More than rain:

Identifying Sustainable Pathways For Climate Adaptation And Poverty Reduction

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The Development Fund is a Norwegian independent non-government organisation (NGO). We support environment and development projects through local partners in Asia, Africa and Latin America. We believe that the fight against poverty must be based on sustainable management of natural resources in local communities.

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PREFACE

In one sense, the Development Fund has reduced climate change vulnerability throughout our 30 year history. It has always been crucial for us to support rural development in a way that enhances people's capacity to use natural resources in a sustainable way, and in a way that reduces risk and dependency. We have always focused on marginalized farmers and on strengthening their capacity to adapt to change, even if we have only gradually begun to realize the immensity of the current climate crisis.

We now realize that the current situation brings new and increased risks and that development thinking and planning needs to change. While the Development Fund still believes that our basic approach is sound, we also believe that both we and our partners need to become more systematic in our approach to tackling climate change. Therefore, we initiated the More than Rain project, in collaboration with some of our local partners and with the Global Environmental Change and Human Security project (GECHS) at the University of Oslo.

We have learned that there are many national and local barriers that negatively affect people's ability to increase their adaptive capacity. At the same time we believe there is a tremendous amount of untapped potential and opportunities for people to improve their livelihood situation and increase their resilience to external and internal stresses. However, in order to use this potential, we need to identify and strengthen people's perceptions, knowledge, values and culture and somehow merge it with support for new and innovative ideas for livelihood improvements.

More than Rain seeks to understand the adaptive capacity of the people themselves and how this can be enhanced. People have resources within themselves, such as knowledge and culture, as well as resources in their nearby localities, such as access to water, livestock fodder and education. Poor and marginalized people, such as women-headed households in Tigray, or landless Dalits in Nepal, have fewer resources than others and will most likely be vulnerable to climate change which adds to their daily struggle to feed themselves and their families.

Through this project, we want to achieve two objectives. First, we wanted to *document* the work of the Development Fund and local partners in order to critically learn and improve the results for farmers and pastoralists. Secondly, we wanted to use this learning to improve and develop our own and our partners' *methodology* in project planning and implementation, and thus decrease climate vulnerability of farmers and pastoralists.

The *documentation* part attempts to address a need for greater understanding of how to approach climate change adaptation in development projects and programs. We also need to understand what climate change and vulnerability means for local populations and their livelihoods. This project therefore includes three case studies illustrating political and technical interventions and local adaptation techniques to meet changing climatic conditions.

As part of our own learning process, we wanted to critically analyze what we are already doing. We want to systematically document the experiences of some of our partners, and to analyze these according to a common analytical framework. This should obviously be useful for the partners involved, but we also hope this can be of use to some of the many partners that were *not* directly involved in this project. We therefore hope that documenting these experiences will be a catalyst for new thinking among many of our partners, as well as others worried about how to overcome climate change.

However, we feel there is a need to move beyond just documenting experiences, and also start addressing the issue of *methodology or first and foremost – guiding principles* in adaptation project planning. Important questions are thus first, what types of factors need to be addressed at local, regional, and global levels in order to make climate adaptation and alternative development pathways possible; second, what kinds of activities and measures for climate adaptation should be included in development projects; and third, what methods can be applied in order to facilitate a holistic yet local in-depth understanding of the relevant factors, and the guidance on how to address them.

The Development Fund is particularly pleased to be able to bring together different types of actors in the More than Rain project. While collaboration with local partners is at the core of what the Development Fund does, we have never before carried out a systematic documentation project involving partners on three different continents in this way. LI-BIRD in Nepal, CIPRES in Nicaragua and REST in Ethiopia are all strong and competent organizations which also have good links with grassroots communities. They are therefore at the front line in the battle against changing climatic conditions.

In the More than Rain project, we are not only bringing these organizations together to share information amongst themselves, but also having their work analyzed critically by some of the world's leading climate change vulnerability experts at GECHS. Thus, we hope to bring together analytical expertise with on-the-ground experience, and hopefully be able to provide lessons and insights applicable also in other contexts.

In addition to the immediate audience, such as staff and other stakeholders associated with the Development Fund and our partners, we hope this work can be of use for other development

actors as well. If donors live up to at least some of their generous-sounding pledges, quite a lot of funding will be made available in the coming years for all sorts of activities with the words "climate change" in their headings. Our hope is therefore that development planners will take advantage of the insights provided in this report, and to use them to improve their own work.

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EXECUTIVE SUMMARY

Aim:

This report aims to contribute to the increased understanding of how to integrate climate change adaptation in poverty reduction projects and programs in ways that increase the capacity of individuals, households and communities to respond to climate variability and change. The analysis investigates what types of factors need to be addressed at local, regional, and global levels in order to make sustainable adaptation to climate change possible, and what kinds of activities and measures for climate adaptation should be included in development projects. In other words, the report explores what adaptation to climate change can look like in practice.

Approach:

Societal development paths not only influence the levels of emissions and thereby the levels of human-induced climate change, but also the ways that individuals, communities and sectors are affected by climate variability and change. Economic, social and environmental conditions influence vulnerability and capacity to adapt. Research on the vulnerability, adaptation and implications for human security has shown that climate change adaptation has to be considered as a dynamic social process, as it involves adjustments in practices and policies within a context where people are confronted with a number of stressors to their daily lives, climate being one of them. Climate adaptation measures must therefore be context-specific yet comprehensive, addressing a broad range of factors and scales. Faced with this complexity there is a call for a holistic approach to adaptation that entails a suite of measures that i) reduce the physical risk posed by climate change, ii) address and reduce the underlying factors of vulnerability and iii) strengthen adaptive capacity. A central objective in the notion of sustainable adaptation to climate change is to address poverty in ways that reduce climate risk and vulnerability and increase the capacity to respond and adapt to climate variability and change, as well as other shocks and stressors.

Case-studies:

The report discusses and applies this comprehensive approach to climate adaptation in three case studies; demonstrates its usefulness and suggests a way of handling its complexity. The three cases are projects for poverty reduction and sustainable natural resource management supported by the Development Fund in Ethiopia, Nepal and Nicaragua. The case studies represent illustrative examples of what risk reduction, vulnerability reduction, and enhancement of adaptive capacity to climate change can look like in different contexts, as well as how poverty reduction measures can influence these facets and thus enhance resilience. The data collection is to a large extent based on qualitative methods, focusing on the experiences of the local population and project staff. In this way it has been possible to get insights in the strategies that poor people use to try to secure their basic needs, how these strategies and their outcomes are influenced by climate variability and change in combination with other factors, and how the project activities influence such relationships between climate change and poverty.

Findings and recommendations:

Based on the case studies and the climate adaptation literature, the report introduces some guiding principles for how to take climate adaptation into account in poverty reduction efforts for reducing climate risk and vulnerability and increasing the capacity to adapt. The guidelines aim to promote poverty reduction projects and programs that are robust to climatic variability and change, and that make climate adaptation work to the benefit of the poor:

- Incorporate adaptation into broader development efforts, instead of planning separate climate change adaptation projects. Address central development challenges facing people and communities, while considering ways that climate conditions influence challenges. Be aware that some development projects can increase vulnerability and reduce flexibility of people and communities.
- Base adaptation activities on sufficient understanding of local livelihood strategies and contexts, poor people's problems, efforts, values and aims and how these relate to local climate variability and change. Involve and empower local actors in planning and implementation.
- Base adaptation activities on sufficient understanding of a diversity of potential solutions. See the importance of different types of knowledge systems as a basis for promoting diversity and flexibility in livelihood strategies, for example: Be aware of the risks of conventional agricultural strategies and learn from initiatives on participatory plant breeding, organic agricultural techniques, water harvesting, planting of trees on farms, diversification in livestock, area enclosure and other initiatives described in this report. Support local knowledge and encourage local innovations. Be aware of the risks and shortcomings of conventional energy projects. Implement efficient, locally adapted energy supply for households in ways that improve income opportunities, education, and information, health facilities, water supply and communications and also reduce workload and health problems from traditional energy use among women and girls.
- Identify and address barriers to social and technological change for sustainable adaptation. Identify and address the links between local living conditions and factors at different geographical levels influencing the opportunities to upgrade people's livelihood strategies. Rehabilitate degraded vegetation cover and soils through sustainable use of the natural resources instead of conservation measures which exclude the population from them. Develop local and national markets for climate adapted products, and address problems of market access and import competition.
- Identify and spread good examples of social and technological change, especially through South-South learning, and

involve poor people in the processes. Attempt to use school curricula and agricultural extension services to provide crucial knowledge for local food security, livelihood options, including marketing, small business training and technical training, for example inspired by the Barefoot College in India. Build on experiences with sustainable development efforts to increase the options for choice between different solutions.

- Identify adaptation strategies and policies that are also resilient to future climate change, increased variability, and more intense and frequent extreme events. Very significant changes in the climate are expected in the future; even if drastic actions for mitigation are initiated, development practitioners and policy planners must think beyond already-observed climate variability and change when planning for adaptation.

Method for planning and evaluation of climate adaptation:

This approach to climate change adaptation in poverty reduction and natural resource management can be used both as an analytical framework for research on how climate change affects people, and as a tool for examining development projects and programs for planning and monitoring adaptation efforts in poverty reduction work. This report covers both of these applications, and shows how research results can be translated into practical and applicable methods and knowledge. As demonstrated throughout this report, the approach can be useful for understanding what climate change means for individuals, communities and societies, and how appropriate responses can be designed and embedded in poverty reduction efforts. The analysis demonstrates the potential for fruitful interaction between research and practice for mutual learning and collaboration both on development of methods and on exploring emerging sustainable development paths for climate adaptation.

Conclusions and comments:

The experiences from the projects supported by the Development Fund are relevant and useful for how to address adaptation to current climate variability and observed changes, and they are also relevant for the discussions on how climate adaptation can be addressed under future climate change. For developing countries, the pressing need for climate adaptation means an additional challenge to the overwhelming poverty problem. However, this report suggests that poverty can be reduced in more efficient ways if the climate aspect is taken into account and points to alternative pathways of development from those that currently dominate. Furthermore, community based changes such as those encouraged by the Development Fund in the analyzed cases are useful for several other reasons than climate change. Due to longstanding social and environmental problems, it is crucial to bring new aspects into food security, poverty reduction and development efforts. The climate problem is just another reason—although a powerful one—why alternative solutions could fruitfully be brought into the center of the debates and efforts. The approaches supported by the Development Fund are not mainstream solutions, but have been part of the efforts towards sustainable development of the last few decades. The climate issue makes such efforts even more important than before, as key drivers of poverty and vulnerability is brought center stage. At the same time climate change impose both adversity and opportunities beyond current knowledge and experience. Through sustainable adaptation to climate change we can use this opportunity to generate societal shifts towards a more resilient, flexible and sustainable society. This is an opportunity we can not miss.

1 INTRODUCTION

Climate change has brought increased attention to the role of environmental factors in social and economic development and poverty reduction strategies. Many development practitioners recognize that the promotion of development paths that make households and communities more resilient to climatic stresses can also help to reduce poverty in more robust and sustainable ways. There is at the same time a growing realization that a failure to take into account changing climatic conditions can undermine poverty reduction efforts and their intended social, economic and environmental benefits. There is currently a need for greater understanding of how to design poverty reduction projects and programs in ways that increase the capacity of individuals, households and communities to respond to climate variability and change. Important questions remain regarding what types of factors need to be addressed at local, regional, and global levels in order to make climate adaptation possible, and what kinds of activities and measures for climate adaptation should be included in development projects.

The growing demand for knowledge and guidance on climate change adaptation that can be applied at a practical level poses challenges to climate change and development researchers, practitioners, and policy makers. The relationship between poverty reduction and climate change adaptation is not straightforward, and theoretical results can be diffuse and difficult to translate into concrete changes in development activities in local communities. Much of the research on the linkages between poverty and vulnerability to climate variability and change concludes that climate adaptation measures must be context-specific yet comprehensive, addressing a broad range of factors and scales. Nonetheless, it is widely recognized that climate change is not the only process that is affecting households and communities in developing countries, and that many other ongoing environmental and societal changes influence the capacity of households and communities to respond to stresses and shocks. These complex interactions make it difficult to isolate measures that can be considered "adaptations to climate change."

While there are many measures that may reduce climate change impacts, it is clear that not every adaptation to climate change will contribute to poverty reduction. Some adaptation measures may provide benefits to a particular sector or group, yet may have negative consequences for others, or create new types of social, economic, and environmental problems. This suggests that it is important to assess the consequences of climate change adaptation measures for poverty reduction. Similarly, not every poverty reduction and development measure will reduce the adverse impacts of climate change. In other words, what is called for is *sustainable* adaptation measures that contribute to both poverty reduction and more climate-resilient societies.

1.1 Objectives and structure

The aim of this report is to provide insights and guidance on how to address climate change adaptation in development interventions. The report has three objectives. The first objective is to present a method for examining poverty reduction projects and programs in order to identify, plan, monitor, and evaluate climate adaptation activities. The second objective is to identify what sustainable adaptation measures can look like in on-the-ground development projects. Specific examples drawn from three projects supported by the Development Fund illustrate the potential for promoting development paths that both reduce poverty *and* increase people's capacity to respond to climate change. The third objective is to present some guiding principles for the design and implementation of climate change adaptation in poverty reduction strategies and activities.

The report is organized into seven chapters, including this introduction. In Chapter 2, the framework for the analysis is presented, as well as the methods for data collection. The framework emphasizes that adaptation can be realized not only by reducing the risk of direct climate change impacts, but also by reducing vulnerability and increasing adaptive capacity. In Chapters 3 to 5, three Development Fund-supported projects are presented and analyzed, with an emphasis on the ways that each currently addresses climate risks, vulnerability factors and adaptive capacities. Chapter 6 introduces some guiding principles for how to take climate adaptation into account in poverty reduction efforts. The aim of these guidelines is to promote poverty reduction projects and programs that are robust to climatic variability and change, and that make climate adaptation work to the benefit of the poor. Chapter 7 concludes with the usefulness of this approach as a general tool for planning and evaluating climate adaptation in poverty reduction projects and programs. It also highlights some important messages about what types of development paths can make households and communities more resilient to climatic stresses and help to reduce poverty in more robust and sustainable ways.

2 CLIMATE ADAPTATION AND POVERTY REDUCTION

International efforts are needed to reduce greenhouse gas emissions to a level that avoids the possibility of dangerous climate change. Yet even if emissions were held constant at today's level, some temperature increases and related impacts will occur due to past emissions and lags in the climate system. It is well-recognized that climatic variability, including the frequency and magnitude of extreme events, may increase in association with climate change. Climate change thus refers here to both *climate variability and change.* Adaptation is a necessary and urgent response to climatic changes that cannot be avoided, and many of these changes already represent dangerous climate change to some individuals, communities and regions. Due to increasing climate variability and uncertainty, adaptation measures cannot always be linked to specific weather and climate conditions. Under such circumstances, adaptation measures should focus on increasing the flexibility and resilience of households and communities in the face of variable and uncertain climate conditions, as experienced in the cases presented in this report.

Adaptation will not necessarily occur automatically in response to observed and projected changes. Experience has shown that identified adaptation measures do not necessarily translate into changes because there are context-specific social, financial, cultural, psychological and physiological barriers to adaptation (IPCC 2007). Barriers may include societal values and priorities, governmental regulations (or lack thereof), lack of availability or access to technologies, or economic or political interests that may hinder new technological systems or knowledge systems. There is a need to acknowledge the political nature of adaptation, and recognize that solutions at one scale may lead to very different outcomes at other scales (O'Brien and Leichenko, 2008). Addressing adaptation thus may involve trade-offs that ultimately raise questions about what decision-criteria are used (e.g., cost-benefit assessments versus equity considerations). Adaptation to climate change is influenced by many other factors and processes. Developing countries, in particular, are faced with a pressing need to adapt to climate change at the same time as they face enormous poverty problems. However, experiences suggest that poverty can be reduced in more efficient ways if climate change is taken into account, and that adaptations can promote alternative pathways of development that are more sustainable (Ulsrud and Eriksen 2007).

2.1 Adaptation to climate variability and change

Climate change adaptation is defined by Agder et al. (2007) as adjustments to reduce vulnerability and enhance resilience in response to observed or expected changes in climate and associated extreme weather events. Adaptation can be considered a dynamic social process that involves adjustments in practices and policies within a context where not only the climate is changing, but where societal transformations are also taking place. Structural and systemic factors, such as local, national and international economic policies and power relations, influence the capacity of individuals and local communities to respond to the challenges and opportunities associated with climate change. Individual and cultural characteristics such as beliefs, values and worldviews also influence adaptation processes. Faced with this complexity, there has been a call for a more comprehensive and holistic approach to adaptation, rather than an approach that focuses exclusively on climate risk. At the same time, it is important to make this holistic approach simple enough to be useful in practical adaptation efforts.

Adaptation to climate change includes local-level responses to both climate variability and long-term change. At the local level, it is difficult to separate human-induced climate changes from natural climatic variability. Yet the point in climate adaptation is not to identify whether a specific drought or flood is the result of climate change, but rather to help households, communities and societies minimize the consequences of current and future variability and changes in climate conditions. Climate-related disasters have important implications for development in all countries. Although this report does not explicitly focus on disaster risk reduction, there are nonetheless very important linkages between risk reduction and climate adaptation, and the potential for synergies to reduce risk is likely to be very high. Both the climate adaptation and the disaster risk reduction research communities point to a need to address the underlying causes of vulnerability, and there are thus common objectives and many entry points for increased collaboration between the two communities. However, despite common interests and a clear demand for interaction, the bridging of the climate change adaptation and disaster risk reduction communities is still at a preliminary stage. This report discusses a range of measures that can be useful in order to reduce vulnerability and increase adaptive capacity in the face of extreme climate conditions. This is important because many communities are not well adapted to current climate conditions, and the poor are often the ones who are the most affected by this.

2.2 Climate adaptation and development

Climate change and development are linked processes. Societal development paths influence the levels of net greenhouse gas emissions and thus the rate and magnitude of human-induced climate change, and climate change impacts influence societal development paths. Yet economic, social and environmental conditions also influence vulnerability and the capacity to adapt to climate change, and prioritized development paths can have significant consequences for the ways that individuals, communities and sectors are affected by climatic changes. In short, the consequences of a drought or a flood depend not only on the magnitude of the event, but on the wider societal context in which individuals or groups experience these events. The connections between climate change and development are rarely taken fully into account in climate change policies, and they are often ignored in development policy. Despite the important human and social dimensions of climate change, the issue is typically considered by scientists, policy makers and practitioners as an environmental problem that can be solved or addressed separately from development.

Since poor people are often vulnerable to climate variability and change, there is a tendency to view poverty and vulnerability as identical, with the assumption that any kind of poverty reduction efforts will automatically reduce vulnerability to climate change. Many poor people are indeed vulnerable, and they are often the ones to suffer injury, loss, death, or harm from extreme climatic events. However, poverty reduction measures do not automatically decrease vulnerability to climate variability and change. In fact, poverty reduction measures can either reduce or increase climate risk and vulnerability, just as they can either increase or reduce the capacity to adapt to climatic change and other stresses (Huq *et al.* 2006). Some strategies for economic growth, such as agricultural specialization in water-intensive crops, can increase vulnerability to climate variability and change, particularly if they increase the risk of crop and livelihood failure during periods of droughts. Furthermore, it is often assumed that any type of adaptation to climate change in development activities will benefit all of the poor, and in the same way. Yet some groups may be more vulnerable than others (e.g., women, elderly), and the underlying causes of vulnerability can differ significantly across different groups. Importantly, adaptation measures may (unintentionally) increase the vulnerability of some individuals and groups. For example, increasing irrigation infrastructure can benefit some farmers, but it can also increase the vulnerability of poor farmers who do not have the resources to dig deeper wells to access a decreasing water table (Eriksen et al. 2007).

It is important to consider the diverse scales at which adaptation takes place. In the scientific discourse on climate change, much of the focus has been on improved global climate modeling and the development of future climate projections, as well as on understandings of associated biophysical and sectoral impacts. The aim of such research has been to highlight specific climate-related impacts and risks. At the national level, indicators and indices have been used to assess the factors contributing to vulnerability and adaptive capacity among different sectors and social groups. As pointed out by Vincent (2007), many of these studies aim to assist international decision makers when deciding on investments in adaptation under the UNFCCC funding mechanisms, where there has been a major focus on technical and physical adaptation measures that reduce specific climate risks, for example through construction of flood defenses, wells, irrigation schemes, provision of drought resistant seeds, and so on. In contrast, the social dimensions of climate change have been underemphasized, and little attention has been given to addressing the underlying causes of high vulnerability and low adaptive capacity.

2.3 Context-specific adaptations to climate change

There has been surprisingly little attention in global climate debates to local-level adaptations and to the linkages between poverty and vulnerability. At the local level, a number of case studies have been carried out to examine the specific contexts for impacts, vulnerability and adaptation, and in particular how these influence the capacity to adapt. Bridging the gap between analyses at the global, national and local levels will be critical to addressing adaptation, as the scales interact and influence each other. In this analysis we focus on the local level, but recognize that comparative studies and cross-scale analyses are needed to identify the full spectrum of adaptation options. From the local perspective, it becomes clear that climate adaptation has to extend beyond climate risks and associated bio-physical impacts to also consider the social context that affects vulnerability and adaptive capacity, including multiple stressors, behaviors, responses, barriers and thresholds.

A comprehensive approach for understanding how climate change adaptation can contribute to poverty reduction strategies was presented by Eriksen et al. (2007) in a report on "Climate change adaptation and poverty reduction: Key interactions and critical measures." The approach targets three key facets of adaptation that need to be taken into account in order to achieve both poverty reduction and climate change adaptation through ongoing development activities: Climate risk, vulnerability and adaptive capacity. These facets must be addressed within specific local contexts, and every context is likely to demand its own set of measures to promote adaptation. Actors involved in poverty reduction and climate adaptation therefore need a tool for identifying measures that address the three facets of adaptation within any given development context (Eriksen et al. 2007). The comprehensiveness of this context-specific approach to climate change adaptation can been seen as a challenge, but as will be shown in this report, it can be usefully applied in practical development work as a way of structuring thinking about what types of factors should be taken into account in adaptation, and which factors are relevant to different groups.

Poor people often lack opportunities to meet economic, social and other standards of well-being (OECD 2001). Climate variability and change affect opportunities to secure well-being. Poverty reduction projects and programs must ideally address all three types of factors in order to be economically, socially and environmentally sustainable by including measures that reduce climate risk, decrease vulnerability, and enhance adaptive capacity. If not, they may unintentionally increase the vulnerability of poor people to climate factors, or fail to increase the capacity to adapt, which have implications for the results of the poverty reduction projects and programs. Efforts to address both poverty reduction and climate change adaptation in an integrated way have been conceptualized by Eriksen et al. (2007) and Eriksen and O'Brien (2007) as *sustainable adaptation* to climate change.

2.4 Addressing climate risks, vulnerability and adpative capacity

Below, we explain the comprehensive approach and demonstrate how it can be used to examine and analyze poverty reduction activities and identify the ways in which climate change adaptation should be taken into account in projects and programs. The approach can be used both as an analytical framework for research on how climate change affects people, and as a tool for examining development projects and programs for planning and monitoring adaptation efforts in poverty reduction work. This report covers both of these applications, showing how research results can be translated into practical and applicable methods and knowledge. As demonstrated throughout this report, the comprehensive approach can be useful for understanding what climate change means for individuals, communities and societies, including income generation strategies and quality of life, and how appropriate responses can be designed and implemented. By focusing on the three facets of adaptation in a given development context, it is possible to understand the ways that climate variability and change influence the opportunities of poor people to meet their human needs. In order to achieve sustainable adaptation in poverty reduction projects and programs, the first step in such efforts should be to identify the factors that influence climate risks, vulnerability, and adaptive capacity in a particular local context.

Climate risk reduction

Confronted with climate change, households and communities are likely to face *climate risks* that relate to the direct physical impacts of climate variability and change, such as increased surface temperatures, changes in rainfall, sea level rise, soil erosion, fluctuating rivers flows, changes in frequency and intensity of storms and extreme weather patterns, including floods and drought, as well as the risk of glacier lake outbursts from increased melting of ice-capped mountains (Eriksen et al. 2007). Such hazards threaten lives, health, property, infrastructure, and quality of life. They can, for example, destroy infrastructure and settlements, increase problems in water supply, damage crops in subsistence or commercial farming, increase malnutrition, and increase geographical diffusion of vector borne diseases.

Reducing climate risk, and particularly the biophysical risks, has been the most common way to think about adaptation to climate change thus far. Poverty reduction projects need to be aware of the ways that different activities influence the risk of impacts from climatic variability, which affect poor people's livelihood strategies and quality of life. Climate risk reduction strategies may include land-use planning that avoids high risk areas, improved building and infrastructure standards, seasonal forecasts, drilling of irrigation wells, construction of flood defenses, and so on, all of which aim to reduce the specific impacts of climate change.

Vulnerability reduction

Whether climatic stresses result in adverse or positive impacts on societies is influenced by levels of vulnerability and adaptive capacity. Vulnerability is closely related to contextual conditions shaped by multiple social, economic and environmental processes and stressors (Eriksen et al. 2007). These may include lack of basic infrastructure and public services, loss of employment opportunities, violence and insecurity, low world market prices for export products, import competition for agricultural products or other economic globalization trends. HIV/AIDS is also an important factor influencing vulnerability to climate variability and change. There are differences in vulnerability among poor people, due to differences in their livelihood strategies, and their social and political relations. In order to achieve poverty reduction and climate change adaptation, development projects need to reduce poor people's vulnerability to climate change by addressing the factors and conditions that make poor people vulnerable. As stressed by Eriksen et al. (2008) this means that adaptation involves promoting social transformations that contribute to reduced vulnerability, such as land reforms, market opportunities, service infrastructure, flexible livelihoods, increased diversification, and improved democratization.

Increasing the flexibility and capacity to adapt

Closely related to vulnerability is the concept of *adaptive capacity*. All societies have an inherent ability to adjust and adapt to climate stress. However, the capacity to adapt is unevenly distributed both within and across societies and countries. The adaptive capacity of individuals and households is influenced by available

Box 1

Examples of climate risks (climate stress and associated consequences)

- Changes in rainfall
- Decreased rainfall in most sub-tropical land regions
- Warmer and fewer cold days and nights
- More frequent warm spells/heat waves
- More frequent heavy precipitation events
- More areas affected by droughts and floods
- Increased tropical cyclone activity
- Increased incidents of extreme high sea level
- Instability of winds
- More intense tropical cyclones
- Localized negative impacts on livelihoods, food and water security, health, biodiversity etc.
- Increased number of people suffering from deaths, diseases and injuries
- Increased number of people suffering from malnutrition and diarrheal diseases
- Increased aridity and scarcity of water resources
- Increased land degradation, soil erosion and landslides
- More frequent damages of settlements and infrastructure (particularly in coastal areas)
- Reduced food production and food security
- New areas exposed to malaria, and changes in transmission season

(source IPCC 2007a)

Box 2

Examples of factors contributing to vulnerability

- Lack of alternative income-generating activities
- Lack of public services and social safety nets, pensions, and other types of support from the government to poor groups
- Poor health facilities, lack of safe water and sanitation, contamination of water, endemic illnesses, diarrheal diseases, dengue and malaria, HIV/AIDS
- Lack of access to relevant and already existing information and technology for improving local livelihoods under different contexts, including climate
- Local power relations and marginalization of some groups in access to loans, social networks and common resources, like fishing grounds
- Household and production assets have been lost in earlier extreme events
- Low quality school content; school curricula that are to a large extent irrelevant for local opportunities for income generation and improved quality of life in the local climate conditions, including sustainable management of natural resources
- Gender inequality, constraints on women's access to land and loans, high work load on women and girls, "harmful traditional practices" (HTP), including female genital mutilation and gender inequity
- Deforestation and other environmental degradation, leading to more serious impacts of climate stress
- Low work force in some rural areas due to migration, many households run by single women, temporarily or permanently, and high dependence on remote labor markets
- Ongoing and recent violent conflicts, raiding of cattle, conflicts regarding access to water wells

(source IPCC 2007b)

economic and natural resources, social networks, entitlements, institutions and governance, human capital, and access to relevant technology (IPCC 2007/Agder et al. 2007). Thus, adaptive capacity is related to the resources people have in themselves, as well as resources that they have access to. The capacity of people to adapt is influenced by factors such as their strengths, knowledge, experiences, skills, aspirations, resources/livelihood assets, the natural environment (e.g., ecosystem services), technology, money, health and livelihood opportunities. These are examples of factors that can enable people to create livelihoods, get jobs, live a decent life, maintain their health, have social and cultural affinity, political influence and psychological wellbeing in the face of stresses and shocks associated with climate variability and change.

In order to achieve sustainable climate adaptation, including robust poverty reduction, development projects have to use their potential to increase the capacity of poor people to adapt to observed and projected climate change, by addressing the factors influencing adaptive capacity, including poor people's access to resources, power, information, education, technology, social networks, and insurance. Poor people are active agents, using a range of strategies in order to provide food and income and live a decent life (Hesselberg 1996, 2005). As shown by Eriksen et al. (2008) it is important to support and widen local adaptation strategies and remove obstacles that limit them. This point is also illustrated in the case studies presented in the next chapter.

Box 3:

Examples of factors influencing adaptive capacity among poor people:

- Rehabilitation of local vegetation cover and forests for sustainable use and better access
- Enhancement of on- and off-farm conservation and access to indigenous plants
- Education adjusted to labour needs and local diversification of livelihoods
- Strengthened school feeding during periods of climate stress, like droughts
- Reduced costs of health services and reduced school fees
- Strengthening of local democratic participation in, for example, management of water
- Transparent systems to gain access to land
- Increased collaboration between formal institutions and informal networks
- Link formal and informal knowledge systems to improve relevance of local knowledge

(Eriksen et al. 2007, pp. 26)

2.5 Linkages between poverty reduction strategies and climate adaptation in Development Fund projects

The case studies analyzed in the next three chapters represent illustrative examples of what risk reduction, vulnerability reduction, and enhancement of adaptive capacity to climate change can look like in different contexts, as well as how poverty reduction measures can influence these factors. Three projects supported by the Development Fund are examined through the lens of the framework presented above, in order to show how some of the activities may contribute to sustainable adaptation to climate change. The analysis elaborates on the linkages between poverty reduction and climate adaptation in development projects, and thereby suggests a method for holistic integration of climate adaptation with poverty reduction work. The potential for using the method in planning and evaluation of projects and programs is further discussed in Chapter 7.

A central objective in the notion of sustainable adaptation to climate change is to address poverty in ways that reduce climate risk and vulnerability and increase the capacity to respond and adapt to climate variability and change, as well as other shocks and stressors. As will be discussed in the following chapters, it is likely that numerous development activities carried out by the partners of the Development Fund include examples of sustainable adaptation to current climate variability and already-observed climatic change. Several of the activities have the potential to not only reduce poverty and improve the quality of life of the people, but also to reduce climate risks and vulnerability and to increase the capacity of people and communities to respond to variable and changing climate conditions and other threats to food security and livelihoods.

The emphasis of the projects supported by the Development Fund has been on enhancing food security, developing the local livelihoods, and initiating rehabilitation and sustainable management of local nature. Within such work, experiences with climate variability and change nonetheless represent an important component of the work. The projects have responded to creeping weather changes that have been observed and experienced by the population and the staff in the local partner organizations, including increased variability and changes in extreme events. Many of the measures and responses may be useful for adaptation to future changes, although this aspect has not been explicitly considered in the projects. As these projects are focusing on rural livelihoods and agriculture, where enormous impacts are projected to take place, not only in terms of reduced yields but for food security in general, climate change is likely to represent a major threat. This suggests that the types of measures that have been supported by the Development Fund may be only partial responses in terms of sustainable adaptation to climate change. Nevertheless, many lessons can be learned from the experiences that have been done in these projects, and some of them are likely to be relevant also for other poor groups than rural farming populations.

In the following chapters we will look more closely at the linkages between climate change adaptation and poverty reduction in three specific development projects. Specifically, the extent to which activities carried out in these projects have been relevant for adaptation to climate change and variability in their respective geographical areas will be assessed. The projects have not been designed with the main objective of addressing the need for climate change adaptation, but the efforts for increased food security nevertheless touch upon many issues related to climate risks, vulnerability and the capacity to adapt to climatic stresses.

2.6 Case studies and data collection

Three Development Fund-supported projects will be presented and analyzed, each separately: The first is from the Tigray region in Ethiopia, the second is from the Western Development Region in Nepal, and the third is from the North Zone in Nicaragua. All three projects work with the rural poor, primarily people involved in mixed farming systems with different types of farm animals and crop production, but including landless farmers and those who have no animals. In the following chapters we will examine the three projects in terms of the factors influencing climate risks, vulnerability and adaptive capacity that can be identified in each project area, then consider how the projects have influenced these factors and thus the opportunities of households for sustainable adaptation.

In order to analyze the activities implemented by the projects and their potential to contribute to sustainable adaptation, it was necessary to map out key linkages between poverty and climate change impacts in each of the geographical locations of the three projects. Questions or check lists were developed to guide a systematic mapping of risk, vulnerability and adaptive capacity and the influence of project activities on these factors.

First, the local climate risks experienced by the population were mapped. In other words, the kinds of climatic conditions and weather patterns that were the most problematic for the population in the project areas where identified, as well as why these were problems. Next, it was necessary to assess the social, economic and environmental factors that were likely to influence their vulnerability to climate risks. Since the vulnerability context is constituted by an inexhaustible number of factors and conditions, the aim was to identify those factors that were most significant in the study areas. Finally, it was also necessary to get insights into the local capacities and strategies, including the local knowledge with which people attempted to handle the challenges they faced – both the climatic and the non-climatic stressors. Data was collected on what the household and community responses were to such

challenges. Through this approach insights were also provided on the interactions between the climatic and non-climatic factors influencing livelihoods and quality of life. Based on this systematic information, it was also possible to assess project activities to see how they influenced the risk factors, vulnerability factors and adaptation factors.

The local partners of the Development Fund carried out the data collection based on this method and produced the three climate documentation booklets in the series "More than Rain", published by the Development Fund. The data provided by those case-studies are analyzed in this report. The data collection is to a large extent based on qualitative methods, focusing on the experiences of the local population and project staff. In this way it has been possible to get insights into the strategies that poor people use to try to secure their basic needs, how these strategies and their outcomes are influenced by climate variability and change in combination with other factors, and how the project activities touch upon such relationships between climate change and poverty.

3 ETHIOPIA CASE STUDY

This project aims to increase food security among poor people, including restoration and management of ecosystems, in different watersheds in the Tigray region in Ethiopia. Relief Society of Tigray (REST) is the local partner of the Development Fund in the Tigray Region, a regional non-governmental organization that works with poor and marginalized communities. The livelihoods in the project area are mostly mixed farming, often on a very small scale. The project focuses on diversifying farming, gardening, animal husbandry, other uses of ecosystems, and other rural income-generating activities towards enhanced food security. Farm animals are important for food security in the area.

The data for this analysis of the project in Tigray have been provided by the case study called "Assessment of Climate Change in the DF Supported Integrated Rural Development Project Area of Tigray Region, Ethiopia. Climate change documentation", conducted by Emana (2008) , based on the framework presented in chapter 2. The projects selected for the case study includes three watersheds in the Kolla Tembien district and one watershed in the Abergele district. Data are collected through focus group discussions and interviews with community representatives, REST-staff and other key informants. Social groups, age and gender have been taken into account, but there are only 8 women among the local informants, and 49 men. Secondary data have been collected from government offices and REST. Based on the case study, we will in the following, attempt to identify the main climate risks, vulnerability factors and adaptive capacity of poor people in the project areas.

3.1 Climate risk

First, the climate conditions in the area and their impacts on individuals and local communities were assessed. The population in the four districts is living with climatic conditions which are generally dry, with a short rainy season and a long rainy season. Severe, long lasting droughts have occurred, and also some events of flooding in relation to intense rainfall. The community recognizes changes from the past, towards more serious droughts and shorter and more erratic rainy seasons. The observations are supported by historical records of weather data, showing that the rainy seasons start later and stop earlier than before. People have experienced increased surface temperature, which is partly due to deforestation and lack of shade from trees. Flood has led to significant damages to farmland and residential houses, also probably partly due to deforestation and other environmental degradation. The statistics show increasing average temperature and declining precipitation. Together with strong climate variability and a shortening rainy season, these changes represent major challenges for the population. In particular more frequent droughts have contributed to severe impacts on livelihoods. However, the very grave consequences are clearly due to both the climatic conditions and several other factors making people vulnerable, which will be explained below.

The direct impacts of the droughts, in combination with the environmental degradation have lead to reduced or totally lost crop yields, serious losses of livestock, soil degradation and loss of soil fertility. This has resulted in starvation, increased poverty, migration and dependence on food aid, as well as deaths, health problems and economic and social stagnation.

3.2 Vulnerability

This section will present the main social, economic and environmental problems affecting people in these Tigray communities, and thus their vulnerability to climate variability and change. The Tigray case clearly illustrates how environmental degradation can seriously increase vulnerability and reduce resilience to different types of stresses. The interactions between the climatic and the environmental factors have been so close in this geographic area that it is even difficult to separate them, and the population partially presents them as one problem. In the past, the forest cover was considerably denser, population pressure on the land was smaller, the rainy season generally longer, and water springs and rivers had more water. The consequences of drought were less serious than in later years, when these factors were therefore substantially changed.

The extreme environmental degradation in the area started several decades ago. It is estimated that before 1950 the forest cover was around 65% of the land in the watersheds. The population density and settlement was low, there was high productivity of crop and livestock due to cultivation of virgin land, good grass cover and plenty of livestock feed. Grasses for roof covering were easily available, women collected firewood in the home vicinity, forestland was communal and had low protection. There was no soil erosion, the rainy season was long (March to October), the temperature felt cooler because of the shading from the trees, and there was a high biodiversity of flora and fauna. Even though many of these reflections are subjective there is no doubt that the situation was very different from now.

The deforestation and degradation of the biophysical environment have mainly been driven by insecurity and competition for land, conflict and reckless exploitation of forests by military parties, population pressure, and privatization and occupation of large areas by landlords. Although land reform was useful for many groups, the way it was carried out also increased insecurity for some, and thus increased the pressure on the forests. In addition the armed struggle between Tigray Peoples Liberation Front (TPLF) and Derg not only contributed to the land degradation, but to the overall vulnerability of the population.

When the biophysical environment became more and more degraded, it also became more exposed to further degradation, like severe gully formation, erosion, soil degradation and loss of soil fertility and drying up of remaining trees and other vegetation due to droughts and intense rainfall. The ground could absorb and store less water and moisture, and more water evaporated. Permanent rivers dried up or became temporary and flowed only during the rainy seasons. The discharge rate of spring water supply declined. Wildlife declined and migrated. All these factors contributed to making the land more or less bare, affecting livelihoods seriously, and increasing vulnerability.

Although the vulnerability created by environmental degradation is one of the most obvious and direct causes of vulnerability in the Tigray case, other factors also influence vulnerability. Also, the two worst droughts in the 1990s coincided with conflicts.

Health problems, lack of public services and infrastructure also contribute to vulnerability. Illness, especially HIV/AIDS among family members, has a highly adverse effect on households' ability to undertake important agricultural and domestic activities, and thus influences their vulnerability towards stresses such as droughts and other climatic extremes and changes. There are risk areas for HIV/AIDS in the project districts, such as in the places where the army is located, where commercial sex workers are located, where there are many women-headed families and unemployed people. The labor force is limited in Tigray, and therefore the effect of HIV/AIDS is dramatic.

The population is also vulnerable to climatic stresses due to few water sources. On average 900 people get water from each source. There is lack of infrastructure, like roads to local communities. Schools, health services and markets are therefore scarcely accessible by the population in these places. Access to health services from health centers and hospitals (often located in urban areas) is limited for large parts of the rural population because of transport obstacles and affordability.

Climatic variability and change comes on top of these problems. The poorest are particularly vulnerable to additional stresses because of their already extremely low food security and few options for income-generating activities. However, the differences between poor groups are only grades of serious vulnerability. Many people are vulnerable because they own no land, and especially many of the young people are landless. There are few alternative income opportunities outside agriculture, and the youth who were not assigned land during the last land redistribution depend on their parents to access small pieces of land or they have been migrating to urban centers in search for work. According to the case study, landlessness is becoming a crucial economic factor leading to social crises. Also lack of economic empowerment and access to decision making of women are important vulnerability factors, not least for woman-led households.

3.3 Adaptive Capacity

As described by IPCC (IPCC 2007b), societies have a long record of adapting to the impacts of weather and climate through a range of practices. In addition, they have adapted to all kinds of other factors influencing their livelihoods. Also in the project areas, traditional livelihoods have been developed in close interaction between people, society, technology, the local nature and climate conditions. However, in recent years these livelihoods have been put under stress, and people have tried to cope and adapt to circumstances that they are less familiar with and within the limits shaped by the social, political, economic and environmental barriers they face. For example, the population has started to produce seedlings of different indigenous and exotic species of trees and plants in the area[1]. The indigenous natural gum tree is one of them and it has proven to be valuable to the local people. The eucalyptus tree is an exotic species which has become a major commercial wood in the area. To protect biodiversity of the project area eucalyptus trees are planted on localized sites such as plantation backyards and other specified pocket areas of private lands. They are planted in wider spacing than before to avoid the allopathic effect of the tree, so that other species and grasses can grow on the ground, due to shade and nutrient competition. Eucalyptus trees are no longer planted along rivers, springs, irrigable areas, etc., because farmer have become aware of the negative effects of nutrient competition of minerals and water, shading effect, etc. Due to the drastic decline in the population of wild animals, people have stopped hunting.

As a response to the land shortage, the low productivity, the droughts and other threats to food security and income generation, the population has intensified crop and livestock production systems and attempted to diversify the means of livelihood by engaging in alternative income generation activities including petty trade, off-farm activities and food-for-work organized by the government and REST, both separately and in collaboration. Casual work supplemented agricultural income already in the 1960s and 70s. In connection with the drought in 1974 and later droughts, NGOs, national and international communities carried out relief work, Food for Work programs and development projects.

When crops have failed, families have temporarily migrated to urban areas, attempting to generate income for subsistence through casual work. During the time families are split, family life has been negatively affected, and the demand for child labor has increased. The women and girls have worked harder in order to fetch water and firewood. People have reduced their savings during periods of drought, and the local saving system has been weakened.

In the project areas important livelihood assets include cropland,

1 These species include Acacia abide, Acacia seyal (All the acacia species are nitrogen fixing and mostly drought resistant and are used for fuel wood, farm implements, livestock feed, fences, construction and so on), Cordia Africana (fruit tree, timber, livestock feed, shade, ornamental tree, bee forages) and Olea Africana (hard wood used as construction wood, ornamental tree, teeth brush, shade, farm implements, etc.), Acacia tortilis, Ficus vesta (large fig tree with large leaves used as shade tree, fruit, fuel wood, fodder, etc.), Salvadora persica (used for fuel wood, toot brush, fodder, etc.), Dodionia abyssinica (drought resistant ever-green shrub that grows on degraded areas, used for fuel wood, hand tools, roofing materials, etc.), Acacia etbica, Cactus interaptus, Eucalyptus (planted mostly around living houses, used as fuel wood, construction, bee foraging and sale), etc.

***Local teff production in Tigray,* Teff is a cereal well adapted to the heavy, well-drained, clay-like soil areas of the Ethiopian highlands.**

pastureland, forest trees, river water and oxen for traction power[2]. Most of the adult people own land, although some of the plots are very small. However, both for these and the landless people, the capacity to adapt to additional stresses can be very small. On the other hand, it can also be said that if opportunities for other activities could be found, those without land would generally have more time to engage in other activities, because they are not bound to concentrate on time consuming agricultural activities. But it should be underlined that few alternative options exist.

The population in the Tigray region has knowledge and skills in growing cereal crops such as maize, teff, and wheat, but not so much in planting and growing trees, fruit production, use of trees for fodder production, irrigation and water harvesting and storage techniques, etc. They have knowledge and skills in livestock-keeping, but not in fodder production and collection. They also have knowledge on how to carry out agriculture and gardening in a dry environment, for example by spreading small stones on their farmland to preserve moisture in the soil.

Livestock is very important to the household economy, and the population has many skills in livestock-keeping and highly appreciates and cares for their farm animals. Besides providing traction power for agriculture, the animals provide income, food and means of accumulating wealth for the household. Cattle, sheep, goat, camel, equine and poultry, and last, but not least, the donkey are important for income generation and food security. Livestock is also one of the most important assets used as a wealth indicator. Under the major drought periods in the recent decades, the loss of livestock was very serious.

The central and demanding challenge for the poor people in the area is to produce enough food and provide enough income for the household to access food the whole year round. As part of this challenge, it is crucial to succeed in providing enough fodder and water for the livestock the whole year round. If they do not manage, the lives of the animals are in danger, and thus people can lose some of their most important livelihood assets. It is also important for these people to earn enough money to send children to school, invest in improvements of livelihoods and pay for health services. Central challenges are also to get access to land or to jobs.

2 *Even very poor farmers that cannot produce enough food to support the family and have no or few livestock, strive to own at least an ox, providing traction power for crop production.*

3.4 Development Fund-supported work with rural poor in Tigray, Ethiopia

In this section we will examine the available information from the Tigray project and analyze the extent to which the project has included activities that may be useful for sustainable climate adaptation – for reducing risk and vulnerability as well as increasing adaptive capacity of the poor households involved in the project. The overall objective of the project is to improve household food security on a sustainable basis in the project watersheds including sustainable environmental management. Diversification of rural household crops and livestock production and productivity at household levels, as well as alternative micro enterprise development are seen as crucial elements in the project. The project also aims to improve access to clean potable water and increase children's school attendance by providing water around the homesteads and water for irrigation. Economic empowerment is to be increased, especially in women-headed households and for landless youth. Improvement of the natural resource base and management of the degraded land and sustainable usage of natural resources are central issues.

This analysis is not an assessment of whether the project has reached these goals, but of the ways in which the project measures may have relevance for people's adaptation and resilience to climate variability and change. The types of measures implemented in the project may have the potential to influence climate risk, vulnerability and the capacity of the population to live with and adapt to climatic variability and change, and each type of measure can sometimes touch upon more than one of these aspects.

Seed banks, fruits, vegetables and compost

Measures towards the development of livelihoods through crop and livestock development includes establishment of a seed bank system to help farmers who have been forced to consume their seeds. Access to local seed varieties are thus secured at affordable prices, which is crucial for the farmers in order to be able to grow their crops each year, and in order to get seeds that are well adapted to local climate conditions and variability. Vulnerability is thus likely to be reduced by such seed banks. In order to diversify crop production, the project has introduced different varieties of vegetables, fruits and root crops that can be produced under local climate conditions. For example maize growing, which is sensitive to drought, is reduced and replaced by fruits, like papaya, guava, mango, banana, orange and lemon. These crops can also be consumed or sold at the market. Fruit and vegetable production in small gardens are also encouraged. Early maturing cereals, vegetables, root crops and fruits which can be grown using irrigation are used in order to adapt to shortened rainfall. The growing of root crops has improved backyard or small garden cultivation, providing more food by the households and particularly by women. For example, sweet potatoes grow under moisture stress and serve as security crop in times of drought and food shortage. However, some kind of irrigation technology is necessary in order to grow most of the vegetables and fruits. According to the case study, these measures have reduced the risk of crop loss and seed shortage due to droughts, improved the food security and income in the context of climatic variability and already observed climate change.

Capacity building activities have improved farming and gardening practices through measures such as investment support in irrigation, use of compost and manure, and fertilizer application. Such techniques are relevant not only for food security and income opportunities, but also for adaptation to climatic stresses. For example, organic growing techniques increase the content of organic matter in the soil, thus reducing the risk of soil erosion during flash rains and storms and increasing the ability of the soil to absorb water and keep moisture (Bjune et al. 2007). Moreover, flexibility and resilience to climatic shocks and stresses can also be improved if increases in production can occur without increased dependency on bought inputs. Also, improved and more diverse diets are important for health and work capacity, and can thus reduce vulnerability to diverse challenges and increase the capacity to influence one's own life.

The new crops have the potential to increase market opportunities and incomes, thus increasing food security and income in ways that are adapted to local climate conditions, and that are also more likely to be useful under predicted changes. Improved personal economy can increase the opportunities to choose among a larger number of adaptation options. For example, farmers who were earlier forced to undertake seasonal migration to urban areas will potentially have enough employment on their farms and in Soil- and Water Conservation work, Food for Work, alternative income generation activities and farm crop and livestock development.

The Begite cow, sustainable fodder production, zero grazing, and investments in goats

The project has helped to increase the number of varieties of farm animals, which in turn has played a significant role in household asset building, according to the case study. The Begite cow, a productive breed of dairy cow, has been brought from the western part of the Tigray region, 250 km away from the study area, which can be seen as an example of technology transfer. The cow gives 6 liters of milk per day compared to the local cow which produces 1,5 liters of milk per day. The cow has demonstrated its ability to survive under harsh conditions like the local cows, and can therefore be important for the economy and food security under the observed climate variability and changes. Introduction of new poultry breeds and small ruminants are especially targeted at women. A specific loan system for household asset creation, particularly for women-headed households, has been developed. Women take loans from the project to buy 2-4 sheep or goats, which thereafter reproduce five or six times in a few years. This has enabled the women to sell animals and get income for school fees, clothes and food. Fodder production is now practiced, and a system is developed for rearing livestock based on "zero grazing" or "cut and carry system", and supplementary feeding, which is part of the rehabilitation of degraded areas. The enclosure of areas facilitates natural regeneration of vegetation cover on degraded communal lands by protecting them from livestock and human intrusion. Grass is then cut in these areas and carried to the animals.

A more resilient type of animal husbandry here seems to be under development, which is less dependent on grazing in communal lands, and at the same time more productive and economic. In this way the animals can improve food security, income and saving opportunities and at the same time increase people's capacity to handle a drought or a flood or other types of challenging climate conditions. Thus food security becomes less affected by climatic shocks and stresses. The case study points out that these improvements in the household economy have made people able to invest in children's education and to further diversify and increase incomes, thus in several ways increase the capacity to adapt to climatic and other types of stresses.

Jobs for the rural youth; honey cooperatives, handicraft training, higher value crops for markets and small business management

Increased diversification of livelihoods has been developed through small scale enterprises in dairying and selling of butter and yogurt, small ruminant development, honey processing and formation of honey cooperatives, petty trade, handicraft training and small business management training. Support is given for production of high value crops for the market. The market for the products from the project area is the central town of the project area – Abi Adi. The potential of selling fruits in the local market is encouraging, since there is high demand for fruits in the town. However, there is a problem of sorting and grading. So far the marketing channels are not well developed, and are at an infant stage. To enhance access to markets, REST is establishing different user groups and cooperatives such as honey producer and marketing cooperatives, milk processing and marketing cooperatives, vegetable producer and marketing groups.

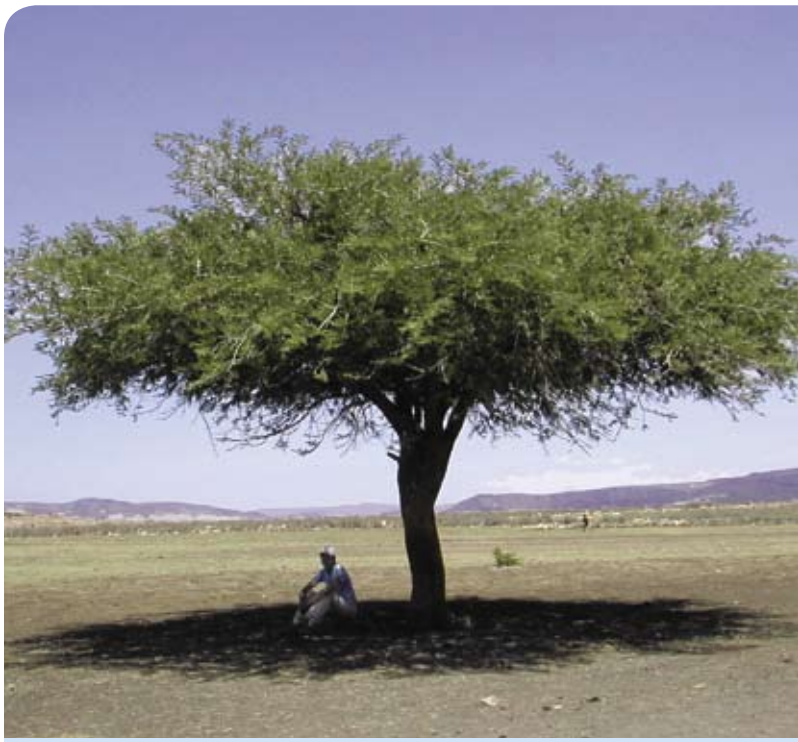
Some of these income-generating activities are less at risk for adverse weather events than the traditional livelihood activities. Jobs have been created for the rural youth, increasing their food security and quality of life, in ways that fit well with local climate and nature conditions, and therefore are likely to be more resilient to some of the predicted changes in the climate than previous livelihood strategies. These activities are also relatively little affected by global fluctuations in markets, which in many cases create vulnerability among poor people. The people in the area may also have benefited from the increase in urban employment in Tigray since 2003. According to REST, the government has developed activities for employment generation in cities and towns, such as different medium and small scale enterprises for youth for improvement of infrastructure, such as electricity, telephone, road, etc., that enhance the governance in towns and cities. This employment generation is important in order to reduce rural unemployment and dependence on agricultural activities for landless youth, thus reducing the vulnerability of these youths and their families to climate stress. Moreover, the infrastructure that is being built through these employment generation initiatives from the government, have the potential to reduce vulnerability of the population if the infrastructure is provided in ways that benefit the poor.

Study tours and South-South learning

The project has implemented training, workshops and tours, in-country learning and South-South learning. Transfer of experiences is facilitated between geographical contexts in Tigray and Ethiopia, for example through exposure visits for women to share experiences on market-oriented production, dairy development, cows, as well as vegetable and root crops production. Women are now teaching neighboring women root crop production and local processing. The capacity to adapt to climate variability and change can increase when the knowledge about different options for adjusting livelihoods increase, and knowledge from similar, dryland contexts in the South is more likely to be relevant than knowledge and techniques from very different social, economic and biophysical contexts. The new knowledge has also been useful for the work of REST and the Development Fund, increasing their capacity to design and implement useful and innovative poverty reduction measures in climate adapted ways, in close cooperation with the population.

Planting of trees for many purposes

The project spreads agro-forestry systems of multipurpose trees, for example for improving soil fertility and supplying fodder. Flowering plants are useful for honey production and fodder plants give livestock feed. Forestation and shade from trees on farms improve the microclimate and quality of life. The shade from trees is highly appreciated by people, and increases their ability to live with extreme heat and drought. Moreover, if livelihoods, including the feeding of animals, depend more on bushes and trees and less on grasses and annual grain crops, the risk of losses during floods, drought and storms becomes less, because trees are more resilient to such weather conditions than other plants. Many trees are very well adapted to dryland conditions, and the roots keep the trees in place during floods whereas smaller and weaker plants are washed away. Trees are also independent from annual plowing, sowing and care for seedlings, and less dependent on manure. These different advantages of trees make them useful for economic development which is adapted to several types of adverse climate conditions (Garrity et al. 2006).



Trees for many purposes

Rainwater harvesting, treadle pumps, hand-dug wells, motorized pumps, drip irrigation

Water resources development and irrigation systems have been tackled through a diversity of practical solutions in order to improve household water supply, reduce the risk of losing crops and animals during droughts, and to develop new income-generating activities. Irrigation and water supply for households are developed by check dam ponds, river diversion, rain water harvesting, underground water tanks and community and private hand-dug wells for women-headed households, treadle pumps, motorized pumps, and water-saving technologies such as drip irrigation. There are challenges with regard to maintenance and spare-part provisions for pumps, and REST is trying to overcome these challenges by giving training to farmers on the technical operation and minor maintenance, such as cleaning and changing oil. REST is also trying to link maintenance matters with small scale enterprise development which is an ongoing job creation project implemented by the government for youths in urban and semi-urban areas.

The potential for provision of water to irrigation systems has increased because of the rehabilitation of the ecosystems in the area. According to REST, irrigation liberates people from dependency on relief and Food for Work. For example, horticulture production using different irrigation techniques has changed the life of those farmers benefiting from the project. In addition to the impacts of the project, sometimes good rainfall has contributed to good yields, especially in combination with the project measures.

Rehabilitation of woods, participation by communities, planting of communal trees, cut and carry harvesting of livestock feed

Natural resources conservation and rehabilitation have been undertaken both by the project and by the local and regional government. Forestation, rehabilitation and development of gullies, area closures and water development have been among the activities. The closed areas are accessible for people who use it for cut and carry harvesting of livestock feed and honey production. The local government uses the Food for Work program for community labor mobilization for rehabilitation of degraded areas. The check dams have rescued land and conserved moisture in the area, and rehabilitation of gullies and terracing have protected the soil from further erosion and increased rainfall infiltration into the soil. The increased moisture and the increased vegetation cover improve the micro climate in the area. Techniques for soil and water conservation, raising of tree seedlings, plantation of trees and area closure, protect the top soil against erosion and improve the soil fertility. Because they have learned from these activities, people have carried out soil and water conservation measures also on their own farms and backyards, increasing the resilience of their soils and availability of water, despite the experienced climatic stresses.

The project has also trained experts on environmental assessment, irrigation and conservation sciences. Both for REST and for the local community, the capacity to implement integrated rural development in a sustainable manner has increased, alongside the capacity to adapt income-generating activities to extreme climate conditions occurring in this area, such as droughts and intense rainfall episodes.

Degeneration of vegetation due to cutting of trees and droughts has left many areas in Tigray in arable. Rehabilitation of such land areas through area enclosure regenerate vegetation, secures local biodiversity, as well as reducing erosion and floods.

Measures for reducing the burden on females, improving their rights and opportunities for income

Some measures are especially directed at capacity building on gender relations and support for women, including training on "Harmful Traditional Practice" (HTP), which includes female genital mutilation and discrimination of girls and women. Activities are also directed at issues of rights, HIV/AIDS and women leadership. Such measures have the potential to reduce the vulnerability of women, and also their children and other family members. Despite improvements in land rights for women, there are still inequalities. Therefore, the project addresses the needs of the women through provision of small ruminants, dairy development, root crop development and improvement of water access around the homesteads to increase children's school attendance and reduce the work burden of females. The women's capacity to make improvements in their livelihoods and quality of life in the face of droughts and floods can be improved by such changes.

Mobility, health, education, information

Efforts have also been undertaken to improve community services, like transport opportunities, health services, schools and access to markets for remote communities. The government has invested in schools and health services while REST is involved in ACCESS Education in remote communities for children who have no access to formal schooling. Construction of ACCESS Schools is carried out by REST and the community themselves. REST is also constructing access roads in the remote areas to link the communities to the main road and link between and among the villages. These will have significant importance for market access. Improvements in such services can increase the opportunities of the population to respond to climate variability and change and other challenges that they meet.

The project has also supported HIV/AIDS orphans and/or victims, and trained health extension workers, anti HIV/AIDS clubs, adolescent promoters, adult literacy facilitators and religious leaders. According to the case study, the capacity building activities in the community as well as the training of experts has created social capital, which has lead to better social relations in the communities. Orphan children get support from the project through capacity building and school fee coverage.

3.5 Conclusions, Ethiopia case

People in the project area in Tigray are very poor and also very vulnerable to climatic changes, and they are also exposed to harsh climate conditions. People struggle hard in order to cover their basic needs under conditions that are difficult to understand for people who only read about them. The capacity of poor people to live with extreme conditions is well illustrated by this case and also the following ones. At the same time, it is also evident that people's vulnerability would remain high if no interventions were undertaken. Although people have strengths, knowledge, skills and make efforts to live with climatic and other shocks and stresses, they are not able to use and increase their potentials and resources if the society is not doing its part. Societal efforts are necessary in order to make people able to upgrade and extend their income-generating strategies and their quality of life in ways that also make them less vulnerable to climate variability and change. And the types of

Ethiopian children and youth participate in farming activities.

interventions must be based on the specific problems, opportunities, knowledge, constraints and vulnerabilities that influence the results of people's efforts, as exemplified by this analysis.

Less sophisticated strategies implemented without the same understanding of local livelihoods and involvement of local communities would risk being less useful for the population, and could even increase vulnerability by introducing livelihoods less adapted to local conditions. Moreover, it is important to upgrade and develop the livelihoods based on local resources, nature and climate, instead of introducing practices and knowledge from very different contexts, such as modern agricultural practices developed in northern countries. For example, it is indicated by this analysis that traditional livestock keeping, which is often regarded as a backward livelihood, but which is very important for the food security of the population, can be fruitfully upgraded and become an even better way of using available natural resources. Through the project activities, innovative ways of improving livestock-keeping are developed, for example by the introduction of animals from other parts of the region, by new ways of providing fodder and water and by increased value-adding to milk products. Such measures have the potential to increase adaptive capacity, especially in combination with measures that target the underlying causes of vulnerability, such as improvement in public services for the poor. In Tigray the regional and local governments have taken responsibility for several efforts to change the conditions of the poor, through employment generation and improved public services, in close collaboration with community groups and REST. These government efforts could be good examples for governments in other places. There is a long way to go in order to reduce vulnerability and poverty and increase the adaptive capacity more drastically in such vulnerable communities, but the project and government activities seem to be relevant and useful steps.

The project activities are designed in order to improve household food security and restore degraded natural areas in an environment of recurring and intensified droughts and other extreme weather conditions, like floods. Therefore, the project itself or its outcomes are relatively climate-resilient in the short term perspective. However, REST points out that outright rain discontinuation over a large area, poor distribution of rain and other weather related changes are risk factors for the project achievements. In addition, they point out economic risk factors to the project, such as large price variations, unexpected shifts in terms of trade, new land use policy, and other factors that are not under direct control of the program.

4 NICARAGUA CASE STUDY

The second Development Fund-supported project that is analyzed in this report takes place in the northern region of Nicaragua, and the local partner is the Centre for Promotion of Rural and Social Development (CIPRES). The centre is working with families of small, poor farmers on sustainable farming practices and sustainable environmental management. These practices include the improvement of their seeds and crops, and promoting alternative livelihood strategies for food production. The livelihoods in the area are mainly small-scale basic grain production at subsistence level. A part of the crop is sold when there is surplus, but storage capacity is small and hinders storage for better prices at other times of the year. Households also produce vegetables, cooking bananas and fruit. They raise pigs and hens in the yards and most people keep a few cattle. In some districts, shade coffee is grown in the highlands, some of it produced organically in agro-forestry systems, and tobacco is also being grown.

The data for this analysis is provided by a case study conducted by CABAL, S.A. (2008), and the data for the case study were collected through focus group discussions and a workshop, interviews with plant breeding technicians, specialists from plant breeding institutions, and farmers. Women farmers were well represented among the informants and four of seven members of the CIPRES technical team were women. The projects selected for the case study are located in the dry zone of Nicaragua, in the municipalities of Condega, Pueblo Nuevo, and Totogalpa.

We will here present the main climate risks, vulnerability factors and adaptive capacity of smallholder farmers identified in three of the project districts in the CIPRES project in Nicaragua, which is supported by the Development Fund.

4.1 Climate risk

The climate in the project area is a tropical savannah climate with variations according to elevation; semi-wet in the highlands and dry in the lowlands. The topography of the region is irregular with steep slopes at 550 to 1.450 meters above sea level. The climate in the area is highly variable, with drought periods and wet periods, storms and hurricanes often occurring. Also changes in the weather patterns have been increasingly noted by the population for several years, including instability of winds, variations in temperatures, and irregularities in rainfall. El Niño is becoming more frequent and intense, increasing droughts and heat waves, as well as intense rain and long periods of cool and wet weather. The climate is reported to be more unpredictable than before, and extreme weather events occur more and more frequently. Hurricanes tend to be increasingly intense, and in some years droughts have been so serious that families have had to move temporarily or even permanently.

Changes in climate have particularly affected the cultivation of basic grains. Many small farmers have lost the whole crop several times, leading to lack of food and starvation for people and animals. The losses are caused both by water and wind erosion depleting soils, excess rainfall resulting in crops rotting in the field or serious loss of harvests, droughts destroying crops, and pest and disease outbreaks by overly wet conditions. Droughts have been the most frequent and damaging climatic stress, as part of the irregularity of the rainy season. The ground water table is becoming deeper, so that new and deeper wells must be dug, and wells sometimes dry up. Soil is eroded by wind after it has been dried up into dust. The risk of erosion and landslide risk increases. The best time for planting basic grains has changed, and varies between years. The cattle are affected by instable temperatures, and pastures grow less under droughts and temperature rise. Animals suffer miscarriages or die. Farmers are at times also forced to sell animals to cut losses.

Hurricane Mitch hit Nicaragua in 1998 and seriously damaged infrastructure and environment. Arable land was destroyed, trees were washed away and rivers changed their course, leaving farmers with even less land to cultivate.

Hurricane Mitch hit Nicaragua in October 1998, and more than 3,000 people died, 41,000 homes were damaged or destroyed; infrastructure, harvests, and arable land was lost, due to frequent landslides, landslips and erosion. Trees were swept away, including fruit trees and trees for firewood. Rivers changed their course and the flow level dropped. The rivers started to dry up in dry seasons, hindering the use of the river for irrigation. Fish diversity has also declined. Processes of environmental and social degradation were revealed and reinforced by the hurricane, and migration increased.

4.2 Vulnerability

The adverse climatic impacts in the communities have been further intensified because of degraded water sources, erosion and impoverished soils. Lack of public services and social security nets for the population are other reasons for disastrous outcomes of climatic impacts. This section will present some main factors that influence the vulnerability of individuals and households in the project areas in Nicaragua.

There is a high level of poverty in the area, and the quality of life is low for a substantial part of the population, due to poverty, difficult working conditions, long working hours, low food security, unemployment, and low incomes. In the project area there is little land available for agriculture, due to the irregular landscape with many steep slopes. The existing land is degraded by inappropriate farming practices, and by Hurricane Mitch. The use of agro-chemicals, over-cultivation of soils, deforestation, slash-and-burn agriculture, and deterioration of water sources has decreased the productivity of the land, according to the case study. Water sources have become unprotected because of long-lasting deforestation and because of the mismanagement of soil, reducing the capacity of the soil to infiltrate water. Thus, the rain easily runs off, carrying soil away from the fields. Climate events with intense rainfall therefore have worse consequences than if the soil had been managed with other, organic techniques, and increasing the content of organic matter, which changes the structure and water-keeping capacity of the soil (Bjune et al. 2007).

Livelihoods have been eroded and lost because many families have lost their land and animals, houses, cowsheds and tools, which is the capital for production of crops and meat. This decapitalization means that the families do not have the capacity to invest in their farms, the majority of them do not have credit, and when they are able to access some credit programs, which are expensive, they often cannot meet their obligations, due to loss of the harvest. Creditors must in many cases expropriate basic production goods from the families. Extreme poverty is the result, and there is a high risk of malnutrition. Any surplus from the farming goes to covering domestic costs as food, schooling, clothing, etc., but is insufficient for investing in the farm.

Preschool and primary education is easily available, but schools are deteriorating, and there is a high level of illiteracy. Secondary school attendance is hindered by economic costs and risks of moving to the larger cities. The quality of water and sanitation is low – there are no sanitary sewerage systems, and there is limited access to drinking water, especially in rural areas. Poor sanitation combined with erratic climatic conditions leads to contamination of water and endemic illnesses, like acute diarrheic diseases, acute renal infections, dengue and malaria.

Due to high unemployment, many men have migrated and a high proportion of households are run by single women, temporarily or permanently. Children are taken out of school when whole families temporarily migrate for seasonal work. At the same time the dependence on these remote labor markets makes migrants and their families vulnerable to shifts in these economies. The migration can become a vicious circle because there is less labor available to work on the farm and to produce better quantities and qualities of crops, and the family may remain with the debt of the trip and often may not receive the expected remittances.

All these challenges are likely to make people vulnerable to the additional stress from a variable and changing climate. When extreme events or long periods of drought or rainfall coincide and interact with these social, economic and environmental factors, the fragile livelihoods are seriously threatened.

4.3 Adaptive Capacity

It is evident that poor people are experts in adapting, as far as possible within their means, to tremendous challenges of different types. One of the main responses of the population to the increased climatic, environmental, social and economic hardships in this area, has been the migration for employment outside the country. Work is found in the agricultural sector of neighboring countries, especially Costa Rica, but also in El Salvador and Honduras, and some in the United States. Also traditional survival strategies have been reintroduced, such as exchanging products, and landless farmers rent land or work for landowning farmers. Farmers who lost arable land due to Hurricane Mitch have tried to use such methods of getting access to land.

The capacity to adapt to climate change is dynamic and varies between individuals and groups. In the Nicaragua case, for example, women, orphans or elderly without support often lack adaptation options that exist for other groups. This may be related both to the resources people have within themselves, for example in terms of literacy, health condition or trust in their own capability, as well as resources they have access to, like land, money, social networks, cattle, equipment/technology, spare time, or freedom to decide over their own time and resources.

The population in the region has knowledge and skills of growing maize, beans and sorghum, some vegetables and fruits, as well as in traditional animal husbandry. They also have traditional knowledge on how to interpret and predict weather and seasons, but the patterns have changed, thus this knowledge is of less value today than before. In the project area important livelihood assets are land, animals, seeds and the work capacity of women, men, youth and children. People have little access to technologies which could strengthen their food security and incomes. There has been limited cooperation within the communities, little exchange of products or services, little organization of activities, and few community initiatives. But people show that they have the capacity to catch onto ways of cooperation that they find useful.

Faced with climate adversity and associated impacts such as pests and diseases the farmers are trying to cope and adapt in order to secure crops and farm animals. An important concern, like in the Tigray project area, is to get enough fodder and water for the animals year-round. They also try to find other sources of income

when farm activities fail. Education is valued among the population, despite limited opportunities for school attendance. A central challenge is also to get access to arable land, and some have lost their land due to hurricane Mitch and other extreme climate events.

Among the main aims and hopes of these people is to avoid migration, produce their own food, have access to credit, have a source of income, have their children go to university, and have access to health care and medicine.

4.4 Development Fund-supported work with rural poor in Nicaragua

The CIPRES project in Nicaragua considers biodiversity and good seeds among the fundamental resources for a farmer community. At the same time climate shocks and stresses may result in devastating seed losses. The project analyzed the existing, local diversity of crop varieties in the project area, and there was a low diversity of crops and low yields of the cereal sorghum. The purple mosaic in beans was a problematic disease, and many seed varieties were not suitable for the area and highly demanding of water and chemicals. The project aims to address such problems by rescuing the diversity of local seeds, and developing and improving seeds which are adapted to the local conditions in cooperation with the local farmer. The project institutionalizes participatory methodologies for crop improvement, sustainable use of biodiversity and income-generating activities. The core activity is Participatory Plant Breeding of main food crops: maize, sorghum and beans. The project is also part of The Collaborative Programme for Participatory Plant Breeding in Mesoamerica.

Assistance to farmers to develop their own, locally adapted plants and seeds

Farmers in these areas have always been improving the varieties of the plants they grow, generating a diversity of farm plants. But the program contributes to rescuing the now declining diversity and the ancestral practices, as well as improving them with technically and scientifically advanced plant breeding in a participatory way. Participatory plant breeding work is conducted in cooperation between farmers, NGO technicians, National Institutes for agricultural research and research institutes in Central America. The farmers define the qualities of interest for each crop selected for improvement. They collect seeds from their traditional varieties from selected plants that have shown to have valuable characteristics, such as high yield, drought and pest resistance, good taste, good storage qualities, and qualities for animal forage. A wide group of farmers tests the plants on their parcels of land under natural conditions and again select the best seeds. The plants are thus developed and improved on the farms at different elevations, soils, access to water and other growing conditions so that the resulting, improved plant varieties become very well adapted to local climate variability and change. Food security and income thus become more resilient to the climatic factors. There is close cooperation between the farmers and the academic and scientific sectors, students come to the farms, and all parties increase their knowledge through these activities. There are now several new varieties and advanced types of plants, which contribute to agricultural biodiversity. Major progress has been done with beans and sorghum varieties, and the production yields have been increased for basic grains by at least 50% according to the case study. Farmers have also learned to handle and conserve seeds properly. They now apply the knowledge from the plant breeding work on other plants, like fruits, and on animals, motivated by the good results.

Testing of food qualities of crop varieties for the plant breeding process

Farmers also test the food from the different crops, such as bean soup and sorghum tortilla, assessing taste, smell, softness, and other food qualities. The locally improved, white sorghum, also called white tortilla sorghum, is found to have an almost identical taste to that of maize. The tortillas taste good, stay soft, and maintain the taste the next day. The white tortilla sorghum grows very well in the whole project area, and is resistant to droughts and pests, while maize is more sensitive to adverse climate conditions. Moreover, some hardy maize varieties have been developed in the project. The animals like the taste of the sweet sorghum stalks. These results exemplify the importance of the participatory plant breeding method for the development of useful plants that not only are healthy and well adapted to local climate conditions, but also to local food culture and preferences.

Self-sufficiency and diversity in seeds, increased flexibility under climate variability and change

Growing a large diversity of plants in gardens and on farms allow some varieties to succeed under certain weather conditions, whereas others fail, thus reducing vulnerability and increasing adaptive capacity. Furthermore, the opportunity to become self-sufficient in seed production reduces vulnerability by reducing the dependence on bought, costly seeds that may not even fit with the needs of the farmers.

Development of farmers' cooperatives and youth groups

The farmers are also trained in the establishment of relations and alliances with governmental, non-governmental, academic, and cooperation organizations, and with markets. The farmers are developing their own cooperatives, which will carry on the work started by the project. The local cooperatives link with each other and a national federation has been formed. Relations have been proposed with the Ministry of Agriculture and Forestry for the production and dissemination of seeds, registration of parcels of land and technical follow-up, and as mentioned above, the project is also part of The Collaborative Programme for Participatory Plant Breeding in Mesoamerica.

Some farmers have formed a commercializing committee for seeds, credit, education, and research, which aims to commercialize improved seeds from the participatory plant breeding work. The cooperatives are also investing in capital goods under collective ownership, for example a wet coffee processing plant and a chicken farm. They are also addressing environmental, social and economic issues in the communities. Women groups make family gardens, and apply organic and agro-ecological practices with better results. The farmers also bring their sons and daughters into the plant breeding activities and cooperatives, and some youth groups have been formed. More and more families exchange information, knowledge, strategies and plant and animal products. These networking activities contribute to enhancing and broadening the capability of individuals when faced with hardship, as they can interact with the wider community to solve their problems. The capacity to adapt to climate variability and change is a very likely result of such activities.

This Nicaraguan farmer has diversified the production on his piece of land, cultivating a mix of maize, beans and malanga Diversification reduces the farmer's vulnerability to pests and diseases, failing crops and market variations.

(a nutritious root vegetable).

Organic growing and water harvesting for resilience and independence on bought inputs

Knowledge on organic growing techniques has been provided in the project and more and more farmers make changes in their practices. Cover crops and compost is used to recover and increase the fertility of the soil and increase infiltration of water. Branches of trees are planted to root along fences and weeds are plowed into the soil to increase organic matter content. The case study points out that crop rotation and diversification of plants and animals makes it possible to get enough food for the whole year, improve family diets and generate income if there are surpluses. Squash, onion, sweet pepper, yucca/cassava, and cooking banana are all part of multi-cultivation in the parcels of land, and the farmers experiment with new crops. Some farmers have built small dams on their farms to hold back water for animals and irrigation, and there are also some examples of raising tilapia fish. Cisterns to store rainwater are used by some families. Resource use in animal feeding is made more efficient through intensive grazing with planning and by rotating the use of pastures. Animal feed is also produced on farms. Such measures as those mentioned here can contribute to improved food security, and less dependency on basic grains.

Recovery of ecosystems, improved energy supply, saved time

Due to the project activities, farmers gradually stop burning crop residues, which has been damaging to ecosystems because it has removed ground cover and thus increased evaporation, water erosion and loss of top soil. In such cases the ground dries and becomes compact and hotter, and loses organic matter and thus its fertility. Such burning of residues also in some cases provokes forest fire. In one community fire fighting brigades have been organized; and they monitor and work with farmers who are burning and applying agro-chemicals. People have also gradually stopped using firewood for cooking – finding other energy sources, like biogas-systems (biodigesters). Another practice that has been encouraged is natural regeneration of trees - young trees are not cut down, and only dead branches are used for firewood. The awareness is rising about the importance of reforestation in order to recover and conserve water sources. The case study emphasizes that there is a need for promoting collective action for quick change, and to also protect wildlife flora and fauna. The organic farming techniques are a means to avoid poisoning of the ecosystems with agro-chemicals. The changes in energy use have great potential to improve the health of women and girls, because of less smoke in kitchens. It also saves the heavy work of carrying firewood, and gives more time left for other activities. These activities have the potential to reduce climate risk by keeping the vegetation cover and increase adaptive capacity by freeing time and improving health of women and girls.

Processing and market development

The project has increased local awareness of market opportunities for different types of products, and farmers consider these in their choice of crops and the way they process and market them. For example, women have started to make sweets and marmalades, and package dry flowers and wine for sale both in the community and in municipal seats. Some cooperatives produce poultry and organic coffee and other products in larger scale. There is also an eco-tourism initiative cooperating between several communities and different other actors, connected to an already established tourism route. These are initiatives that diversify income-generating activities and increase incomes so that the dependence on the most climate sensitive traditional farming activities is reduced, and thus vulnerability can be reduced.

4.5 Conclusions, Nicaragua case

The poverty is deep in the project area and the dramatic and increasing climate variability is a huge challenge. In several aspects the project activities seem to increase the capacity of households and communities to respond to the threats they are facing, and also to develop livelihoods which are less vulnerable to those threats, although vulnerability and poverty is of course still present in the project area, due to the huge challenges. For example, as a result of the activities in the project, some of those who used to migrate are now employed at home, and engage themselves in improvements and are inspired to take control of their situation.

The improved food security in the project area reduces vulnerability to non-climatic shocks and changes, since food security secured by these new ways of working is not very vulnerable to outside stresses. Also nutrition, health and income can advance through such improvements. Thus the quality of life of the households involved can be improved despite lack of other jobs, lack of social security systems, low and irrelevant education or weak health care. In this way, the activities make people considerably less affected by factors otherwise making them vulnerable. These vulnerability factors also need to be changed, but they are slower to change and depend more on national governments and international agencies and organizations than on the project. The project activities increase the number of livelihood options which are viable under current socio-economic framework conditions and current climate variability and change, and people's capacity to make use of those opportunities. Thus, such project activities can be seen both as a kind of first aid measure to reduce people's suffering in a society with poor socio-economic conditions for them, and the beginning of important changes in society. The positive local changes are at the same time threatened by the challenges formed by extreme weather stress and vulnerability. For example, when extreme weather events occur, some of the crops of seeds under improvement may be lost, and the plant breeding work gets disrupted.

5 NEPAL CASE STUDY

The third project supported by the Development Fund that is analyzed in this report is situated in peri-urban areas of Pokhara Valley in Nepal, and the local partner is LI-BIRD; Local Initiative for Biodiversity, Research and Development. The project aims to contribute to community based improvements in livelihood options through biodiversity-based activities for better food security, income and living standards, including improved nutrition for poor and marginal farmers. Farm diversification and sustainable management of natural resources are seen as important elements in the project.

The data for this analysis is provided by the case study of Regmi, Thapa, Sharma and Khadka; "Climate Change Risk, Vulnerability and Adaptation Strategies at Community Level". The data for the case study were collected through in-depth interviews with key stakeholders, and focus group discussions with representative farmers based on the framework presented in chapter 2, similar to the other two case studies analyzed in this report. Time series of economic, social and meteorological data were also collected.

Based on the case study, we will here present the main climate risks, vulnerability factors and adaptive capacity of smallholder farmers identified in three of the project districts in the LI-BIRD project in Nepal, before discussing the potential of the project for influencing these factors.

5.1 Climate risk

The case study looks at project activities in four villages in Tanahun and Kaski districts. Both of the districts are located at high altitude, and have a large range of altitudes within each district. They have climates ranging from sub-tropical, mild temperate climate to cool, temperate climate, and even tundra and alpine climate. According to the weather statistics, the temperature in the region is increasing, and the average rainfall has also increased, although it has decreased in some mountainous districts. In one of the meteorological stations in Kaski district, the average rainfall had increased by 744 mm in the years from 1965 to 2005. Several sources of meteorological data show that the temperature in Nepal is increasing at a high rate. And the increase is highest in high altitude regions.

Although rainfall has increased in the valley, the duration of the monsoons has shortened. During the three years from 2002 to 2005, the valley had the lowest average rainfall in 20 years, with springs, wells and rivers drying up and reducing agricultural production. Rice fields, especially, dried up. All the four villages experienced such water stress, and people have linked it to erratic monsoon and changes in rainfall intensity and patterns. Negative impacts were also observed on aquatic plants and fish species, with major consequences for livelihoods of fishing households along streams and lakes. Excessive rainfall, longer drought periods, landslides, glacial outbursts and floods are coming more frequently and intensely. Intense rainfall contributes to more erosion of soils, riverbeds and banks, as well as sedimentation on fertile land in the project areas. The drying up of water sources in some areas lead to longer walking distances to collect water, and in some areas they have got improved the tube wells for water supply. Also pools for bathing of livestock have been lost.

Meteorological data are to a large extent consistent with farmers' experiences, as in the two other projects. Some severe impacts of climate variability and change have been experienced by the population in the area. In some villages, droughts have increased, and intensity of hail-storms has increased in some areas while decreasing in others. Intense rainfall has led to landslides, flooding, and loss of homes, agriculture fields, crops and infrastructure. One such event took five lives, mostly from poor households. More landslides and flooding, as well as frost and fog have been experienced in all the four villages, affecting agricultural work and yields.

The increased unpredictability and intensity of weather events and hazards causes disruptions to rain-fed agricultural systems, even contributing to the loss of local landraces of crops, which require specific timing and intensity of rainfall. Pear, plum, peach, citrus and coffee flowering has been earlier than before, and changed ripening and harvesting patterns have been observed in some crops. Grazing resources for farm animals has declined due to a decline in some local grass species and reduced size of some fodder trees. The number of livestock has therefore decreased in the area, and thus negatively affected the diet of the population. There has been an increase in mosquitoes and flies, and illness among children. Many poor cannot afford mosquito nets and repellent. There are also new pests attacking local landraces of crops, including snail attacks on vegetables, and more cockroaches, according to the local population.

5.2 Vulnerability

This section will present the main vulnerability factors identified in the selected project areas in Nepal, reflecting the dynamic

In Nepal farmers have developed techniques on how to cultivate land in slopes and mountainous areas. Terracing prevents

s land erosion and ensures that the soil retains water.

contexts in which the poor people in the area experience adverse weather events. Also in this case, there are several social, economic and environmental problems creating vulnerability to the climatic risks exemplified above.

More than 80% of the population in the project areas engage in agriculture and rely on natural resources for their livelihoods – for food, fodder, fibre, medicine, water and income; depending on forests, lakes, grasslands and agricultural land. They have few other options for livelihoods, and are therefore vulnerable to adverse weather which is affecting their crops, animals, water sources and other natural surroundings. They also have very few assets to recover and rebuild livelihoods after hazards and climatic stresses.

The livelihoods vary among different social groups (castes), and some of them own more land than others. Brahmins are often farmers, while Dalits are often landless and rely on skilled or unskilled wage labour and remittance. High caste groups like Brahmins and Chetris are also engaged in service jobs. Among Dalits about 20% are landless in the project areas, and the others have very small landholdings. Sharecropping is common among Dalits. The interest for agricultural practices is small in this group, because they have so little land. The employment pattern is changing in the project districts, and about 5% of the population has migrated to foreign countries in search of jobs. They take loans to be able to pay for their travel and search for work.

Poverty is widespread in the area, and more than half of the population in the villages own less than 5 ropani of land, which is between ½ and ¾ of an acre. Average length of food self-sufficiency is only 6 months a year and in one of the villages more than 40% of the population are food self-sufficient for less than 4 months. People in the area are engaged in various on-farm and off-farm activities to provide food and income, including the sale of agricultural and livestock products. The cash income is spent on food, medicine, investments for children and clothes. Richer households invest in land and houses in nearby cities. There are gender differences in people's workload, and females work more than males. Females do more agricultural work, like planting, sowing, processing, and harvesting. Males do agricultural work, marketing and social service work. Among poor people, children will also participate in heavy household and farm work as well as wage labor.

Causes of vulnerability to the impacts of climate change or other shocks and stressors in the area include low education levels, poor health conditions, conflicts and lack of infrastructure and public services. The education level is generally below secondary school, and some are illiterate. In one of the villages as many as 60% of the inhabitants are illiterate. Dalits and poor household from other groups have the lowest education. Education rate has increased compared to the past, and almost all children go to school currently. However, Dalit children drop out early due to labour needs in families.

There are many health problems in the area due to lack of clean water and sanitation and insufficient health services. The villages have no formal drinking water facility, and the poor and Dalit households have no latrines in their homes, and therefore use the private and public land. This affects water quality and health conditions through poor personal hygiene and favourable conditions for insects, and quality of life is negatively affected. The health problems are also related to lack of proper medication and health support, lack of nutrition and heavy workload. Smoke from use of firewood in the houses also affects the health conditions.

Ten years of Maoist revolt and associated social conflicts have been disruptive for the communities, and many of the development programs had to close down. The distribution of resources in the communities was disrupted, and strikes and blockades hindered farmers from reaching the markets before the crops rotted. Tourism was self-evidently negatively affected. The revolt has encouraged poor and Dalit people to join the Maoist and other pro-ethnic groups in order to stop the historical suppression and humiliation they have been subject to. There is still turmoil and political instability, contributing to the continuing suffering of people in rural areas. Faced with such problems, the vulnerability to additional climatic shocks and stressors is obviously increased.

There is little or no support to the communities from the government. There are fewer activities initiated by the government than by the NGOs. The social security system in the whole country is poor. Insurance is not common, and there is only some voluntary material support to disaster-affected groups. There is generally weak physical infrastructure, and distance from government services.

During the last 10 years, there has been a rapid transformation from subsistence agriculture towards more intensive production methods. The modern, high-yielding varieties have been introduced through markets and public policy. The extension service plays an important part in introducing and distributing new varieties. 50% of households in the surveyed villages use chemical fertilizers and pesticides and purchased modern and hybrid varieties of seeds. However, farmers are frustrated with the problems occurring in the growing of these varieties. LI-BIRD views this agricultural transformation as one of the biggest challenges in the project area. The modern varieties and hybrids demand excessive use of chemicals and pesticides, and they therefore increase the economic and ecological burden of marginalised farmers in the project areas. According to the case study, the agricultural services offered by the government fail to benefit poor people since they lack both land and financial resources for high investments in inputs. At the same time, the support and input from government agencies is low. It becomes difficult for farmers to purchase the seeds and costly chemical fertilizer and pesticides. They become dependent on companies, and if seed is not available, the farmers are helpless. The yields are lower than expected, and the pressure on farmers is high. According to the farmers, the use of chemicals and pesticides has also affected ecosystems and productivity of soil and crops. The vulnerability to additional shocks and changes is therefore most likely negatively influenced for many poor households.

The agricultural shift is contributing to loss of biodiversity both in agriculture and in wild species. Other causes of loss of biodiversity are the unpredictable rainfall pattern, deforestation, illegal trade, lack of awareness and insufficient programs to conserve biodiversity. Moreover, increased squatter settlement leads to illegal harvesting of forest products. Loss of local biodiversity on farms influences the poorest the most, because they cannot afford to buy seeds and inputs. A critical issue for them is also lack of animal feed, reduced numbers of animals and thus lack of animal manure, which is one of the causes of dependence on chemical fertilizers. Local livestock breeds are declining due to the introduction of hybrid and conventionally "improved" breeds of livestock. According to the farmers, hybrid livestock are more prone to diseases, which create major losses. There are also fewer wild animals than before. Medicinal plants are also disappearing, and there is loss of local aquatic plants and local fish species due to infrastructure construction, agriculture, encroachment of land and illegal poaching. Furthermore, forests, lakes, grasslands, wetlands and

agriculture ecosystems in the study area are in a critical condition, which reduces opportunities both in fisheries, non-timber forest products and ecotourism. Grasslands are converted to barren wasteland due to human intervention. These different types of losses increase vulnerability to climate variability and change, because they weaken the livelihood resources that the poor have access to.

Since the villages are in the peri-urban areas of Pokhara Valley, they have roads and other infrastructure, and farmers of the villages can bring their products to Pokhara and nearby market outlets. However, the quantity of products they can sell is often low. And during monsoon season the roads are bad so it may be difficult to get the products to the markets. These barriers for the marketing of products contribute to the vulnerable situation of the population through the limited opportunities for income-generating activities.

5.3 Adaptive capacity

Some measures carried out by the population in the face of the challenges mentioned above, have appeared as necessary in order to get a crop at all. For example, during the years when rice fields dried up due to delayed rainfall, farmers in two of the project villages were forced to grow black gram and millet instead of rice. Many winter crops were not grown, and in one of the villages maize was cultivated in late May instead of April. Millet sowing was postponed for two months, and wheat sowing was postponed for one month due to less winter rain.

As mentioned under the Tigray case, the capacity to adapt to climate change varies between individuals and groups. Also in the Nepal case, for example women, orphans or elderly without support are probably lacking several of the adaptation options that may exist for other groups. This may be true both for the resources people have within themselves, for example in terms of literacy, as well as resources they have access to, like land, cattle or equipment/ technology. It is difficult for poor people to explore new practices for adaptation to changing climate conditions.

The population in the project region has knowledge and skills in agricultural activities like planting, sowing, harvesting, processing, animal husbandry, food processing and storage, and fish farming, although the transfer of this knowledge to the youth has been reduced. Some traditional knowledge for maintaining local biodiversity still exists, but the passing of this knowledge to younger generations has also been diminishing. According to project staff, the school curriculum also lacks focus on management of natural resources and climate science, and is theoretical and often non-applicable to poor households. Information on crops and biodiversity, wetland conservation and other issues that may be useful for farmers mainly comes from radio, magazines and television, which mostly reaches rich farmers. But the District development committees and Village Development Committees also provide some conservation-related information.

In the project area important livelihood assets are agricultural land, agricultural biodiversity, farm animals, water wells, rivers, ponds and lakes, forests, wild plants, roads, access to some markets, local varieties of seeds, many of which are threatened by climatic and non-climatic factors, as explained in the previous sections. Irrigation is facilitated on 8% of the cultivated land in Tanahun district, while approximately 25% is irrigated in the Kaski district.

Other resources in the area are community groups. Around 50% of the households in the four villages are now affiliated with at least one local farmer group or community based organization, stimulated by support from donors and civil society. Saving- and credit-schemes exist in these groups for lending money to poor and needy households at low interest rates. The adaptive capacity of the population probably benefits from the many local, national and international organizations working in the villages, implementing development programs. However, not all interventions are unproblematic, as exemplified by the agricultural transformation mentioned above, which contributes to increased vulnerability to climate variability and change.

Migration to cities and other countries, particularly the Gulf countries is popular among rural youth, and they can get work there despite low education. In many cases this gives a positive contribution to the economy at home through remittance. At the same time, the migration has led to labour shortage and it has become more difficult to adopt organic farming and other more labour intensive but less capital intensive practices. Two villages reported to have 20-30% of land without crops due to labor shortage. Some of the dreams and hopes for the future among poor people in this area are prosperity and a better life, meaning better education, health facilities, economic prosperity and lasting peace.

5.4 Development Fund-supported work with rural poor in Nepal

The activities of LI-BIRD are focused on poor and marginalized farmers with small land holdings, and aim to increase the choices of these farmers, in order to give them more options and opportunities for improving their livelihoods in the context of both climatic and other stresses. We will here discuss the potential of these activities to protect poor people from climate risk, reduce the vulnerability and increase the capacity to adapt to climate variability and change.

Organic, innovative techniques in growing of crops and animal husbandry

Organic farming is one of the main activities in the project. It can improve soil fertility through the use of bio-pesticides and compost manure, and reduce the excessive and haphazard use of chemical fertilizer and pesticides. These solutions also require less investment. In-situ manuring is used, which means keeping livestock in the field after harvest or in fodder-deficit periods. The project implemented activities for cowshed improvement for compost and slurry management. 500-liter plastic drums are used for making bio-pesticide and bio-manure. Vermi-compost is used for landless farmers without livestock, and it is useful for kitchen gardens. Use of green manuring and leguminous cash crops also improve the soil fertility and income. The soil management using organic farming techniques increases the robustness of the soil towards wind- and water erosion and other damages from climatic stress. Diversification of gardens and crops has the potential to provide additional income and improve nutrition, and reduces risk of crop failure as a consequence of climate variability and change. Bee keeping, goat-rearing and bag-weaving are other income-generating activities developed in the project, and many of these activities are relatively robust to climate stress.

Agricultural innovations are encouraged through technical and material support, in order to increase the capacity of the farmers to

implement innovative practices. These activities are clearly relevant for climate adaptation, through reduced risk of climate impacts, and an increase in the capacity to respond to changes. Among the innovative solutions in the project is vegetable farming in tunnel houses (simple green houses made of local material and plastic covers) to be able to produce vegetables off-season, but also to protect the crops against adverse weather. Fodder trees are planted to cope with the invasion of new grass species, and rainwater harvesting is carried out by building water conservation ponds which collects water during the monsoons. Waste water is collected and used in irrigation, and in one of the villages, drip irrigation is adopted in vegetable farming. This technique saves water compared to bucket irrigation, improves yields and reduces the risk of losses during droughts. Coffee needs rain for flowering, and farmers sprinkle water on the coffee trees to induce flowering when rain fails to come in the flowering season. They also sprinkle warm water in nurseries to maintain heat and spray ashes around nurseries to control ant-attacks. Hanging nurseries are constructed in order to control pests and save seedlings from frost, weeds, fungus and red ants. Investment is made in small livestock (goat, poultry farming), which is easier and less labor demanding than cattle. In the village Chaur, there is the planting of useful trees[1] and broom grass on uncultivated public land, due to loss of forest biodiversity. These plants have started to produce income. Many of these activities are typical examples of measures that can reduce the risks of climate impacts on crops and livelihood assets. However, they can also at the same time be useful in order to increase the ability to innovate, to develop the agricultural activities in new ways and improve incomes, thus increase flexibility and the capacity to handle increased climate stress.

Further examples of agricultural innovations can be mentioned. Potatoes are cultivated on heaps of soil and mulching practices are used to reduce the loss of soil moisture. Farmers are constructing supporting walls and planting vegetation barriers to avoid soil loss (such as planting broom grass, mulberry, and Napier grass on sloping lands and roads). Drainage canals are dug to check soil loss from intense rainfall. Check dams, trail improvement and vegetation barriers are used to control gully erosion. Alternative energy sources such as bio-gas are used in order to save firewood and are also useful for sanitation. Growing techniques that require less water are developed, and a "diversity kit" is given to the poor farmers, containing seeds from a variety of fruits and vegetables. Training and exposure visits are important in the project in order to assist farmers to try new solutions for farming and value-adding and reducing crop failure and loss. Rising awareness on the value of biodiversity is made possible via radio, food fairs and educational programs, including information on the nutritional value of local species like finger millet and buckwheat.

Lately Nepali farmers reported that the number of pests has increased with a rise in average temperature. By installing hanging nurseries elevated from the ground the damage from pests was reduced. These nurseries also save seedlings from frost, weeds, fungus and red ants.

These activities exemplify ways of reducing climate risk and increasing the capacity to adapt to climate variability and change by increasing the flexibility and robustness of income-generating activities and improving food security in the context of climate stress.

Market development

The project activities include promotion of local products through attempting to create demand amongst consumers for new types of crops and locally processed products as part of the work to rescue the diversity of local farm plants and increase food security and income generation in resilient ways. The income-generating activities like production of local crops, crop seeds, including vegetables, cereal crops and mushroom are useful for the farmers involved in the project and are adapted to local climate conditions. Different types of bean seeds are sold as quality seeds at a premium price. In two villages most of the farmers increased the production and sale of crops like ginger, black gram, perilla, buckwheat, soybean, taro, and lentils and other vegetables. Some poor farmers, including women farmers have become employed in collecting the products from the sites and transporting and selling them in the market. It has been difficult for farmers to obtain reasonable prices for their products due to market complexities, lack of infrastructure and services, and low volume of production. Organic products have higher market value than conventionally grown products.

Technical and financial support, institutionalizing the activities, addressing local inequalities

Agro-information and collection centers have been established in three villages, providing knowledge, technology and guidance to farmers. Farmers visit the center and get information, and there is also a meeting room and collection of products for marketing. The project has initiated revolving funds, and community based institutions are able to take the activities further. These institutions are still influenced by local power relations, as the leader positions in the community groups are held by males and high caste Brahmin and Chettri-people. Poor and Dalit households participate only to some extent. In one of the groups, the entry fee for the latter was lowered after pressure from the project. The community groups initiate a number of livelihood based activities. Some farmer groups have invested in activities that support Dalits and landless groups, by leasing land for them. The project supported them with seeds, and they produced crops for their own consumption and for sale. Extra funds for these groups were also received from donors. In places where no community groups existed, the project formed new groups, and in other places, they strengthened existing groups. These community group activities ensure group cohesion, build community level support and act as a kind of insurance system to help poor and marginalized communities to cope with climatic stresses, shocks and losses. In some villages, Dalits are not affiliated at all or have low participation. The groups lend money to poor

1 *Harro (Terminalia species), Barro (Terminalia species), Amala (Implica officinalis)*

In Nepal vegetables are produced for self consumption and the surplus can be sold at the local market. This reduces the farmer's vulnerability to stress by providing an additional income as well as ensuring a nutritious diet for the family.

and needy households with low interest rates. The capacity to adapt to climate variability and change can be increased for poor people through these activities, although there is a danger that some of the most marginalized people do not benefit from the activities in some places.

Participatory plant breeding

The biodiversity on farms is threatened by many different factors, as pointed out above. The farmers in Begnas village asked the LI-BIRD project for assistance to reintroduce local varieties and landraces of rice. They were motivated by the gradual yield decrease and disease and pest outbreaks in the modern varieties released by the government, and they needed good yielding varieties that were healthy, less dependent on fertilizer and pesticides, and adapted to the local climate conditions. Participatory plant breeding was started in order to improve the local varieties through the conservation and use of local biodiversity of farm plants. The use of the local biodiversity in the breeding process, and the fact that participatory plant breeding is carried out in the farmer's own fields, facilitates the development of seeds that are adapted to local climate conditions, variability and change as also explained in the Nicaraguan case above.

As part of the participatory plant breeding activities, a community seed bank was established, and 69 rice varieties were collected in this bank. The farmers analyzed their characteristics and selected 8 varieties for further improvement, based on the farmers' preferences and knowledge. One of the varieties, Mansara, had good drought tolerance, early ripening, low fertilizer input and suitability for delayed monsoons, but had some negative characteristics like low productivity and lack of good taste. It was therefore crossed with a selected modern variety, and a new variety was developed.

In conventional plant breeding, the breeding is carried out in research institutions, creating few, but high-yielding varieties for broad dissemination. Some of them are bred with the aim of providing drought resistant seeds, but they are still not adapted to diverse, local climate conditions and ongoing changes. Moreover, such conventional high-yielding seeds often have the disadvantages of high fertilizer, water and pesticide need. Local, participatory plant breeding, as presented in the case from Nicaragua and in this case from Nepal, can bring the advantages of plant breeding without also bringing these disadvantages of many conventional high-yielding varieties. In addition to giving increased yields, the locally bred varieties are well adapted to local conditions, including the climatic. The local, participatory plant breeding is also an important incentive to maintain the local biodiversity in agriculture, which is important

in order to be able to be flexible in the choice and composition of crops, and to keep the genetic diversity that makes it possible to breed plants with the desired characteristics. Furthermore, a diversity of crop species and varieties in the fields is an insurance against losing the whole crop during difficult weather conditions, since some of them will stand the conditions better then others. Participatory plant breeding is thus a method that can reduce the vulnerability of the farmers to climate variability and change. It reduces their dependence on commercial seeds and other inputs, a dependence that puts them in a vulnerable position. It also reduces the risk of losing crops in adverse weather events, which is crucial in the context of increasingly extreme weather events and expected, continuing climate change. As a result of these advantages of participatory plant breeding, losses can be reduced and incomes increased. The capacity to also undertake other responses to climate change can thus increase, especially if awareness and knowledge about different options are available, which this project contributes to.

The seed bank promotes conservation and use of local genetic resources, and gives access to seeds for poor and marginalized farmers after crop failure and when they face seed shortage, thus reducing the vulnerability to crop losses. Some local crops and species are conserved through value addition, product diversification (for example cookies, biscuits, flour and bread from finger millet) and marketing. There are several neglected and underutilized local agricultural plant species and lack of awareness of their nutritional and economic value. Buckwheat is used in new ways, for example young tender shoots are used and sold as green vegetables. In these activities there is sharing and exchange of information about how to manage newly introduced crops. Farmers of the village Lekhnath are managing more than 60 local landraces of important crops and medicinal plants for their livelihoods. One farmer, Mrs. Lal Kumari Thapa manages 120 species of non-timber forest product and makes ayurvedic medicine. She is providing medicinal support to the villagers and spreading knowledge on the use of medicinal plants. Also these activities can contribute to reduced climate risk and increased resilience of local livelihoods to climatic stressors because of the increased ability to benefit from the unique characteristics of a range of plant varieties thriving in local climates.

5.5 Conclusions, Nepal case

Although many vulnerability factors are not possible for the project to change, and climate risks in the Nepal project area are high, these project activities can increase the number of options that poor people can use to respond both to the climatic and non-climatic challenges they face. Knowledge, awareness, sustainable management of local biodiversity, equipment, value-adding, financial support and organic agricultural techniques both reduce the risk of climate related losses from farms, and increase the capacity and flexibility to adapt the income-generating activities to the very variable weather conditions.

LI-BIRD points out that an important success factor for the project is high participation of communities. Several of the activities were also allowed to continue during the Maoist revolt due to the goodwill of the organization and the pro-poor nature of the activities. According to the case study, the project has capitalized the existing knowledge and resource base by promoting local knowledge and farmers' innovations, and the livelihoods diversification has reduced vulnerability to a wide range of shocks and stresses, particularly for poor and women farmers. However, LI-BIRD also points out that there is a significant need to create more opportunities for income generation for the poor. Also health and

sanitation, basic infrastructure like schools and roads, irrigation and other needs should be covered, and the project is not able to support all these needs. Furthermore, there is demand for processing plants and investments in high cost materials for processing and packaging of products in order to increase the market opportunities for the farmers' products.

6 TOWARDS SUSTAINABLE ADAPTATION IN DEVELOPMENT PROJECTS

There is still limited knowledge about the types of operational measures that are needed for integrating adaptation to climate change in development activities in a manner that can meaningfully address the enormous challenges ahead (Gigli & Agrawala 2007). There are currently many initiatives to develop adaptation strategies, including development project screening tools, but they focus largely on risk reduction and management, and pay less attention to the underlying causes of vulnerability and potentials for transformations towards more resilient local communities (Klein et al. 2007). In the following sections, we present six guiding principles that should be considered when addressing adaptation. These principles may serve as guidelines for integrating climate change adaptation measures with poverty reduction projects and programs. The suggestions are based on the cases presented earlier, as well as empirical literature.

Sustainable adaptation involves thinking about climate change in a different way. It is not simply an environmental problem that can be solved through managerial efforts, but it is closely related to development pathways and must therefore be addressed in a comprehensive manner. Below, we consider some general principles that draw upon different facets of climate change adaptation. First, we emphasize the importance of incorporating adaptation into broader development efforts, instead of planning separate climate change adaptation projects. Second, we point to the need for basing adaptation activities on sufficient understanding of local livelihood strategies and contexts, and how these relate to local climate variability and change. Third, we discuss the important role of knowledge systems as a basis for promoting diversity in livelihood strategies in the context of variable and changing climate conditions. Fourth, we underscore the need for identifying and addressing barriers to sustainable adaptation. Fifth, we emphasize the usefulness of identifying and spreading good examples, especially through South-South learning. Finally, we highlight the fact that very significant changes in the climate are expected in the future, even if drastic actions for mitigation are initiated, and we stress that development practitioners and policy planners must think beyond already-observed climate variability and change when planning for adaptation.

6.1 Adaptation as part of development - but not any type of development

The analysis in this report emphasizes the importance of carrying out climate change adaptation as part of broader development measures, and not as isolated climate adaptation policies or projects, as pointed out by Eriksen et al. (2007) and Schipper (2008). An important reason why the projects supported by the Development Fund have relevance for adaptation is that they address some of the central development challenges facing populations, and consider ways that climate conditions influence these challenges. The fundamental problems of poor households are being addressed, their capacities are being strengthened and new opportunities are being developed.

Still, it must be noted that even a development-based approach can be misdirected if it does not take into account local climate and environmental risks, the factors that contribute to vulnerability, and differing capacities to adapt to change. Furthermore, development measures and processes that damage ecosystems or drive poor people away from their land, such as privatization of land for large scale biofuel-production or building of large dams, risk increasing vulnerability of the poor by undermining their livelihoods and their capacity to respond to shocks and stresses. Development directed towards economic growth, but lacking environmental and social sustainability may increase vulnerability (Eriksen et al. 2007, Leary et al. 2008). In fact, as mentioned in the introduction, climate change adaptation measures may in some cases increase vulnerability for some groups. For example, excessive water pumping for commercial agriculture may lower the ground water table and make it more difficult for poor farmers to extract water with small pumps or access water by digging wells.

6.2 Sufficient understanding of the local livelihood strategies and vulnerability

The adaptation literature emphasizes the importance of understanding local contexts in order to see which types of measures can increase the opportunities of the population to respond to threats and challenges (Eriksen et al. 2007, Eriksen & O'Brien 2007, Leary et al. 2008). Such an understanding makes it possible to make use of existing strengths and opportunities and to design measures that support poor people in their own efforts. Methods similar to those used to collect data from the three projects in this analysis can assist in the effective and systematic examination of local contexts when planning development activities. In addition, local organizations and the people who are addressed by development projects must be partners in the design of measures. Creativity, innovation and a diversity of solutions are useful both for development and adaptation.

Sustainable adaptation has important geographic aspects, because each place and region is formed by specific developments that have shaped the capacities, values, and resources existing there. Climate changes will also manifest differently in each local contexts. In addition, there are many possible paths for sustainable adaptation, even in similar types of contexts. Large-scale adaptation projects implemented by international NGOs as well as governments may fail to obtain sufficient knowledge on local needs, opportunities and barriers that should be removed, and instead of supporting local efforts they may create hindrances and overrun local civil society. For example, local opportunities can be hindered by conservation of nature areas in ways that exclude the population from any use of the resources in the areas instead of facilitating and encouraging restoration and protection through sustainable use.

Perceptions of climate risk

Climate is something everyone can relate to and in many cultures there are strong linkages between weather, livelihoods and identity. Climate change is somewhat more difficult to grasp as it refers to changes in the climate over longer time periods that are linked to activities taking place in distant places that will have implications for both present and future generations.

Past and current climate stresses were considered in the analysis presented in this report by looking at people's subjective experiences of climatic events. Such perceptions of climate are important for showing how people have been affected by the climatic conditions in diverse ways, which is a key to adaptation analyses. The outcomes of climatic events depend not only on the meteorological qualities of extreme weather conditions, but on societal factors that influence people's experiences and their ability to respond. Thus, although a drought might have serious consequences for some, others may perceive relatively small consequences. The context in which climate change is experienced influences the outcome, as much as the event or change itself.

Without information about what people have experienced, and how climatic events have interacted with other events and changes, the diverse consequences of climate change are difficult to understand. For example, elderly people can report information about environmental and social changes several decades back in time, and are therefore a valuable source for information. Although there may be a tendency to view the past as better than it actually was, the major climatic and societal events that the communities remember are in all likelihood the ones that have affected them the most. Such experiences are important to learn from in order to understand how and why people were affected, and can thus support sustainable adaptation to climate variability and change.

This also has implications for the use of climate change scenarios in anticipating and planning for future climate challenges. Better models and higher resolution scenarios are needed, and there is particularly a need for improving projections of seasonal variability and extreme events. However, in recent years, the notion of "climate prediction first and then adaptation action" has been questioned. Some suggest that long term climate predictions may not be the right starting point for addressing adaptation because climate is just one of many stresses that are triggering responses in human systems (Dessai et al. forthcoming) Instead, it has been argued that adaptation decisions should be informed by a range of plausible climate projections, where uncertainties in the scenarios are made clear. Thus climate change scenarios can help practitioners and decisions makers to consider a plausible range of climate outcomes.

Nepali farmer Toran Bahadur experiments with tomato produ vegetables. This innovative farming technique creates more

ction in a tunnel green house. The tunnel ensures higher yields of predictability and economic security for the farmers.

Activities based on poor people's reality and aims

The activities promoted in the three Development Fund-supported projects are based on an aim to understand, extend, strengthen and influence indigenous strategies for food security in the local social, economic and environmental context. Cooperation with local partners has facilitated a good understanding of local factors. The projects have introduced improvements and knowledge that seem to fit well with the existing human resources, livelihood opportunities and knowledge systems, and local natural resources and climate. Environmental sustainability is seen as an important element to secure and improve local livelihoods. Self-reliance and dignity have been promoted, and farmers are proud of being able to develop their own types of seeds and feel satisfied and more in control over their own situation. It is likely that the projects have continued in directions where people themselves are heading, which ensures motivated participants in the different activities. Nonetheless, the projects and local people could possibly also work together with local governments in order to develop a social security system for the most vulnerable people, and in other ways attempt to change the policy context for poor people's livelihoods.

Furthermore, good quality education and health care for all emerges as a major factor for reducing vulnerability, but the question is how it can be translated into reality. Governments in rich and poor countries, multilateral finance institutions and international NGOs can influence policies in these fields, as they have in the past, when developing country governments were under pressure to reduce public services under structural adjustment programs promoted by the World Bank and the IMF. Some movement can be seen in the opposite direction today, as in Kenya, where primary school education has recently become free.

There are large inequalities and deep rooted power struggles between groups in many local communities in developing countries. The projects have attempted to empower the poorest and most marginalized groups, as for example in the Nepal case, where Dalits have in the past been excluded from many of the opportunities and social networking activities available to more powerful groups. Here these relations were addressed and altered, for example by advocating that community groups give Dalits special support in leasing land.

The projects have also carried out other capacity building activities in order to change some ways of thinking amongst the population, for example on gender relations, rights, work culture and health. These are initiatives which can increase the capacity of vulnerable groups to improve their own situation, economically and socially. Also, such activities towards awareness-raising are probably more likely to be successful if they are based on an understanding of the local issues as well as combined with the increased opportunities for income generation.

Farmers techniques and innovations

Examples of modernization or innovations that are locally embedded are found in the Nicaraguan and Nepalese projects, within participatory plant breeding. Farmers have a long tradition of improving varieties of plants, and the development projects extend and upgrade these activities and the related knowledge, both in order to rescue the declining diversity and to improve the plant breeding practices with advanced plant breeding techniques. Another example of farmers' innovations based on local knowledge and practices is found within the provision of fodder for animals through "cut and carry systems" as explained in the third chapter of this report. The cultivation of fodder trees also represents important improvements for poor people in Tigray, not the least for women, who are able to improve their economy through goat keeping. The innovative development of the seed bank concept and credit schemes are also very useful because they are well adapted to local needs. Another example of people's contributions to new solutions is the way that resources within enclosure areas in communal land are negotiated and decided by local groups in the Tigray project area, ensuring that people take turns in access to the grass, wood, water and other resources that can be fetched there. These are locally based, innovative activities that reduce climate risks and increase the capacity to adapt to climate change.

6.3 Understanding a diversity of knowledge systems

As part of the required understanding of local contexts, as well as barriers and opportunities in poverty reduction and in climate change adaptation, it is important to be aware of local knowledge as a resource that can be positively utilised. Local knowledge is an important basis for learning in a local community, and for the development of new knowledge in cooperation with local actors and academic institutions, NGOs and local, regional and national governments. Failure to relate new knowledge to existing knowledge and practices will risk being perceived as irrelevant for poor people and can also be useless for them. It can reduce the opportunities for creating local ownership in processes of change, and can ignore and waste useful and important knowledge about local contexts and opportunities. An important task for poverty reduction projects and programs is to consider how local knowledge and technology can be used in the projects in order to be added to in relevant ways, and to contribute to sustainable adaptation.

Poor people are experts at coping with and adapting to prevailing circumstances, and they use a variety of strategies and types of knowledge in order to attempt to cover their basic needs and live a decent life. Local strategies and knowledge have their limitations, and are not sufficient for reducing poverty, due to a range of constraints and structural barriers that contribute to maintained poverty. In addition, existing strategies and knowledge may have limitations under circumstances of increasing climatic changes occurring in parallel with factors such as rapid demographic and socio-economic changes, loss of biodiversity, soil degradation and increasing water scarcity (Næss 2005). However, this does not mean that these strategies and this knowledge should be abandoned. Instead, new, relevant knowledge can be added to existing knowledge; the options for income-generating strategies can be strengthened and widened, and the barriers for such strategies can be identified and addressed. As pointed out by Eriksen et al. (2008, page 15), one of the reasons that indigenous strategies are inadequate is the fact that they largely have to operate without any formal government support or facilitation: "The local knowledge, networks, customary institutions and local biodiversity that are used for coping are often ignored by the formal financial, technological and institutional framework of most countries."

Ignoring local knowledge can lead to the loss of important information about factors and processes that create vulnerability and adaptive capacity. Development projects then risk increasing people's vulnerability, instead of reducing it. Although it is

commonly realized that livelihoods of poor people should be considered in poverty reduction efforts, there is often insufficient understanding of people's problems, as well as the strengths and the potentials of local livelihoods (Eriksen et al. 2007).

In the projects analyzed in this report, many measures build on local knowledge and strategies or are relevant in combination with these. The local knowledge and strategies are supported by the introduction of new knowledge and equipment that extend the opportunities for getting more out of local practices, livelihoods and natural resources in sustainable ways, thus increasing the opportunities for income-generating activities and improving the quality of life for people. This can be seen as a type of modernization that explores alternative and sustainable development paths that are embedded in existing human and natural resources. An adaptation measure related to local knowledge in combination with introduced, but locally useful knowledge could influence school curricula to provide crucial knowledge for local food security and livelihood options, including marketing, small business training and technical training. As pointed out in the Nepal case, school curricula are very theoretical and less relevant for the local knowledge needs. In general, the inclusion of local knowledge in government policies remain limited, and local knowledge is often neglected (Næss 2005).

Promoting diversity and innovation

Many of the development pathways which may be useful for poverty reduction and sustainable adaptation to climate change are not based on mainstream knowledge systems or mainstream technological systems. As parts of new and emerging socio-technical systems, they may in fact question existing social structures, infrastructure systems and institutional arrangements (Rohracher 2006). There is also a continuously developing potential to find new ways of combining local livelihood strategies and modern technologies. Many technological solutions exist and develop with relevance for poor communities, both technologically complex and simple, but many of these are not well known, or they are not considered interesting by governments and donors because they are not seen as useful for national economic growth. There is also a fear of immature technologies, and also failure to study existing experiences properly and learn from them.

From a broader perspective, the current domination of well-established and stable, but unsustainable socio-technical systems or paradigms hinder not only mitigation of climate change, but also adaptation needs. Many alternative solutions exists, and have been under development for some time for social, economic and environmental reasons. Examples include decentralized, locally adapted energy supply, sustainable agricultural systems, modern and efficient public transport, ecological sanitation, climate-adapted and ecological architecture, low energy and passive houses, as well as energy producing buildings. Climate adaptation may be seen as another reason for putting more emphasis on such solutions.

In the planning of sustainable development and sustainable adaptation measures in poverty reduction efforts, innovativeness needs to be facilitated in order to improve food security and create alternative employment. Access to diverse solutions gives options for choice, which is important for adaptive capacity and flexibility, and many different types of knowledge and technology are necessary for the innovative use of ecosystem services. For example, it may be necessary to increase the diversity in energy-, water-, and sanitation-technologies and production technology, and it may be useful to think very broad about food production, food security, agriculture, and employment. In the analyzed projects, useful knowledge has come from organic agricultural techniques, the use of valuable trees on farms, the diversity of farm animals, the use of a range of solutions for collecting, storing and using water, the biogas systems for cooking fuel, the participatory plant breeding, the development of sweet sorghum type which can replace maize for tortilla baking, and other such options which would not have come to mind to many policy makers and development practitioners if they were not aware of their existence. Although these are small and seemingly trivial details, they represent parts of larger socio-technical systems based on fruitful society-nature interactions where society couples itself onto the circulations of nature. Ecotourism can be an option in some areas, as well as the use of forest by-products for handicraft in tourism areas. Training of youth in handicraft and for tourist guiding can be relevant in some places, and youth should be informed and included and given leadership in activities attractive for young men and women, as suggested by the Nicaraguan Development Fund partner, CIPRES.

A method for the restoration of degraded areas and improvement of income for poor people is the analogue forestry method which is used in a project in Sri Lanka implemented by Future in Our Hands and supported by the Development Fund. The aim of analogue forestry is to establish an ecosystem analogous to original forest in degraded, barren areas. In addition it also seeks to strengthen rural communities socially and economically through the species that provide commercial products. High trees provide shadow and protection against intense rainfall and erosion, and different crops are planted below the trees, such as pepper, coffee, cardamom and others. The trees planted have either ecological or economical functions or both. Poor farmers, many of them women, have received income through these multiple cropping systems, and the success of the methodology provides a good example for other farmers than those involved. Also, soil moisture has been improved and dead streams are functioning again.

Engage new types of experts in poverty reduction projects

Projects similar to those supported by the Development Fund could serve as openings for cooperation with new actors, such as organic fair-trade marketing companies and agricultural certification organizations, in addition to the agricultural experts typically involved in such projects. Building-up local, regional, national and international markets for products that poor farmers can produce can provide new livelihood options under changing climate conditions. Technical and academic knowledge on how such solutions can be organized and become embedded in societies are among the types of expertise that could contribute to sustainable adaptation. Relevant research environments investigating social change could be engaged in action research activities to understand opportunities and barriers and to suggest implementation strategies in cooperation with development practitioners, government actors and communities.

Some of the same experiences and principles that have been applied within the three projects or discussed in this report could be useful for promoting sustainable adaptation in slums and poor areas in or around the big cities. Such activities would not solve all problems of the slum dwellers, but could contribute to rehabilitating soil and vegetation, planting of diverse, useful trees and cleaning up of rivers. In this way, poor people in these areas could take greater advantage of the natural resources in their home areas, including

Afar women make straw mats for house construction and for sale at the local markets.

water sources, and health problems could be reduced. Gardening to grow vegetables and fruits, raising small animals, producing firewood or using smart energy for cooking, establishing small businesses, market development and processing of fruits are among the relevant activities. In addition, ecological sanitation, biogas and manure techniques may be interesting. However, in urban areas it is nonetheless crucial that the underlying causes of poor people's vulnerability are addressed.

Efficient, locally adapted energy supply

Improved systems of energy supply for households, such as sustainable production and use of charcoal, use of biogas, or sustainable provision and use of firewood, can increase adaptive capacity by improving the income opportunities for poor people and reducing vulnerability by reducing workload and health problems, especially among women and girls. According to a recent NORAD report by Angstreich & Jackson (2007), women's status and economy have benefited from the efforts on efficient wood and charcoal stoves implemented by TaTEDO in Tanzania. Such activities can also conserve and develop forests and farms for provision of wood, food and other non-wood products, contributing to healthy forests which again contribute to reduced risks of landslides, erosion and degraded water sources. Supply of electricity, if implemented in ways that benefit the poor, can reduce vulnerability and increase adaptive capacity by improving health facilities, education, income generation, water supply and communications. Decentralized electricity systems can reduce the problems of remoteness from central grids, supply problems and black-outs, and transform local climate and environmental conditions into energy resources. For example, bountiful sunshine conditions can be used through solar cell systems, and modern bio-energy electricity generators can be used in areas where plenty of biomass can be grown or harvested without affecting food production. Thus it is important to choose the types of energy technologies which are well adapted to local climates, natural resources and the social and economic context. Governments, international organizations and the private sector can contribute to improved access to a diversity of energy supplies by increasing the number of alternatives available in each place.

Conscious implementation

The introduction of technologies requires social innovations, including models for how to organize and implement the changes, and social innovations often require new technologies (Hoogma et al. 2002). In order to be successful in the implementation of technologies, even if they are small and simple devices for food drying or cooking, implementation processes have to be carried out in very conscious ways, based on already-existing experiences. The risk of failing with technology projects is, however, always present. To minimize this risk, technological improvements should not be technology driven, but development-focused and integrated with job creation, infrastructure development, communication development, health, education, market stimulation and agriculture (ESMAP 2005). This is also true for electricity supply from a conventional grid. If nothing is done in order to make the electricity useful for improvements that are important and affordable for the poor, they are likely to get few or no benefits from electricity gridlines passing through their neighborhoods, as in the example from the Nepalese project sites. If issues for implementation of technologies are considered, technological changes can contribute to increased adaptive capacity and resilience to climatic challenges.

Bread making on a traditional stove in Tigray. The bread, called injera, is an essential part of the traditional Ethiopian cuisine. Women in Tigray can earn an extra income by selling injera at local markets.

It is often important to develop systems for financing, training, maintenance and repair of equipment. For example, in the Nicaragua project, the farmers were trained in the production and use of biodigesters and taught how they could reduce the use of firewood and the smoke in kitchens. CIPRES provides the materials for the production of biodigesters. The activities around treadle and motor pumps as well as the biogas systems for household cooking in the projects supported by the Development Fund provide useful learning on how new technologies can be introduced in ways that benefit people and become embedded in local economic, social and environmental contexts. As will be mentioned later in this report, the transfer of experiences between contexts also has the potential to promote learning that makes processes of social and technological change easier. Learning-related failures will thus not have to take place in each new context.

Mrs. Ghanawathi in her analogue forest in Sri Lanka. Analogue forestry is an attempt to reproduce a forest with all its natural functions and components on a smaller scale. Analogue forestry secures local biodiversity as well as generates income for the farmer.

Understanding the difference between agricultural knowledge systems

Agricultural philosophies and knowledge systems are highly relevant for the livelihoods of the poor and also for future food supplies and biological production for the global society. In the poverty reduction strategies supported by the Development Fund, the insights in sustainable, organic agricultural approaches influence the work, which differs from conventional, mainstream approaches to agricultural development in the South.

Measures aimed at better food security can influence people's opportunities to live with climatic stresses in both positive and negative ways. For example, food security measures can positively or negatively affect the dependence on specific weather conditions, water availability or global food prices. Some food security measures can risk increasing vulnerability instead of reducing it. In Malawi, Norway-supported sustainable livelihood projects have been reviewed by Bie et al. (2008), who points out that production-oriented interventions such as specialized maize production at the expense of other crops like sorghum, millet, legumes and vegetables may make the farming systems significantly more vulnerable to adverse weather. They recommend measures such as diversification, specifically for vegetables, including leguminous, nitrogen fixing plants and fruits to address high malnutrition levels prevalent in the project sites and diversification into small livestock production if properly managed – including promotion of fodder crops. These suggestions are supported by the experiences in the analyzed projects in this report.

Another example, also from Malawi, describes productivity increase in agriculture with conventional methods (Human Development Report 2008). Successive droughts and floods destroyed substantial parts of the maize harvest in Malawi in 2005, and a large number of households had few resources to invest in input for the next season. A donor-supported government program started to distribute and sell subsidized fertilizer and maize seed, and the subsequent harvests showed that good rains and modern crop varieties raised productivity and output. However, such specialized maize production based on bought inputs is also at risk to adverse weather conditions and fluctuating deliveries of inputs, as shown in the Nepal project, and in the study conducted by Bie et al. (2008). Moreover, the high-yielding seeds are usually more dependent on irrigation, pesticides and enough fertilizer. In the Nepal project area, an NGO in the project area as well as the government extension service promoted new types of vegetable seeds and fertilizer as the solution to the problems of the farmers. According to the case study it appeared to be a hasty conclusion which created problems and vulnerability for the population, such as gradually declining production, loss of the local varieties of vegetables, and problems of soil structure and fertility. In addition, production costs were high, market access was limited, markets were uncertain, and farmers faced losses and bitter experiences.

Approaches based on monocultures and rationalization of farming often creates dependence on bought inputs, and often fails to improve food security for the poor. In many cases, debt-dependency is a serious problem and an important vulnerability factor. Moreover, soil degradation often results, as mentioned in the Nicaragua and Nepalese cases. In alternative approaches, people can become more self-sufficient with a diversity of seeds as well as compost and manure, and if they find it useful, they can add bought-inputs as a supplement. In Malawi, the subsidies have been irregular, and the consequences have been negative and serious for poor farmers when the program has been absent.

In addition, the results from the subsidy program in Malawi were not only related to the subsidies and the good rainfall, but also to the role of the state, the duty regime, agricultural policy adapted to the country, ability to negotiate with donors to get support, the agricultural cooperative organization, the public agricultural market organization, university- and research environments and access to weather information. Thus, an explanation of good yields which only mentions the provision of seeds and fertilizer is too narrow. Moreover, the program included not only subsidized sale of input, but also buying of crops from the farmers, securing them sale and income (Bjørn K. Wold, Bistandsaktuelt 25/3 2008, Sjaastad m.fl. 2007) Agricultural policy from governments and agricultural organizations is important in order to improve the opportunities for poor farmers, and in recent decades, there has been little focus on such policy.

Organic farming

The organic farming techniques promoted in the case projects, like composting, mulching, effective use of animal manure, intercropping, diversity in crops and use of nitrogen fixing plants are part of an alternative agricultural knowledge system, which has less economic interests behind it than the large, powerful agro business companies promoting conventional farming (Weis 2007). Organic agriculture protects the soil and increases the content of organic matter in the soil, thus reducing the risk of soil erosion during flash rains and storms. It also increases the ability of the soil to absorb water and maintain moisture (FAO 2006). Increased knowledge on these techniques would be useful for poor people engaging in agriculture, horticulture and backyard gardening, both in rural, urban and peri-urban areas. For many poor growers this gives increased productivity, and it happens without making them dependent on bought inputs. It can also increase diversity in diets and increase market opportunities.

Scientists, politicians and development practitioners need this type of knowledge in order to plan policies and projects for agricultural development, not least under climate change and increased climate variability. In addition, organically produced food, herbs, teas, coffees, flowers and materials can achieve higher prices in an increasing number of markets. Such markets are also emerging in the larger cities in the South, such as Nairobi. Organic production techniques and a high diversity in crops are critical for the poorest

6.4 Identification and understanding of barriers for change

and at the same time interesting for wealthier consumers.

There may also be a lack of knowledge on other aspects of food security, including the significance of a wide biodiversity in agriculture, on and around farms, and the value and income-generating opportunities of products from different types of trees that can be planted on farms and communal areas (Garrity et al. 2006). Opportunities also lie in market development for dryland products or forest products. The participatory plant breeding and other biodiversity-based agricultural activities in the three projects are examples of alternative ways of developing agriculture and food security and reducing the risk of climate damage on crops. Increased self-sufficiency, control, and independence are promoted through such activities. However, the changing climate is at the same time threatening positive achievements.

Cultivating sweet potatoes by organic farming in Tigray

Several barriers to sustainable adaptation emerge at different geographical levels, particularly in relation to on-the-ground efforts to start new, income-generating activities and change social and technical systems. The dominating systems for food, transport, energy, production and consumption are often strong and stable systems, while the emerging and alternative ones are not. Furthermore laws and regulations are often adapted to the dominant social systems and may hinder innovative livelihood options. It is necessary to be aware of structural and cultural barriers that appear when new solutions are pursued, particularly because of the inertia in such processes of social and technological change. Typically, established social systems are represented by powerful actors (e.g., government departments and officials, private businesses and other actors) who support and perpetuate the systems.

Structural barriers for poverty reduction and sustainable adaptation in the three project areas include the lack of transport opportunities to markets, few opportunities for farmers to get access to enough land for a livelihood, lack of public services, lack of adapted technologies, lack of relevant education for local work opportunities and the time it takes to develop markets for new products. Often, the barriers for adaptation activities are some of the same factors which made people vulnerable in the first place, such as lack of health-, education- and social security systems, import competition for agricultural products and degraded natural resources. Barriers can also be found at the local level, for example skepticism and criticism from neighbors, as seen in the participatory plant breeding project in Nicaragua. However, these neighbors were convinced by the usefulness of the plant breeding after some time, by observing the results in their neighbors' fields. Other examples of structural barriers for change at the community level include import competition due to subsidized exports from other countries that may hinder the development of local and national markets. There are large potential markets for agricultural products delivered from regions around the larger cities in the South, which could be important for small farmers, but local products may not be able to compete with imported products, and the farmers may have limited access to those markets. Another structural barrier is the lack of priority of decentralized, renewable energy solutions from many national governments and donors in the South, which may hinder the use of rural electrification funds for off-grid solutions in remote areas (Kirubi 2006).

A cultural barrier in the Nicaragua project has been the strong taboos around sanitation and handling of excrements in bio-digesters. It has been difficult for people to understand that the technology is clean and that there is no risk of contamination. There is lack of confidence in existing capacity and skills to use this technology. However, the families using the technology are nonetheless satisfied.

Other barriers to change can be found in the example of charcoal production among poor people in Kenya. The contribution from

charcoal to the Kenyan economy is comparable to the annual returns from tea exports (ESDA 2005). Charcoal production is an employment opportunity and adaptation strategy during droughts for poor people in areas where charcoal is in high demand among the population, as in many cities in Africa. However, only some of the charcoal is sustainably produced, and there is a huge potential for improving the efficiency of kilns, thus getting more charcoal out of the same amount of wood and replanting trees. These factors are strongly influenced by legal and institutional barriers hindering open, regulated and sustainable production and transport of charcoal in the country, creating corruption and hindering better incomes for the poor from this strategy (ESDA 2005, Bailis et al. 2006).

Lack of social capital

Lack of social capital can also be seen as a barrier for adaptation. Studies have shown that communities with strong social networks and the ability to act collectively are more likely to cope successfully with adverse situations, as these forms of social capital play an important role in securing consumption needs and protection. Networks have also shown to be important beyond securing the immediate needs of individuals and households. Ties across scale give locals access to resources, information and political power through engaging with state, market and other civil society actors (Warner 2001, Bebbington and Perreault 1999). This has also been the case in the Nicaragua project, where the practical activities in the project, such as the participatory plant breeding work, have been a starting point for the development of increased social networking.

Actors at different levels in different roles

The responsibility for, and the ability to remove structural barriers for poverty reduction and adaptation to climate change rests on many actors, such as governments, policy makers, and also national and international level organizations of different types, including development agencies and research communities. Where social and technical change takes place, there is typically interaction between structures and actors at multiple, geographical levels (Kemp et al. 2005). Different governmental actors and representatives of development agencies and international organizations can have different roles in processes of social change – some can be part of networks driving change, while others can be hindering change. Importantly, locally based groups and organizations have other types of knowledge than the other actors, especially about the local conditions, opportunities and challenges. As argued in this report, social changes need to be based on the understanding of local contexts and involvement of local actors. This is often not the case today, and poor people suffer for it. However, it can be difficult for local actors and individual development organizations to influence decisions in governments, large organizations as well as powerful business interests maintaining dominant socio-technical paradigms. Nevertheless, it is important for development practitioners to identify and create awareness of the barriers and attempt to find partners among other actors to cooperate to address barriers to climate adaptation in poverty reduction work. Development agencies can, together with local institutions, play an important role in identifying structural barriers and create actor networks, including the enhancement of vertical networks and scale-up of local efforts in addressing structural barriers.

6.5 Identification and spread of good examples

Among the capacities of all people, poor as well as rich, is the universal ability to learn new things. Poor people can learn from what people do in other places if they get the chance to go there and see, and to stay there for a while and learn, or to get information in other ways. They have the ability to assess whether those practices and types of knowledge are relevant for their own life and opportunities to carry out income-generating activities, and they have the capacity to adapt new types of knowledge and technology to their own context and thus innovate and develop ideas, practices and technologies in their own directions. As demonstrated in the projects supported by the Development Fund, it is very important that the farmers themselves participate in this process and learn to identify those elements of the new knowledge that are relevant to use in their own context. South-South transfer initiatives need to put this knowledge in the centre of the process as well as letting it be the basis for "up-scaling" of activities.

There is a large potential in South-South-learning for diverse social and technological innovations that can be part of sustainable adaptation. This is a potential that is not so well recognized by dominant actors within the development and poverty reduction communities or research communities. Success stories of social and technological change often remain small islands of experience unknown to people in other communities. It would be particularly useful to increase the South-South exchange of experiences on implementation strategies and how to overcome barriers, because these tend to be the most difficult challenges in processes of social and technological change.

South-South learning

There are some examples of learning across geographical contexts in the presented projects. Study tours by bus have been organized for women from Tigray in Ethiopia, to study the cultivation of root crops in other parts of Ethiopia and get access to the types of seeds that were used there. After studying the practices in other regions, these women spread the knowledge in their home area. In Nicaragua, the exchange of experiences is occurring on at different geographical levels. Seeds, products and lessons learned are exchanged between families, and good seed varieties, bred locally, are disseminated between local communities. New varieties of locally improved seeds are disseminated between regions in the country and between neighboring countries because they are resistant to drought and to the purple mosaic disease, and because they give better quality sorghum and beans in terms of taste, cooking time and yield of sorghum flour (more tortilla from less flour). The umbrella program Collaborative Programme for Participatory Plant Breeding in Mesoamerica facilitates exchange of experiences between countries in Meso-America.

Another example of South-South learning is the training of some African women and men at the Barefoot College in India, supported by the Development Fund. For six months these women study to become solar engineers and can work in their home villages to install and maintain solar home systems for basic electricity supply in households. Tukul village in Tigray received the first solar engineer, a woman, and the village has been visited by UNDP, NGOs and regional governments in Tigray and the model has been

In dry areas drip irrigation provide efficient use of water. Small hosepipes with tiny holes in them are placed out in the field, releasing small amounts of water on the plants.

replicated. Ethiopians from several districts have later completed the six month training. Also the Norwegian Church Aid NGO supports the education of solar engineers at Barefoot College (Agder Research 2002).

As the result of collaboration between organizations in Tigray and India, initiated by the Development Fund through the Triangular Project, drip irrigation techniques have been transferred from Gujarat in India to Tigray in Ethiopia, and it has spread in the new context. There is now even a factory in Tigray that is producing the equipment required for drip irrigation. The Triangular Project was a collaboration between two organizations from Gujarat, India, and two from Tigray, Ethiopia, with support from two organizations from Norway. The aim was to share experiences and build competence in innovative ways, involving both NGOs and research organizations. The funding was from NORAD through the Development Fund.

Another potential for South-South learning is within post-harvest-technologies. As suggested by Bie et al. (2008) such technologies for the drying of meat, vegetables and fruits could be considered for improved food security and for adding value to agricultural crops. Equipment such as simple solar dryers have the potential to improve the drying quality without creating dependence on other types of energy supply and bought inputs (like diesel) for drying. Relevant experiences from solar-drying business and private sector diffusion of equipment can be found by studying recent activities in this field, for example in Uganda and Kenya (Okolebo & Hankins 1997). In particular, women have benefited from the solar-drying activities. The experiences show that successful introduction of solar driers in Kenya and Uganda has depended on their ability to generate income for the users, and has been linked to markets for dried mangoes, pineapple and banana in

Europe, Nairobi and Mombasa.

Barriers to South-South learning include travel costs, lack of contacts, language barriers and lack of access to information on what is going on in other places. These barriers are pervasive in poor communities in the South. Furthermore, when trying to implement new ideas and solutions, the barriers to change mentioned in the previous section will often challenge the implementation process and the efforts to adapt new solutions to the home context. Development organizations have the opportunity to encourage South-South learning by identifying success stories, organizing and funding study tours, organizing courses, facilitating access to information, and initiating academic studies, including action research where researchers, practitioners and local population cooperate. They can thus analyze success factors in selected contexts and consider how these can be adapted and transferred to other contexts.

Reaching a large number of people

An important question is what policies can be implemented in order to reach a large number of people with facilitation and support for diverse livelihood activities, and whether community development measures, as exemplified in the Development Fund-supported projects, can be carried out at a larger scale. What are the potential dangers of extension and large-scale replication of successful local projects when it comes to the quality of the work? What important details and close follow up of households and communities are crucial to keep in mind when trying to upscale activities? How can context-specific needs in each local community be recognized and the most vulnerable groups included if measures are replicated in large scale programs, initiated by national governments and supported by donors? Such questions will be important to address in global efforts for climate adaptation in the years ahead.

Ethiopia, for example, will face tremendous challenges that are difficult to imagine, given that the population is expected to increase from 80 million today to 180 million people in 50 years from now (Alexander Müller, Assistant Director-General FAO, presentation, NORAD, 10.01.2008). The country also faces increasing scarcity and degradation of key resources as arable land, forests, and water, which contributes to increased vulnerability and makes adaptation even more difficult. The Development Fund project in Ethiopia demonstrates some activities which can be useful for development and adaptation to climate change, although many other measures will be needed. These experiences should be spread and adapted to new areas in the country and the activities further developed.

Local cooperation between governments and civil society

In Tigray, Ethiopia, there is a unique cooperation between the NGO REST and local and regional governments. As a result of the drought in 2002, REST started a massive implementation of ponds and shallow wells in Tigray, based on a comprehensive interdisciplinary study. The regional government has taken over parts of this work, while REST is continuing to develop the water harvesting techniques, including series of ponds, cisterns, etc. The water harvesting is a pilot activity for the rest of Ethiopia and has been important for the development of regional and national policies. This is also the case for the area closure efforts, where barren areas are protected, and allowing restoration of vegetation cover under the management of the local population. A government extension program also exists for farmers, which is adapted to local climate conditions and livelihood opportunities. Such extension programs are needed and can reach more people than small projects, and if they are further developed, they can be useful for broadening the options for rural livelihoods and at the same time reduce climate risks and vulnerability and increase the capacity to adapt to climate variability and change.

The experiences from the project areas on the promotion of sustainable livelihoods and in the context of climate variability and change could be integrated both in agricultural extension programs and in policy planning at national and regional levels. Such integration depends on what types of responses the government representatives are willing to take and how they cooperate with

Community meeting amongst Afars in Ethiopia. Active participation from all parts of the community is essential in order to change the social and environmental situation in an area.

and listen to local communities. Regional and local governments on the one hand and community groups and local NGOs on the other, often operate parallel to the local level. While political actors focus on laws and regulations and patronizing policies, the community-based groups often try to get around these in order to cover their needs. The political representatives often lack knowledge on the local conditions and the challenges and opportunities of poor people. They also often fail to recognize local groups or NGOs as partners for collaboration, and do no respect or protect their interests. For example, politicians may give land for the establishment of plantations (e.g., for the production of biofuel crops) along rivers and in areas highly needed for grazing in dry periods. According to the Development Fund, this lack of cooperation between governments and civil society actors at the local and regional level may be one of the most important causes of vulnerability in the face of climate variability and change as well as other stressors.

6.6 Future climate change and challenges

According to IPCC (2007) the already observed global average temperature has increased by 0,75° Celsius since temperature measurements were started in the 17th century (IPCC 2007). This has already resulted in reduced glaciers and snow cover, the sea level has started to rise because of warming of sea water and melting of glaciers, precipitation has increased in North and Central Asia, and drying is observed in the Mediterranean area, in Sahel, Southern Africa and parts of South Asia. More intense and longer drought periods have been observed for several decades, especially in tropical and sub-tropical areas, both as a result of higher temperature and reduced rainfall. Intense episodes of precipitation occur more often than before over most continental areas in the world. There are more warm days, warm nights and heat waves than before.

If the global society succeeds with rapid and effective reductions in emissions of greenhouse gases, the global warming may be limited to 2° C within 2050, although this is increasingly seen as unrealistic. The warming may go substantially higher within this timeframe, and in any case the warming in a longer time span is likely to continue. Thus adaptation to climate change will become even more urgent and demanding than what is experienced today. The future climate will probably pose extreme challenges in many areas of the world, and sea-level rise poses a special and new challenge to coastal settlements. The unpredictability of future weather types and patterns will also most likely become an increasing challenge (IPCC 2007). In the projects supported by the Development Fund, many project partners fear the climate challenges ahead, and express the danger of future droughts, floods and extreme events affecting the achievements that are reached in the projects. Such challenges can also hinder future progress towards poverty reduction.

Limits to adaptation?

With this background it is very likely that both ecological and societal limits to adaptation will become increasingly evident. There are thresholds in physical and ecological systems, where a shift from one state to another takes place, which can constitute limits to adaptation. As these thresholds are surpassed, irreversible changes may occur, such as the slowing or shutdown of the thermohaline

Participation and involvement of youth in community development ensures increased awareness and sustainability.

circulation, lost species and transformed ecosystems. The potential for adaptation may become limited if large-scale climate instabilities take place.

In regions where the climate conditions become extreme, and in regions where vulnerability factors remain unaddressed, the only realistic adaptation option for large groups may be migration, which in turn can create new problems, tensions, and extreme vulnerability for some.

There are also significant limits to migration for the poor, as the nearest city may be the only option, creating new vulnerabilities and hardships and new challenges for organizations and governments. But to which jobs or livelihoods can people go, and how can conditions improve for those who remain farmers? These are two crucial questions in future development assistance. These questions are not new, but they become more and more pressing as climate conditions change. Some suggest that more poor farmers should move to the cities, and that society should organize this migration as well as the cities better. (Aftenposten 25. May 2008). However, large-scale migration to cities in the South is already so rapid that enormous resources and efforts are needed in order to improve the opportunities and conditions for a growing number of people. Despite the fact that many are migrating and many more will migrate in the future, it remains important to support poor farmers. Seventy percent of the poorest billion people in the world today live in rural areas from what they can get out of the local natural resources and 162 million of these live for less than half a dollar per day (Bistandsaktuelt 9/2007, IFRI 2007).

Population growth and other non-climatic factors will interact with climate change and force many people to seek livelihoods outside agriculture and pastoralism. Where they will try to go will depend on where employment opportunities can be developed, and where they will be able to go, which will again depend on which development paths that can be developed. A diversity of actors with different interests will influence the future development paths, such as national governments and large bi- and multilateral organizations. The organizations that are actively exploring and developing different alternatives for social and technological change have the potential for being pioneers in processes of sustainable social change, but many of these are small, such as local and national NGOs, social movements, some research institutes, and small, private actors.

The potential for developing innovative solutions

Despite the serious future scenarios for climate change, there may also be reason for optimism, because there is an endless potential for developing the good ideas, knowledge systems and technology use for sustainable development and adaptation, including sustainable paths for industrialization, and addressing the barriers to sustainable development and sustainable adaptation. The social and technological capacity that already exists in the world today in theory gives significant opportunities to go far beyond the suggestions mentioned here when it comes to sustainable social and technological changes. Such changes must not only reduce climate risk, but also increase the resilience of livelihoods and communities all over the world. Green eco-cities and villages driven by clean energy can today be created in the middle of deserts, with sophisticated technical solutions for water supply, greenhouses and fenced fields for food production, friendly environments for people, efficient transport solutions and so on. However, in today's world there is a long way to go before such futuristic high-tech-opportunities can benefit the poor or be carried out on a large scale. There is of course not a technological solution to all climatic challenges, but as shown by Hoogma et al. (2002) social changes usually also involve some kind of technological change, and technological changes usually involve social changes. Significant social changes (political, institutional, knowledge, value) are often needed in order to implement new technological systems and make these new systems benefit all, and new technological systems are also needed in order to achieve significant social changes.

Resilience and flexibility

Due to the uncertainty of future climate changes and the increased variability and unpredictability of weather patterns, future activities for sustainable development and adaptation should not respond only to specific types of climatic events. In contrast they need to be developed with regard to their potential to increase resilience towards a variable climate, as well as economic, political and other stresses affecting local communities. The activities and strategies should contribute to increased resilience and reduced vulnerability. Such activities have the potential to foster social and technological innovation, and put people in a position to create their societies. These suggestions are not only relevant for developing countries. Rich and poor countries have the potential to meet through new, flexible solutions for food production, and energy supply and transport, which can be adapted to different contexts. For example, one of the reasons why the implementation of solar energy projects in the South has not taken off at a more rapid pace than it has today is that the solar cell industry has their hands full in supplying markets in the industrialized world. At the same time, the technology has proven to be useful for people in the South, where solar energy is abundant, and the need for energy is also very large and growing. These developments are an example of how environmental technologies can be relevant to different needs and different contexts, and are implemented in parallel in the North and the South. After some time this can lead to universal access to useful solutions, since the solar industry is growing very fast and the prices of their products are declining. Another example is the organic agriculture development, since there is increasing interest both in the North and in the South, for different reasons, some of which are mentioned in Chapter 4. Both the rich and the poor have their reasons to go in the direction of higher biodiversity and greater sustainability in food and biological materials production.

These issues are related to the question of whether developing countries in some cases can leapfrog from traditional technologies to the modern, environmental technologies without going through the same stages the industrialized world has gone through. It can be observed that leapfrogging is going on when it comes to the diffusion of mobile phones and installation of transmission stations for mobile phones in the South. Similar developments may be seen and can be encouraged in other sectors in the time to come, and if they are implemented in ways that benefit the poor and vulnerable, they have a promising potential for contributing to sustainable

7 CONCLUSION: IDENTIFYING SUSTAINABLE PATHWAYS FOR CLIMATE ADAPTATION AND POVERTY REDUCTION

How can the experiences from this analysis help to plan, integrate and evaluate climate adaptation in poverty reduction projects and programs? The cases analyzed in this report exemplify how a comprehensive, holistic approach to climate adaptation in poverty reduction work can be applied. By examining three poverty reduction projects supported by the Development Fund we have demonstrated a way in which researchers, practitioners, policy makers, and different actors together can identify climate risk, vulnerability and adaptive capacity in a project or program within a given geographical context. Based on this information, the analysis has assessed the ways in which project activities can reduce the risks and vulnerabilities and increase capacities to adapt.

This systematic way of examining contexts and activities may be considered a useful way to structure thoughts and actions about climate adaptation, both for research and project planning, implementation, and evaluation. It highlights different types of relevant factors to consider, and facilitates the integration of climate change adaptation into development project activities. This is important, since poverty reduction projects and programs very often directly or indirectly influence climate risk, vulnerability and adaptive capacity, either positively or negatively. However, the point is not to be able to put the different measures or actions into correct categories, but to be able to discover the types of relevant factors that should be taken into account.

7.1 Addressing the three facets of climate adaptation

The approach that has been used in this analysis assists in understanding local livelihoods and contexts where poverty reduction and adaptation must take place. The approach is also useful for discovering relevant interactions between actors and social structures at different geographical scales. It is necessary to collect qualitative data to understand how local climate conditions and changes are influencing the situation of poor people, and why. For example, in-depth interviews and focus group discussions can be carried out with different types of key stakeholders and representatives from the local population. It may not be necessary to investigate each and every village in a given region, since a few representative villages can give a good understanding of local livelihoods, people's values, aspirations and capacities, as well as the barriers and opportunities for poverty reduction and sustainable adaptation. The required information can be collected in similar ways as has been demonstrated in this climate change documentation project, with local partners and consultants playing important roles.

Identified climate risks

As shown in this report, it is important to identify the local climate phenomena that pose *risks* for people, both extreme weather episodes and more creeping changes in climate patterns. In addition, since variability is increasing, it is necessary to emphasize flexibility in adaptation processes instead of adaptation only to specific climatic stresses. Climate variability and change is experienced on the ground as extreme and changing weather patterns. Although climate change may not be recognized or seen as irrelevant to many, this does not hinder their participation in discussions on how climatic factors influence their living conditions.

Examples of climate risks influencing people in the project areas include shorter and more erratic rainy seasons, increasing drought problems, more intense heat, serious losses of livestock, changes in the length of growing seasons, loss of local biodiversity in agriculture, starvation, health problems and deaths, reduced food security and loss of income. Other climate risks identified in the case studies are more frequent and intense extreme events such as hurricanes, increased hail storms and extreme rainfall, increasing soil erosion and landslide risk both in rural, urban and semi-urban areas, which damage settlements, crops, roads and arable land, often exacerbated by consequences of pre-existing environmental degradation such as lost vegetation cover. Long, cool, periods of rainfall increase disease for people and crops, and crops rotting in the field before maturity are other examples.

Identified vulnerability factors

Social, economic and environmental factors that make people vulnerable to additional stresses from climate variability and change need to be mapped in order to understand the *causes of vulnerability*, why some people are more vulnerable than others, and how to address the vulnerability. The vulnerability context is constituted by a large number of structural factors influencing the local conditions. The most important of these factors in each geographical area need to be identified. In other words, the main social, economic and environmental problems in a community need to be understood, as well as the ways they influence poor people. These conditions strongly influence the ways in which people are affected by the climate impacts.

Examples of vulnerability factors in the project areas include low quality school content, school curricula with little relevance for local opportunities for income generation and improved quality of life under local climate conditions, including sustainable management

of natural resources. Other examples are lack of access to relevant and already existing information and technology for improving local livelihoods under different contexts, household and production assets that have been lost in earlier extreme events, poor health facilities, lack of safe sanitation, contamination of water, endemic illnesses, diarrheic diseases, dengue, malaria, and HIV/AIDS.

Identified adaptive capacity

Individuals, households and communities attempt to adapt to the weather-related challenges and other stressors which they are affected by, and the *capacity to respond or adapt* is differential and dynamic. Poor people have valuable knowledge and skills that are often ignored, and such knowledge often gets lost due to environmental degradation, HIV/AIDS, introduction of monoculture agriculture, etc. The capacity to adapt may be related both to the resources people have within themselves, for example in terms of knowledge, skills or trust in their own capability, as well as resources they have access to, such as market information, transport opportunities, or freedom to decide over their own use of time. Some dimensions of adaptive capacity are generic, such as education, income and health, while others are specific to particular climate change impacts, and can be related to knowledge, technology and institutions (Adger et al. 2007). People are adapting to a whole set of factors that influence them, both climatic and non-climatic.

People in the project areas investigated in this analysis have knowledge and capacity, such as their interest in rehabilitation of local vegetation cover and forests for sustainable use and a range of strategies to provide food and income within the limitations they meet, including traditional livestock rearing. They also have creativity and knowledge about options for fruitful interactions between society and nature, which can be drawn upon for sustainable adaptation. They have many types of local knowledge, and they have aspirations for their children's education.

A comprehensive approach to climate adaptation has the potential to address all the three types of factors exemplified above. Such poverty reduction and adaptation strategies may even make it possible to turn local climate and environmental conditions into resources for the population. An example is the rehabilitation of land areas in Tigray, which brings back local water springs, improves the microclimate, and provides economic resources for the population, such as fodder for animals and special grasses for cultural ceremonies, medicines and returning wildlife. The analysis of the three cases demonstrates that a comprehensive approach, although seemingly complicated, can be fruitfully applied in order to identify relevant factors that should be considered in climate adaptation efforts, for planning, design and evaluation of activities in a given, real life context.

7.2 Climate adaptation in projects supported by the Development Fund

A central objective in the notion of sustainable adaptation to climate change is to address poverty in ways that reduce climate risk and vulnerability and increase the capacity to respond and adapt to climate variability and change as well as other shocks and stressors. Several of the activities in the three cases analyzed in this report have the potential to not only reduce poverty and improve the quality of life of the people, but also reduce the climate risk and vulnerability and increase the capacity to respond to variable and changing climate conditions and other challenges threatening their food security and livelihoods.

The experiences from the three projects supported by the Development Fund are relevant and useful for how to address adaptation to *current* climate variability and observed changes. They are also relevant for the discussions on how climate adaptation can be addressed under *future* climatic changes. Even current climatic variability and already observed changes pose significant challenges to people and communities. Many societies are not well adapted to existing climate conditions. Moreover, adaptation to current conditions is an important preparation and learning process for adaptation to for future changes. The cases analyzed in this report demonstrate the critical need for adaptation even to current climate impacts, and the projects supported by the Development Fund importantly address many of the factors influencing the risk, vulnerability and adaptive capacity of poor people in the face of these impacts. The activities demonstrated in these projects are, of course, not all that it takes to meet the enormous challenges that climate change is expected to bring, nonetheless they are good starting points for further action.

The projects convincingly illustrate the importance of addressing climatic factors as an integrated part of broader efforts for food security, poverty reduction, diversification of livelihoods, sustainable use of natural resources for improved income opportunities and quality of life. The interventions are directed towards some fundamental problems of poor households, whose capacities are strengthened and opportunities developed. This is done under careful consideration of the local climatic and non-climatic conditions and opportunities.

The projects have, for example, implemented activities that can reduce *risk* of damages from droughts, floods, and unpredictable and extreme weather conditions and seasons. Organic growing and soil management techniques, rainwater harvesting, closure of gullies, development of locally-improved seeds and new sources of animal fodder, growing of trees instead of annual crops, use of treadle pumps, and hand-digging of wells, are examples of measures reducing the risk of damage on crops and herds from climatic stresses.

It is also likely that the projects have addressed some of those factors that generate *vulnerability*, by restoration work in degraded landscapes, forests and grasslands, work on women's rights and livelihood opportunities, HIV/AIDS groups, and improved household nutrition and health through the upgraded agricultural and gardening activities. Children's school attendance is addressed through improved household economy.

The projects have also implemented many activities which are likely to increase the *adaptive capacity, flexibility and resilience* to climate variability and change of the households and communities. These activities include participatory plant breeding, introduction of a diversity of crops and farm animals thriving well in local climates, thus promotion of biodiversity in agriculture, biogas-digesters for household cooking energy, small loans, processing of farm products, non-farm employment opportunities, local market development, and strengthening of women's economic opportunities. In these examples, several of the risk-reducing measures at the same time enhance the capacity to adapt, by increasing the available number of livelihood options.

Although there is a long way to go in order to reduce vulnerability and poverty and increase the adaptive capacity in vulnerable and poor communities, these efforts are important steps. It is also necessary to think beyond these measures, and not to believe that this is what climate adaptation is all about. The changes that have been observed are in all likelihood only a small beginning of what can be expected from climate change. It is therefore important to stress the seriousness of the climatic changes that can be expected in the decades to come. Broad socio-technical changes are probably required if climate change is to be addressed in a sustainable manner, and this is relevant to both greenhouse gas emission reductions and adaptation. The project activities described in this report are critical and useful steps, and they can be seen both as a type of first aid measure for poor people and communities, and as emerging parts of larger social and technological changes for future sustainability and climate adaptation.

7.3 Recommendations for climate adaptation in poverty reduction efforts

It is clear that both poverty reduction and climate change adaptation are broad social issues interwoven with most aspects of society, and therefore the suggestions in this report can only be partial. However, the report shows that a comprehensive and holistic approach is both necessary and useful in practical planning, design and evaluation of climate adaptation by directing attention to important factors that could otherwise be overlooked. Furthermore, the examples in this report demonstrate that the details matter both in understanding vulnerability and in strengthening people's capacities and adaptation opportunities. These details are best recognized in different local contexts with their specific geographical characteristics. However, the details form part of a larger picture and the same ways of thinking about climate adaptation are relevant across diverse contexts.

Relevance outside the farming field

Although most of the people whose situation is considered in this report are farmers, this report is not only about farming activities and the farming sector, but about poor people in rural areas: landless workers, people with very little land and with other livelihoods than farming, full-time smallholder farmers, many of them women, as well as children, elderly, unemployed and seasonal migrants. The attention is on individuals, families and communities and their livelihood strategies and quality of life, and how these are affected by climate change. The same ways of thinking can be applied to other contexts and similar principles can be used in planning and implementing social and technological change for poverty reduction and climate adaptation. Some of the natural resource management and food security interventions used in rural areas can also be relevant in and around cities.

The importance of using the local vulnerability and livelihood strategies as starting points

It is necessary for policy makers, practitioners, researchers and other actors involved to understand people's realities and efforts in order to design fruitful and sustainable poverty reduction and adaptation measures. Even existing and changing values, aspirations and dreams for the future as well as local power relations need to be understood and taken into account in order to plan adaptation and poverty reduction measures that can address the issues that are important for poor people's livelihoods, well-being and quality of life. Otherwise there is a risk of designing adaptation measures that fail to address the actual vulnerability factors or fail to use the opportunities and potentials in a given context of climatic and non-climatic factors. Such understanding makes it possible to build on and take advantage of local strengths, knowledge, livelihood opportunities and aspirations. It also reveals how the number of available opportunities for climate-resilient and sustainable livelihoods for the population can be extended. New, relevant knowledge, technology and market opportunities can be usefully added to the existing ones. Furthermore, the understanding of local contexts is necessary in order to be aware of barriers limiting people's strategies and efforts as well as potential social and technical changes. Some barriers are created by long-standing social developments, represented by established and strong socio-technical systems for food supply, energy supply, and transport. Other barriers are created by local inequalities and power relations between local groups.

It is also crucial to discover how local contexts are influenced by factors and actors at multiple geographical levels in order to identify required political, economic, environmental, social and other changes at different scales. The effects for people and local communities of factors at higher geographical levels must be studied at the local level. The understanding of how factors and processes at different geographical levels influence local contexts can be enhanced by similar studies as this one.

Diversify policies and interventions, think "alternatively"

Equally important as the community based/local context-based knowledge for the understanding of what is needed in climate adaptation, is knowledge about the potential solutions. As demonstrated in this report, it is important to promote diversity in livelihood strategies and assess the usefulness of different solutions in the context of variable and changing climate conditions. Past efforts within sustainable development activities as well as recent and ongoing technological development have contributed to the widening of options and knowledge available for diversification of livelihoods.

After several decades of trying, failing and learning on poverty reduction and sustainable development initiatives of different kinds, a substantial amount of knowledge exists for developing societies in sustainable directions, although these initiatives are still not mainstream solutions, and often seen as radical or unrealistic. For example, there is knowledge and technology available for increased diversity in energy- and water supply, sanitation, architecture, transport, and production technology. Many such initiatives appear to be highly relevant for climate change adaptation, and also for emission reductions, through their facilitation of fruitful human nature interactions and diversification of solutions adapted to local climates and natural resources. There is a significant potential for identifying existing experiences and learning from them, and there is a gap in knowledge among social scientists, policy makers and development agencies on existing opportunities and emerging technologies and infrastructures that are available. There is also a lack of research on the relevance of these opportunities for climate adaptation in different types of social and environmental contexts, and on the barriers and opportunities for their widespread diffusion. Development interventions have the potential to address such barriers and opportunities. Also, the introduction of new technologies and practices requires social innovations that can be

facilitated by development interventions, including models for how to organize the use of new knowledge and technology to make them benefit the poor and contribute to social and economic development and increased adaptive capacity. In poverty reduction efforts, there is a need to foster capacity development and sharing of knowledge across local contexts, identifying and spreading good examples of social and technological change. It can be important to study what can be relevant from earlier initiatives for change, although they were not initiated as adaptations to climate change. It is also useful to look at what works and learn from good examples. Building on local knowledge and involving local people in innovative activities can contribute to awareness and access to technologies and knowledge that can be combined with the existing ones.

Mainstream policies for food security and agricultural development need to be changed

As pointed out by the Development Fund and its partners, mainstream approaches to food security and agricultural production place too much focus on conventional mechanization, high yielding seeds, and distribution of fertilizer and pesticides, similar to the current international debate on global food supply, food prices, and poverty. As demonstrated in this report, the needs of small farms and poor farmers must be addressed in other ways in order to improve food security, increase food production and availability, reduce vulnerability and increase adaptive capacity. Although a diversity of technological solutions is important, as is illustrated in this report, there is a danger of implementing the "wrong" technological solutions in the sense that they increase vulnerability of farmers and fail to meet the needs of the poor. A much broader approach to food security and food production than the conventional ones is presented in this report.

Relevant knowledge and technological solutions can be decisive for the outcomes of poor people's farming and gardening activities and their availability of food and income. For example, the participatory plant breeding promoted by the Development Fund partners is a significantly different way of improving seeds and crops than the conventional plant breeding. Participatory plant breeding recognizes the importance of diversity, both in crops and varieties, and is a sophisticated way of creating locally-adapted high yielding seeds through the farmers own improvement of a range of varieties to local growing conditions, including climatic factors. As a result, people can grow a diversity of crops and varieties, so that while losing some crops under difficult weather conditions, other crops can be able to resist the conditions. Such work supported by the Development Fund thus meets the farmers' critical need for increased control over their own situation through reducing vulnerability and increasing flexibility.

Another social and technological issue for reducing climate risk and increasing adaptive capacity in agriculture is knowledge on different types of sustainable, organic growing techniques, addressing some of the unsustainable elements in conventional agricultural approaches. For example, a high degree of self-sufficiency in manure and compost, in addition to the seeds, is a good insurance for stable productivity and avoidance of debt dependency. The use of such soil-management techniques is also shown to be important in order to create soil qualities that can stand harsh climatic stress, such as flash rains, droughts and strong winds, and also to rehabilitate degraded soils. Moreover, intensive, organic gardening for production of fruits, vegetables and other crops in small, protected spaces is important for food security for many people, not least when food prices are increasing. There is often a significant improvement in productivity when going from traditional farming techniques to the more intensive, modern organic techniques, where much emphasis is put on creating fertile soils, as well as intercropping, use of trees on farms, rehabilitation of important natural resources and production of animal fodder. Such strategies have the potential to reduce hardships and improve diets for many vulnerable groups. However, this approach to agriculture has far less economic interests behind it than the conventional ones, which is supported and massively marketed by powerful agro-business companies.

An important barrier for promoting sustainable approaches to food security that are well adapted to the needs of the poor is the lack of knowledge, awareness or interest in such alternative approaches among national and international stakeholders influencing mainstream agricultural policy. Several types of actors, including social scientists, politicians and development practitioners, need more knowledge about the importance of alternative methods and practices, including the role of diversification and improvements in livestock-keeping, the use of valuable trees for production of food, fodder and materials, marketing of dryland products and forest products, diffusion of ideas and technologies between communities in the South, and other opportunities for diversification of livelihoods, as presented in this report. Without such understanding, as well as the understanding of vulnerability risks of the conventional approaches, these actors will not be well equipped to make recommendations on food security measures (and go beyond the solutions promoted by private sector corporations producing fertilizer, pesticides and high-yielding seeds).

The need for increased access for small farmers to the huge markets in cities in the South is an important and interesting challenge which should be addressed after several decades of tough import competition in many developing countries that have undermined many local food markets. Also more selective relations to markets for supply of inputs or sale of products are examples of changes that can reduce vulnerability and increase the capacity to adapt.

Change is required not only in NGO-interventions, but also in government policies

National and international policies are often counter to specific local experiences relevant for facilitating processes of social change, both within poverty reduction efforts and in emerging climate adaptation efforts. The realities of a local community can be very different from what actors at other levels may see as important. Even local governments in developing countries often fail to address the issues that are the most central for improving livelihood opportunities and quality of life for people and communities. Local organizations and the people who are affected by a development project must therefore be central partners in the design of measures. And the recommendations in this report can hopefully contribute to the increased attention to some types of problems that need to be addressed and some potential solutions to them. Such attention is needed from policy makers at the district, regional and national level in developing countries and from donor countries.

There is no doubt that conventional development and poverty reduction strategies have several sustainability problems, environmentally, socially and economically, and thus in many cases they increase vulnerability to climate variability and change.

However, the knowledge, strategies, and technology available today, as argued in this report, provide increasing opportunities to address these problems. Through efforts on the ground undertaken to start new, income-generating activities and socio-technical changes, established systems are sometimes confronted. For example, laws and regulations are usually well adapted to the dominant systems and may hinder innovative changes. Education opportunities may be lacking within the fields of emerging socio-technical systems, and access to equipment and financing may be difficult. Existing power structures, including local, regional, national and international institutions and their policies may be part of systems which maintain some of the poverty, vulnerability and unsustainability problems. It is important for development practitioners and policy makers to identify such structural barriers and attempt to find partners in order to address them. Moreover, policy institutions must address the sustainability problems of some development strategies directed towards economic growth that are lacking environmental and social sustainability and thus may increase vulnerability. Development measures and processes that damage ecosystems or drive poor people away from their pasture lands can undermine livelihoods and capacity to respond to shocks and stresses. A degraded environment is also an important reason for vulnerability, and rehabilitation and protection of natural resources is an important part of climate adaptation, especially through sustainable use and local management instead of closing the areas from access by the poor.

A crucial question in addressing vulnerability and adaptive capacity is also how governments in the South can take a larger responsibility for public services for their population, for example through good quality schools and health services. Also, technical and financial support, adapted agricultural extension programs for livelihoods and food security, institutionalizing activities and addressing local inequalities can be important tasks for local, regional and national governments. Moreover, empowerment of poor farmers, both women and men, support for farmers organizations, access to relevant and diverse knowledge and technology through extension services and facilitation of processing and marketing of agricultural and forest products are relevant tasks for governments.

A poor, devastated community can be seen as a picture of unused potential - human, environmental, technological, economic and social. The opportunities locally are in theory significant, in terms of potential human capital and potential socio-technical and economic development based on existing activities, knowledge, technology and natural resources.

Enhancing interaction between research and practice

The approach demonstrated in this analysis cannot be used only in planning, evaluation and implementation of poverty reduction and sustainable adaptation projects and programs, but also for doing research on climate adaptation processes, projects and programs. The approach facilitates the understanding of local livelihoods and contexts, and the way they are influenced by climate variability and change, as well as processes of social and technological changes that can increase flexibility, resilience and capacity to adapt. The method used in this analysis approaches the people directly and collects qualitative data in order to see the situation through people's own eyes, and identify factors at different geographical levels that influence the opportunities at the local level. This allows for the addressing of barriers to peoples efforts, the building on and extending of their knowledge and skills, increasing the number of available strategies for climate-adapted income generation and in other ways adapting policies to the realities on the ground. Furthermore, the analysis demonstrates the potential for fruitful interaction between research and practice for mutual learning and fruitful collaboration both on development of methods and on exploring emerging sustainable development paths for climate adaptation. As an extension of such collaboration, action research has an interesting potential to follow-up on a variety of initiatives to implement social changes for poverty reduction and climate adaptation.

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