determination.”<sup>4</sup>*

The emergence and development of the global carbon market in avoided deforestation over the next few years represents a huge financial opportunity for indigenous people to be paid for preserving their forest lands. However, there are significant challenges in getting governments to recognise tenure-rights and local priorities and ensure equitable benefit sharing with indigenous groups (Sallick and Byg 2007)

According to the forest people's programme (Griffiths 2007), action is needed to ensure:

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<sup>4</sup> *Indigenous Peoples Major Group – Opening Statement UN Commission on Sustainable Development, Inter-active Session with Major Groups – Monday, April 30, 2007, quoted in Griffiths (2007).*

- Indigenous peoples and forest movements are directly engaged in the current international and national debates on avoided deforestation/REDD;
- Human rights, FPIC (free, prior and informed consent), respect for customary land and resource rights, land tenure and security, equitable benefit sharing and good governance are made central in discussions on avoided deforestation policy;
- Guarantees are forthcoming that customary rights will be recognised and respected;
- Guarantees are secured that indigenous peoples will retain and recover control over their forests and receive support for genuine community-based forest management;
- Any processes to identify national and local drivers of deforestation in tropical countries and decisions on tackling these must involve forest peoples and forest dependent communities;
- Any proposed standard setting and rules for avoided deforestation schemes fully involve potentially affected indigenous peoples and local communities and require full conformity with international law.

### **Pastoralists**

The adaptive capacities of pastoralists have been eroded by their marginalisation, including loss of access to land and natural resources, and as a result they may be more susceptible to climate change than other communities. The vulnerability of African pastoralism and potential adaptive strategies have been assessed by Brooks (2006) for the World Initiative on Sustainable Pastoralism and IUCN, summarised above in section 3.5 of this report. Developmental models based on high densities of people and livestock and permanent, sedentary agriculture in historically or potentially marginal areas are unlikely to deliver sustainable development in the long term. In the Sahelian environment, systems based on flexibility, mobility, and low-intensity use of natural resources are much more likely to deliver a sustainable future (Brooks).

The need to maintain mobility is points to the need of maintain flexibility of tenure arrangements in the Sahel, avoiding the creation of secure rights for agriculturalists in currently marginal areas, and the confinement of pastoralists to more marginal areas, in order to safeguard adaptive capacity. Given the uncertainties surrounding climate change projections in the Sahel, flexible systems of agro pastoralism, which permit pastoralists to take up arable farming and agriculturalists to take up livestock production, according to changing sets of opportunities in different parts of the Sahel are likely to provide an important strategy in the face of the enhanced variability that the environment is likely to face under climate change. Appropriate forms of tenure and institutional arrangements to support such flexible systems need to be put in place.

Successful pastoralism in the Sahel will also require that pastoral populations maintain their freedom of movement, both within countries and across national borders in some areas, requiring sustainable cross border frameworks for pastoral land policy and management.

A rehabilitation of pastoral livelihoods through a combination of traditional and novel approaches to land and livestock management is likely to be needed. Reciprocal relationships between pastoralists and agriculturalists will play a key role in future

development. A legal and policy framework for promoting informal social institutions to regulate access to resources at sustainable levels, which could be based on traditional resource management institutions and informed by modern institutions, is preferable to simplistic attempts to increase productivity through expanded access to resources such as water (Brooks 2006).

Elsewhere, for example in North Africa and the Middle East climate models show greater concurrence in predicting further decreases in regions which already experience extreme aridity. Climate change in these regions is even more likely to have extremely problematic consequences for pastoralists, with severe impact on rangelands and food security, and in some instances may drastically undermine the viability of pastoral systems. Simulations of future climate change indicate an average reduction of rainfall in the Maghreb of some 40% for an increase in global mean surface temperature of around 2°C, which is very likely by the middle of the twenty first century (Warren et al 2006). Climate projections for Southern Africa also indicate drying trends and the region is likely to be adversely affected. Remobilisation of currently stable dune fields in the Kalahari could potentially occur, eliminating local vegetation and presenting severe problems for countries such as Botswana, and for those pastoralists and hunter gatherers who still rely on mobility throughout this region. Declines in rainfall in other arid and semi-arid regions may also have negative impacts on pastoralism, particularly where pastoralists are restricted in their movement and livelihood options.

Drying tendencies induced by climate together with other pressures on tropical forest ecosystems could result in their transformations into savannahs (Warren et al 2006). Emerging savannah environments in regions subject to drying trends such as the northern Congo basin and parts of the Amazon may provide suitable conditions for an expansion of pastoralism and the securing of livelihoods and food resources where climate change is associated with dramatic changes in landscapes and ecosystems. Such changes are however likely to lead to land use conflict between existing forest dwellers and incoming pastoralists or cattle ranchers.

### **Land issues and adaptation by indigenous peoples**

Significantly, security of tenure for indigenous groups is a key concern in discussions of avoided deforestation. The vulnerability of indigenous peoples to negative impacts of avoided deforestation and emissions mitigation land use projects stems from the non-recognition of their land rights in law and the lack of political will and institutional capacity to guarantee these rights in the face of more lucrative land use opportunities and powerful interest groups. The non-recognition of indigenous people's rights makes them vulnerable to forced relocation (e.g. from vulnerable coastal area or tropical forests where their presence may be perceived as a threat) and may exclude them from entitlements to compensation or resettlement. More generally, secure tenure rights for indigenous peoples can assist them in adapting more effectively to the direct impacts of climate change.

Secure tenure rights for indigenous groups provides a *foundation for stewardship of fragile natural resources* and development of innovative and equitable *partnerships for the protection and restoration of tropical forests and other natural carbon sinks* and the biodiversity they support. It has also been suggested that since indigenous peoples have long observed and adapted to the effects of climate change and variation historically, they offer *important potential partners for science in monitoring the*

*progress of climate change* and its impacts on the natural environment (Sallick and Byg 2007). Such initiatives potentially include changing weather patterns, receding glaciers, melting ice sheets, changes in species distribution and changes to specific ecosystems and environments such as montane floras, tropical forest ecosystems, dryland forests and savannas, deserts, island environments and coral reefs.

Because indigenous people's and pastoralists customary livelihoods often depend on their access to natural resources over relatively wide areas and the integrity and biodiversity of extensive natural ecosystems which may be affected by climate change in complex and unforeseen ways. The survival and effective adaptation of indigenous groups therefore requires not only guarantees of tenure security over dwelling places and key livelihood and cultural resources, but guarantees of *access rights to resources over wider areas*, and where these also have other legitimate users, negotiated arrangements for the protection, management and sustainable use of the resources in question.

The principal land tenure policy implications of climate change risks to indigenous groups are therefore to reinforce policies, legislation and mechanisms for the practical guarantee of indigenous land and resource rights, including the *provision of indigenous title*, but also through *legally enforceable frameworks for negotiated access and management rights to natural resources* over the broader areas which constitute indigenous territories.

This is particularly the case for pastoralists in Africa and elsewhere, who face widespread discrimination, tenure insecurity and exclusion from essential resources in semi arid areas likely to experience heightened climate variability and long term drying trends as a result of global warming.

### **3.7 Gender, climate change and land**

The poor are most vulnerable to the impacts of climate change and variability, and women are over-represented amongst the poor. Approximately 70 percent of the world's poor are women and their vulnerability to natural disasters and environmental hazards is further accentuated by questions of race, ethnicity, and age (IUCN 2007).

The people most at risk from climate change are those living in affected areas, who are least able to avoid the direct or indirect impacts (as a result of having poor quality or poorly located housing), being physically more vulnerable, and least able to cope with the loss of income, livelihood assets, ill health and injury. In low income populations, women's vulnerabilities in all of these respects tend to be more pronounced, in part because their limited access to and control over assets such as land exposes them to all of these risks (Satterthwaite et al 2006).

There is some evidence that natural disasters tend to impact disproportionately on women (Cannon 2002, Satterthwaite et al 2006). In both rural and urban environments, pre-disaster patterns of gender inequality can be exacerbated and are likely to be reflected in greater difficulties faced by women in the aftermath, because of their particular roles in childcare, gathering domestic water and fuel supplies, and in household food production and security. There are a variety of reasons for this.

Women represent the majority of low income earners, and have lower educational levels than men, more limited access to property rights, and limited representation in political arenas and community decision making. Women face cultural discrimination which exacerbates their vulnerability (for instance in Bangladesh in not being taught to swim and not being able to circulate freely in the absence of men) and limits access to emergency relief and resettlement opportunities in the event of disaster. Women may be constrained in fleeing rapidly from sudden onset disasters given their responsibilities for childcare or as a result of social norms. Loss of homes and home gardens can also have a major impact on women's livelihoods since women often tend to pursue home-based income earning activities. But despite women's greater ties to the home and its immediate environment their legal and customary jurisdiction over these essential assets is highly restricted.

A variety of forms of gender discrimination in access to land and property rights is one set of factors underlying women's greater vulnerability to the impacts of climate change. While women can lack access to formally recognised property rights because of entrenched legal and institutional discrimination, they also face discrimination in customary tenure systems, and are unable to inherit property and dependent on male relatives for access to land. The lack of secure property rights makes it more difficult for women to access sources of credit. The absence of jointly recognised property rights can restrict female spouse's access to resettlement or compensation for the loss of property, despite their pre-eminent needs for a secure domestic environment. Women face discrimination in access to land registration systems and as a result female headed households, especially where women are poor and illiterate, are particularly vulnerable.

In addition, poor women's lack of access to and control over natural resources, technologies and credit mean that they have fewer resources to cope with seasonal and episodic weather and natural disasters (IUCN 2007). Women play a major role in agricultural production, particularly in farming subsistence crops for family consumption, despite their lack of access to secure tenure. The corollary is limited land use decision making power or control over farm inputs and outputs. As a result changes in agricultural conditions engendered by temperature rises and rainfall variations resulting from climate change can have a pronounced effect on women's farm production, incomes and food security.

Women are disproportionately dependent on access to natural resources such as non-timber forest products for their subsistence and small scale trading. Access to Supplementary food resources from the wild which can be critical to survival during drought or lean periods will become more and more important in a more variable climate, by the same token, availability of wild food resources is likely to become more restricted. Not only will warming trends affect the biodiversity and resource availability to women in forest environments, but women will be more severely impacted by exclusion from forest areas in carbon emissions mitigation tree planting projects and as developing countries seek access to avoided deforestation finance.

When populations have to move – either temporarily or permanently – it is rare for women's needs and priorities to be addressed or even considered in the temporary or resettlement accommodation. Restoring the base for women's livelihoods often gets less attention than men's – and it is common for women to take on most of the child-

rearing and domestic responsibilities, even as these are more onerous and time consuming – for instance greater difficulties getting food, fuel and water, among other domestic responsibilities. Women’s individual and collective capacities for recovery and reconstruction by drawing on their resources, skills, capacities, assets, experiences and hard-won knowledge about how to make life safer and live with risk after disaster also tend to be neglected, although there is good evidence that supporting women’s role in rehabilitation and reconstruction can help maximise the possibilities of social recovery (Satterthwaite et al 2006).

In line with the problems of adopting a non-gendered approach to disaster management and recovery, policies and programmes to address climate change also suffer from a deficit in gender analysis, and as a result are not gender neutral. IUCN (2007) find that “*several areas deserve attention, specifically: gender specific resource-use patterns; gender-specific effects of climate change; gender aspects of mitigation and adaptation; gender and decision-making on climate change; women’s capacity to cope with climate change; and gender related patterns of vulnerability.*”

IUCN quotes an example of good practice in Costa Rica, where the Programme to Pay for Environmental Services, managed by the National Fund for Forest Finance (FONAFIFO) which promotes forest conservation, restoration, sustainable management and carbon emissions mitigation, by rewarding landowners for maintaining forest cover. Although most landowners are men and as a result women have little direct access to the benefits of the scheme, the programme imposes a levy on funds received which is channelled into promoting women’s ownership of forest land (IUCN 2007).

The principle implication of women’s disproportionate vulnerability to climate change is the need for improved gender analysis and targeting in adaptation planning, at all levels. Reduction and eventual removal of discrimination in women’s access to land and property has a key role to play in developing a more gendered approach to adaptation in both urban and rural areas.

Carbon emissions mitigation planning could also promote women’s participation. There are indications that with better access to resources, technology and finance women can increase efficiency in the use of domestic energy and renewable energy sources, assisting mitigation (IUCN 2007). According to the Commonwealth Secretariat<sup>5</sup>, women in developing countries should also be specifically targeted in Carbon finance mechanisms for reducing deforestation and developing sustainable supplies of biomass energy.

To conclude, better, more secure access to property rights and natural resources for women is fundamental to reducing women’s vulnerability to climate change. The risks to which women are exposed highlight the urgency of political and practical action to

- *Provide secure tenure arrangements for women over land and property rights, through individual and joint spousal titling and documentation of women’s rights, this is particularly, but not only for female headed households*

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<sup>5</sup> Gender and Climate Change, information for delegates Commonwealth Finance Ministers meeting, Georgetown Guyana 15 017 October 2007 Commonwealth Secretariat



- *Combat gender discrimination in customary systems of land tenure and inheritance*
- *Promote practical access to land and property through targeted access programmes for women's groups and producer associations in areas most at risk, including coastal areas, drylands and informal urban settlements, as well as through carbon emissions mitigation forestry schemes*
- *Improve women's access to natural resources, through extending use rights to public assets and forest reserves and more gendered approaches to natural resource management, with equal status for women and men in group titling and common property associations*
- *Legal literacy and practical support to women in gaining access to land and obtaining documentation of secure tenure.*

#### **4. The implications of climate change for land policy**

The general messages of the realities of climate change in relation to land tenure are not different from the principles of progressive land policies now widely recognized and promoted by international development agencies. These include: provision of secure land rights under a diversity of forms of tenure, including the recognition of customary rights and the devolution of responsibilities for land registration and management to more local levels; promoting land access for disadvantaged groups including women and indigenous peoples; upgrading of tenure and infrastructure in urban informal settlements; improving equality in the distribution of land; decentralized management of natural resources and inclusive frameworks for stakeholder involvement and management of conflicts; encouragement of equitable rental markets to improve supplies of land; and better governance in land administration, in particular to ensure equitable access to and good use of public land. On the other hand there will clearly be a need for more effective land use regulation in at risk areas which is likely to constrain overall land availability leading to requirements to accelerate provision of land access and secure land and resource tenure elsewhere. In practice however, the relatively high costs of resettlement or compensation for loss of land, and of tenure regularization on a massive scale, coupled with the likelihood of climate change impacts on tenure insecure people in at risk areas may lead governments to neglect questions of tenure security of vulnerable groups. As a result it is not enough simply to promote a positive land policy responses to the risks associated with climate change, and a more systematic integration of land policy with climate change adaptation planning.

In general terms we consider that there will be a need for tenure policies which provide both a) greater security in land and property rights so as to consolidate and extend people's control over land and natural resource assets and provide incentives for good environmental stewardship, and b) for greater flexibility to accommodate changes in land use and settlement patterns so as to provide clear options for people in the anticipated contexts of greater demographic mobility provoked by climate related threats to human settlements and livelihoods. These two elements of security and flexibility are both important considerations in current land tenure policies and we believe they are not in contradiction.

##### **4.1 Critical issues**

On the basis of the foregoing discussion of the land dimensions of climate change impacts, this paper identifies three critical problems which land policy needs to address, which cross cut the range of at risk areas in developing countries.

- i) The need to address land use and settlement issues in areas facing significant direct risks from climate change, notably low lying coastal areas, including cities and river deltas, and particularly in those areas at serious risk in South Asia. There is a need for both:
  - a) provision of secure rights for households to plots of land in safe areas and secure access for local communities to their immediate environments to create incentives for upgrading of infrastructure and for effective natural resource management; and
  - b) action to facilitate resettlement in preparation for the large scale displacement resulting from sea level rise and more frequent storms surges and high impact

disasters, including inventories of current settlements and available land, documentation of informal rights, assessment of land suitability and climate hazard risks, and action to improve land availability and allocation.

To a high degree both these types of measure will involve increasing the capacity of land administration systems.

ii) The need for accelerated provision of secure tenure arrangements which can enhance households and communities existing capacities to adapt to the impacts of climate change on livelihoods and food security production. This will involve rolling out low cost programmes of tenure regularisation and formalisation on both a household and community basis (according to available capacity and existing customary practice) especially in areas of the semi-arid and sub-humid tropics likely to suffer impacts on food production or facing growing land competition. These measures need to incorporate strengthening of natural resource tenure through group titling or joint management frameworks involving local communities, the state and other natural resource users. Tenure security and natural resource management innovations need to be accompanied by measures to strengthen community capacity for resource management and ensure the uptake of appropriate management techniques and productive technologies. Once again these types of measures will require increases in public capacity for delivery.

iii) Measures to protect the poor and vulnerable from loss of livelihood resources and develop the opportunities available for them to gain direct benefits as a result of climate change mitigation measures, in particular avoided deforestation / reforestation and biofuels development, especially where these are led by market based mechanisms. This will involve development of better legal frameworks for the regulation of these programmes, including achieving better coherence across countries land and forest policies, and developing agreed standards and monitoring arrangements for carbon emissions mitigation which properly address questions of land and resource ownership and access. Actions to ensure group titling in forest areas, or in areas where there is already a diversity of legitimate public and private interests are important recognition of secure rights of access and prior consultation and participation for indigenous peoples in forest area management are important first steps, prior to the wider development of these schemes.

There is a need for targeting of all these measures on women, indigenous groups and other social groups at particular risk because of poverty, weak access or restricted access to land and natural resource assets, existing exposure to natural and other hazards, and limited adaptive capacity.

Given the likely increases in mobility, migration and land competition in many areas as a result of climate change, and the fact that the poor are likely to be disproportionately affected by climate change there is a general need to strengthen the governance arrangements over land based natural resources on which the poor and vulnerable depend, in addition to specific measures targeted at women and indigenous groups. This means not only paying attention to lands issues in climate change mitigation planning but ensuring that land tenure and land use management have central places in sustained efforts to improve the governance frameworks for both rural and urban development in the context of climate change.

## 4.2 Land tenure related measures

In responding to these critical problems, a number of specific land tenure and land policy issues which have emerged from the discussion of the land dimensions of issues in climate change adaptation are listed below:

*Tenure security issues:* providing security through a diversity of forms of tenure, (not only provision of freehold rights through) including granting formal recognition to customary and informal rights; granting tenure security to groups, village communities, producer associations and other collective bodies where appropriate, including for indigenous groups; utilizing low cost methods of land survey and registration; devolving responsibility for documentation of land rights to local bodies; moratoriums on evictions without resettlement or fair compensation, and improved legal remedies against evictions and forced removals; gendered approaches incorporating opportunities for women to register land and joint spousal rights; priority access to home area resources, and negotiated frameworks for access to valuable seasonal and fall back resources for pastoralist and other mobile groups.

*Improving land access for the poor:* making existing land redistribution programmes work more effectively; better use of government land and eliminating corruption in access to public land; equitable liberalization and regulation of rental markets to encourage land supply and provide greater certainty on both landlords' and tenants' rights; land release schemes in resettlement areas; programmes to guarantee access to household plots and home gardens for the poor; proactive programmes for land access for women and vulnerable groups.

*Strengthening the negotiation position of the poor:* legal literacy and empowerment; advocacy and intervention by government and civil society organizations to facilitate poor people's access to land distribution schemes and land markets; reducing fees and transaction costs in access to land administration institutions; capacity building for community and residents associations and farmer organizations to play active roles in adaptation planning.

*Land and natural resource information:* improved inventories of land occupation in urban and rural areas including the informal sector; improved analysis and mapping of natural hazard risks for informal settlements; better inventories of land available for resettlement or temporary relocation.

## 4.3 Integration of land into climate change adaptive planning

Land policy is one key element of adaptation planning, therefore in addition to improving and climate proofing" land policies themselves, land policy measures, including land inventories, tenure regularization, resettlement, and improved land use regulation in at risk areas need to be more fully integrated with NAPAs (National Adaptation Programmes of Action) at national and sub-national levels. In turn adaptive measures need to be more effectively mainstreamed into national development policies and poverty reduction strategy frameworks and into government and international agency planning as a whole, which needs to deliver funding to priority adaptive actions, at a scale and pace commensurate with the evolution of the human need. Note that priority land policy actions for adaptation to climate change

are unlikely to be different in essence from land policy's own priorities. However, climate change risks create new demands in terms of the scale and pace of action (e.g. to deliver tenure, security, land for resettlement, squatter upgrading, comprehensive land inventories) prioritization of particular geographical areas and social groups.

In this context of national and regional adaptive planning:

*Integrated land and water resource management:* while action is needed to conserve water resources and improve soil moisture availability at farm level, water resource availability needs to be assessed and programmes for water management introduced at a variety of territorial scales, including river basins, rural watersheds major cities and informal settlements and irrigation schemes. Resettlement and new land allocation should be accompanied by establishment of water supplies and allocation of water rights, and land and natural resource management, for instance of pastoral groups, must include access to and management of water resources. Producers and residents groups can also form a basis of water user associations. There is significant potential in organization of region wide collective action and advocacy to secure funding and technical for simple water harvesting and storage technologies, including cisterns collection of run-off and community construction of small scale dams, as demonstrated by recent programmes in Northeast Brazil. Where water pricing is involved this should to discriminate against vulnerable groups unable to afford the charges. Water rights and water resource management will be particularly important for irrigation schemes subject to diminishing water supplies, which may require substantial reorganization and re-engineering to remain productive under changing conditions.

*Special programmes for land and natural resource tenure in semi arid areas subject to climate change:* including pastoralist custodianship of rangeland areas, territorial plans for water resource management, formalization of reciprocal arrangements between pastoralist groups, agro pastoralist and settled farmers (including leasehold arrangements to accommodate possible emergence of new agricultural areas e.g. in parts of the Sahel which may experience temporarily increased rainfall and "greening") by building on and extending existing local conventions. The action required goes beyond land and natural resource tenure which needs to be supported by appropriate legislative frameworks (such as the *Codes Rural* and *Chartes Pastoral* in West Africa) and incorporate institutional frameworks for participatory governance of natural resources, conflict management, and capacity building and technical support to user groups. Moreover cross border frameworks for land and natural resource access will be needed to address the mobility and migration of affected groups on a regional scale.

*Land and carbon mitigation:* Although carbon emissions mitigation is not strictly part of adaptive planning, the poor need to adapt not only to climate change but also to the spread of Carbon emissions mitigation measures, including the development of avoided deforestation, carbon offset forestry schemes, and the spread of biofuels, all of which risk undermining existing land rights and reducing land access for poor and vulnerable groups. The lands issues involved in these developments need to be pursued within the coherent policy frameworks which also include planning for climate change adaptation and ongoing poverty reduction. Carbon forestry requires legislative frameworks which take account of land tenure and land access issues, and there is a need for "robust cross scale institutional frameworks" (Brown and Corbera

2003) to ensure that market based mechanisms for climate mitigation meet equity and development objectives, within which land and property rights are a central concern. Agricultural land use change and forest preservation by local communities themselves, for instance the adoption of intensive agroforestry schemes should be included as eligible activities for carbon finance, and procedures for local communities and small farmers to gain access to payments for forest conservation, afforestation and reforestation need to be simplified (Peskett et al 2006).

#### **4.4 Priorities for further research**

The above recommendations are based on what we already know about climate change and its likely impacts. Accordingly, they are rather broad. However specific land policy measures and integration of land policy action with wider adaptive planning will need to take place at national and sub-national levels, according to specific sets of climate change impacts and bearing in mind existing legal and institutional frameworks. Consequently there is a need for continuing research to inform improved adaptive planning. Here we outline the major areas for further research on these topics.

*Regional impact modeling:* insufficient work has been done to run and refine existing climate change impact models to understand the likely land use impacts at regional and sub-regional scales in the developing world. The priority should be modeling of short and medium run impacts, based on existing emissions and projections of future emissions in subsequent decades, which as knowledge and techniques improve should allow for growing confidence about the probable scale of impacts. This in turn is an essential basis for understanding the land use and possible land tenure impacts and policy implications for specific countries and social groups, and the scale and pace at which land policy related measures need to be integrated into wider adaptation planning.

*Country and area studies:* in depth using 2050 impact scenarios; existing land policies, tenure systems, institutional and governance frameworks, available land for new settlement and productive activities, demographic features and the links with national adaptation plans, strategies and capacity issues, focused on priority areas:

- i. Profiles and analysis of areas facing significant risk to human occupation and settlement including the institutional arrangements for adaptation and mapping of informal land rights and settlements, climate related hazard risks and available land for resettlement:
  - due to the direct impacts of sea level rise and changes in flood regimes in low lying coastal areas and river deltas, including urban areas, and in small island states);
  - as a result of changes breakdown of existing production and livelihood systems due to temperature rise, and changes in precipitation and water availability with implications for tenure / management / governance systems & possible migration (e.g. the Sahel, Southern Africa, Northeast Brazil, Southern Andes).

- ii. Areas which are important targets for emissions reduction, avoided deforestation, carbon sinks and mitigation (Amazon and Congo basins biofuels expansion in Brazil; oil palm and tropical forest in Indonesia / Malaysia)

### *Climate proofing land policies*

Assessments could be conducted of existing land policies and policy development processes on a country or regional basis (linked to regional and sub-regional development organizations and focusing on countries most at risk) to determine how effectively they can cater for climate change related risks and how they may need to change. The coherence of land policy with related areas including agricultural, forest and environmental management policies is a key concern.

### *Thematic research to inform specific aspects of adaptation planning*

As a result of the analysis of possible land related climate change impacts, we have also identified a number of areas for thematic research in different regions from which important cross-country lessons for adaptation planning might be learnt:

- *How land policy can facilitate mobility and resettlement in climate change affected regions* (including cross border land and territorial policies; negotiated frameworks for inter-group conflict reduction territorial governance).
- *Water management in affected regions* including changing patterns of demand and supply, existing institutional arrangements, water rights and water pricing, the potential role of collective action and civil society organisations, and impact = adaptation scenarios for water supply and drainage in informal urban settlements and for irrigation schemes likely to be affected by accelerated glacial melt and changing flood regimes.
- *Land access and climate change mitigation:* research the position of small farmers and forest communities in relation to forest management, carbon storage, energy production and biofuels development and alternative land uses, with a view to improving the opportunities and mechanisms by which the poor in developing countries from low carbon economic development.

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## **ANNEX: Developed country adaptation to sea level rise**

### **Some examples of developed country adaptation to risks of sea level rise**

#### **United States, *Easterling et al. (2004)***

*Land acquisition programmes taking account of climate change (e.g., New Jersey Coastal Blue Acres land acquisition programme to acquire coastal lands damaged/prone to damages by storms or buffering other lands; the acquired lands are being used for recreation and conservation); establishment of a 'rolling easement' in Texas, an entitlement to public ownership of property that 'rolls' inland with the coastline as sea-level rises; other coastal policies that encourage coastal landowners to act in ways that anticipate sea-level rise.*

#### **The Netherlands, *Government of the Netherlands (1997 and 2005)***

Sea-level rise Adoption of Flooding Defence Act and Coastal Defence Policy as precautionary approaches allowing for the incorporation of emerging trends in climate; building of a storm surge barrier taking a 50 cm sea-level rise into account; use of sand supplements added to coastal areas; improved management of water levels through dredging, *widening of river banks, allowing rivers to expand into side channels and wetland areas;...* preparation of risk assessments of flooding and coastal damage influencing *spatial planning and engineering projects in the coastal zone, identifying areas for potential (land inward) reinforcement of dunes.*

**United Kingdom, *Defra (2006)*** Floods; sea-level Rise Coastal realignment under the Essex Wildlife Trust, *converting over 84 ha of arable farmland into salt marsh and grassland to provide sustainable sea defences;*

The literature on costs and benefits of adaptation to sea-level rise in developed countries is relatively extensive. Fankhauser (1995a) used comparative static optimisation to examine the trade-offs between investment in coastal protection and the value of land loss from sea-level rise. The resulting optimal levels of coastal protection were shown to significantly reduce the total costs of sea-level rise across OECD countries. The results also highlighted that the optimal level of coastal protection would vary considerably both within and across regions, based on the value of land at risk.

*(Source: IPCC Working Group 2 Ch6, 2007)*