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Adapting to Climate Variability: Learning from past experience and the role of institutions

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¹ Arjan Ruijs now works for the Netherlands Environmental Assessment Agency.

Summary

Adaptation to human-induced climate change is currently receiving a lot of attention in international development circles. But throughout human existence, natural resource-dependent people have exploited and coped with the effects of climate variability on the ecosystems from which they derive a living. Learning from this experience can help inform the design of appropriate policies for responding to human-induced climate change.

This paper presents the results of a World Bank study which sought to better understand the role of local institutions in supporting adaptation to climate variability and change in Ethiopia, Mali and Yemen. The study raised three questions. First, what strategies have been adopted by rural households in the past to adapt to climate variability? Second, to what extent do institutions of various sorts assist households in adopting adaptation strategies? And third, what are the factors that prevent households from adopting appropriate adaptation strategies? For the purposes of this paper, institutions are defined as structured, formal or informal organizations.

The study followed a three-step approach. First, drawing on original data from field surveys, focus group discussions and institutional stakeholder interviews, household vulnerability to climate variability was characterized in terms of its three constituent elements: *exposure* to climate-related shocks and stresses, and *sensitivity* and *adaptive capacity* in the face of such stressors. Sensitivity refers to the degree to which people are affected by climate variability and change. High levels of exposure and sensitivity and low levels of adaptive capacity generally result in high levels of vulnerability. But a high level of exposure need not necessarily result in a high level of vulnerability if the household's adaptive capacity is also high. Using data gathered on each of the constituent elements of vulnerability, cluster analysis was conducted to identify types of rural households sharing similar vulnerability profiles. Second, the reasons for differences in households' choice of adaptation strategies were analysed. And third, the role of institutional assistance in adaptation was investigated.

Virtually all households in all three countries engaged in at least some forms of adaptation, such as improved seeds or adjustment in planting dates, to render crop yields less susceptible to climate variability. But the particular adaptation strategies pursued differed markedly among households, both within the study sites in each country and among the countries studied. In Yemen, fewer adaptation strategies were pursued than in either Ethiopia or Mali. Wealthier households adopted capital intensive strategies such as the use of irrigation pumps. In Ethiopia, wealthier households engaged in more communal strategies, such as control of soil erosion, communal irrigation or reforestation, for which external assistance is needed. Pastoralists also reduced exposure through the adoption of collective water harvesting and rangeland management strategies, which cannot be undertaken by individual households on their own. In Mali, the only communal strategy chosen was irrigation, adopted by only a few, wealthier households. Income diversification beyond agriculture alone was also pursued by only a few households. Finally, migration as an income-diversification strategy was practised more frequently in Mali than in Ethiopia, and very little in Yemen. In all three countries, wealthier households tended over time to migrate to urban areas.

Significant differences were observed in the extent and forms of institutional assistance provided to households in dealing with climate variability and change. The network of public extension agencies is

particularly well developed in Ethiopia, where most rural households received such assistance, notably in terms of training. In Mali, on the other hand, public extension agencies are virtually absent and their assistance is focused narrowly on providing inputs for irrigation and home-garden agriculture. The role of NGOs, cooperatives, micro-finance institutions and religious groups was limited in all three countries. In Yemen, households hardly received any assistance from outside institutions, whether from formal government agencies or from NGOs. In all three countries, wealthier households enjoyed significantly more access to outside assistance.

In all three countries, people living in rural areas are both exposed and sensitive to climate variability. Various strategies are pursued for dealing with this, and wealth is an important explanatory variable in adoption decisions. However, differences in coverage of institutional assistance and in the types of assistance provided were substantial, thereby affecting prospects for future development independently of the level of household wealth.

1. Introduction

Human-induced climate change is a global phenomenon. Although projected climate change impacts tend to be highly uncertain at a local level, the expected general increase in climate variability is particularly likely to affect the world's most vulnerable, rural populations (Adger and Vincent 2005, IPCC 2007). These are also people already struggling to cope with the effects of variable rainfall in their daily lives. To what extent is increasing climate variability likely to affect households in different regions of the world?

In this paper we examine the ways rural households in Ethiopia, Mali and Yemen currently deal with climate variability. All three countries have a semi-arid climate and have experienced periods of extreme drought over recent decades. Owing to cultural, historical, political, institutional and geographical differences, however, agricultural systems and development paths have evolved differently among the three countries, and strategies for dealing with climate variability vary accordingly. Through comparative analysis across the three countries, this study aimed to deepen understanding of the factors that explain differences in the strategies pursued by different types of rural households to adapt to climate variability, and of the role and forms of institutional support that can help facilitate adaptation. The research was guided by three questions:

1. What are the main adaptation strategies currently adopted by rural households?
2. Which (formal and informal) institutions help facilitate adaptation to climate variability, and how do they do so?²
3. What are the factors that prevent households from adopting promising adaptation strategies?

Various estimates of the global costs of adaptation have recently been presented in the climate adaptation literature (Stern 2006, OECD 2008, World Bank, 2010a). Most global studies, however, do not discuss concrete adaptation activities at the household level. They tend to focus on technical solutions at the sectoral level and generally do not discuss the reasons why particular options are or are not chosen by poor, rural households. The danger of focusing too much on 'hard', top-down, technical measures is that insufficient consideration is given to low-cost strategies that households could adopt themselves, to critical social and behavioural processes that facilitate adoption, and to factors that prevent the enabling environment from functioning properly (OECD 2008).

Narrow approaches to climate adaptation within development also run the risk of focusing unduly on climate-related drivers of vulnerability without recognizing the multiple stresses that households may face simultaneously. Adaptation is a response to risks associated with the interaction of environmental hazards, of which climate change is only one, and while human vulnerability may be aggravated by climate variability, it usually has other underlying causes (Smit and Wandel 2006, TerrAfrica 2009, Ribot 2009). For adaptation planning to be successful, numerous studies indicate that proper institutional structures should be in place to deliver climate-proofed development programs that result in the necessary behavioral and structural changes (Adger 2003, Adger et al. 2007; Challinor et al. 2007; Twomlow et al. 2007; Wilby et al. 2009). However, it is still difficult to specify the factors that cause institutional structures to be successful in fostering adaptive outcomes, and to suggest what external

² 'Institution' often refers to roles or organizations – this is especially true of approaches inspired by organizational theory, public administration, and management. Another large body of scholarship, particularly in economics and in rational-choice approaches in political science and sociology, refers to institutions as rules (e.g. North 1990). This latter view of institutions includes organizations, but also includes more diffuse and loosely connected groups.

institutions could do to facilitate actions on the part of rural households that reduce their vulnerability to climate variability and change.

The number of case studies documenting the role of institutions in local-level climate change adaptation in developing countries is growing (e.g. Thomas et al. 2007, Barbier et al. 2009; IFPRI 2009; Paavola 2009; Stringer et al. 2009; TerrAfrica 2009; World Bank 2010b, 2011a, 2011b). There is broad consensus among such studies in terms of their overall conclusions. Households have adopted low-cost agricultural strategies that reduce their sensitivity to highly variable rainfall, even though the particular strategies adopted vary by context or region. There has been much lower uptake of more structural measures to reduce vulnerability, however, owing to financial, market and knowledge constraints. In addition, climate adaptation tends to be insufficiently mainstreamed into wider development and planning processes, and local adaptation strategies are not well integrated into policies and programs at the local level.

In this paper, we assess the adaptation options pursued by rural households in selected sites in Ethiopia, Mali and Yemen. Unlike many other studies, we investigate differences among households at the local level in rates of adoption of various adaptation options, and seek to understand the reasons why certain strategies are adopted and why other strategies are not adopted. The focus is on how rural households have dealt with climate-related hazards in the past, irrespective of how such hazards may change in the future. Farmers and pastoralists in semi-arid areas have been dealing with climate hazards for as long as such areas have been inhabited. Our concern is not with how they may respond to an intensification of these climate hazards, but with how they have responded in the past. The various strategies described here should therefore be interpreted not as being necessarily optimal strategies for dealing with climate variability, but as a reflection of current practices in Ethiopia, Mali and Yemen. They describe what households currently do for themselves, with or without external assistance, and how these actions affect their level of vulnerability. The study also considers what households do not regard as viable adaptation strategies, the factors that constrain the set of feasible adaptation strategies, and what may be needed to reduce these constraints.

The remainder of this paper is structured as follows. Section 2 provides an overview of the methodology and briefly describes the study countries and villages selected. The analytical core of the paper is in Section 3. Here, differences in household-level vulnerability profiles are described and explained, and corresponding adaptation strategies discussed. Differences among the study countries are highlighted. The types of assistance provided by external institutions that play a role in reducing household-level vulnerability to climate hazards are then assessed. Section 4 draws out wider implications and conclusions.

2. Methodology and Data Collection

Methodology

The methodology adopted in this study is based on Agrawal and Perrin (2008). The focus is on local-level actions. We do not consider macro-level strategies as described in the National Adaptation Programmes of Action (Yemen NAPA Team 2006, Ministère de l'Équipement et des Transports 2007, Tadege 2009). However, these macro-level initiatives – particularly drought early warning systems and improved weather prediction systems – may improve the efficiency of some of the local-level adaptation options discussed.

Focus on climate-related hazards without neglecting other hazards

The focus of the study is on hazards related to changes in climate variability, namely:

- Drought risk: changes in the pattern and timing of rainfall;
- Flood risk: changes in the intensity of rainfall resulting in floods;
- Average temperature changes; and
- Heat waves: extreme temperature peaks.

In addition to these climate-related hazards, rural households also face other hazards. These include soil erosion, agricultural or livestock pests or diseases, human diseases, increasing population pressure, credit or market problems, rising food prices and hazards related to access to land or other resources (FAO 2006, Thomas et al. 2007). Some of these hazards may indirectly result from climate-related factors (e.g. food price increases due to bad harvests) but it is often difficult to disentangle whether they originate from climatic or economic drivers (Adger et al. 2007).

Adaptation strategies can be grouped into four major categories

The focus of the analysis is on selected adaptation strategies; that is, on the strategies households currently adopt in anticipation or in reaction to external stresses, phenomena or events which lead to changing agro-ecological and livelihood characteristics and which therefore demand behavioral changes (Nelson et al. 2007; Stringer et al. 2009). Many of these strategies have been introduced or promoted since the droughts in the 1970s which partly destroyed traditional farming systems. Combined with other factors such as increasing population pressure, civil unrest and changing social and political structures, farming systems have changed substantially since the 1970s, which in some cases has made them more vulnerable. The strategies households currently adopt to adapt to changing levels of climate variability may be classified as follows (Agrawal and Perrin 2008):

- *Agricultural techniques* to adapt to changes in rainfall regime (e.g. seed selection, modify planting dates, modify fertilizer application, modify feed techniques, improve food storage facilities, change pastoral system);
- *Water management techniques* to adapt to changes in rainfall regime (e.g. use of water harvesting techniques, rehabilitate terraces, improve irrigation techniques, improve watering sites in pastoral areas);
- *Diversification techniques* in order to diversify income sources (e.g. temporary (seasonal/ circular) or permanent migration, use of alternative sources of fuelwood, home-garden agriculture, changes in consumption patterns or reductions in livestock herds); and

- *Communal pooling techniques* (e.g. reforestation, rangeland preservation, communal food storage facilities or local water management rules).

Vulnerability is a function of exposure, sensitivity and coping capacity

To explain differences in the adoption of adaptation strategies, households and communities are compared with each other on the basis of their vulnerability profiles. Vulnerability is composed of exposure to risk, sensitivity to that risk and adaptive capacity (IPCC 2007; see also UNEP 2002; Adger 2006; and Kok and Jäger 2009).

- *Exposure* refers to external stress on people or communities caused by changes in the amount of distribution of rainfall or temperature as a result of climate change.
- *Sensitivity* refers to the degree to which households are affected by exposure to the stress. For example, farmers using irrigation are less susceptible to variations in rainfall than farmers relying on rainfed agriculture.
- *Adaptive or coping capacity* refers to the ability to cope with the external stress. Factors affecting coping capacity include level of education and access to other resources.

This definition is consistent with the view that vulnerability is a socially constructed phenomenon shaped by institutional and socio-economic dynamics (Adger et al. 2007). In general, high levels of exposure, high levels of sensitivity and low levels of coping capacity result in high levels of vulnerability. Individual households are not able to influence their degree of exposure to climate variability, but may be able to influence their sensitivity and coping capacity. Table 1 presents examples of sensitivity-reducing or coping capacity-increasing strategies.

Table 1: Strategies to reduce sensitivity or increase coping capacity

Sensitivity reducing strategies	Coping capacity increasing strategies
Crop selection (more drought resistant crops)	Temporary or permanent migration to urban centres
Adapt planting dates	Migration to other rural areas
Adapt feed techniques (zero grazing)	Home garden agriculture
Adapt cropping densities	Reduce livestock/savings
Adapt fertilizer/pesticide application	Improved food storage facilities
Improved seeds (use seeds that have been improved to be e.g. more drought resistant)	Handicrafts
Use of manure of family herd on the fields	Increase market sales
Use water harvesting techniques	Communal cereal bank
Use irrigation	
Improve, construct or rehabilitate terraces	
Soil erosion prevention	
Restore and preserve forests	
Rangeland preservation / management	
Communal water harvesting	

Institutions

For the purposes of this study, institutions are defined as structured, formal or informal organizations that are the means through which local households cooperate with each other or through which central governments and donors channel resources for local development (Agrawal 2009, Agrawal and Perrin 2009). The focus is on groups of people who are organized formally or informally and whom can be

approached as a group. In order to understand why particular strategies are not adopted or why assistance structures may differ according to country context, use is made of the broader definition of institutions as adopted in the New Institutional Economics literature (North 1990, Williamson 2000) in which institutions also cover social norms and rules which govern the behaviour of households and organizations. The role of kinship and ethnicity, factors affecting commitment among community members, and factors affecting market functioning are particularly important in this respect.

Data Collection

Village surveys were carried out in Ethiopia and Mali in May 2009 and in Yemen in January 2010.³ Within each country, six villages were selected for household surveys, institutional stakeholders were interviewed and focus group discussions organized. Study villages were selected in consultation with ongoing development programs, national and local authorities on the basis of the following criteria:

- Cover the main climate-related hazards and choose villages with different levels of exposure (e.g. low drought risk vs. high drought risk);
- Cover the main agricultural systems in the country; and
- Choose some villages which are participating in ongoing development programs.

Within each village, in consultation with local authorities, 50 households were randomly selected for interview and around 10 institutional stakeholders identified. Informants were selected for focus group discussions in such a way that different sexes, age classes and wealth classes were present. In total, 901 households were interviewed, around 150 institutional stakeholders consulted, and 18 focus group discussions organized. In addition, national and international experts were consulted on the organization and results of the study. The data were analyzed using statistical methods (descriptive analysis, cluster analysis and factor analysis).⁴

The household questionnaire contained three categories of questions. First, in order to create a household profile, questions were asked concerning household composition, education, occupation, migratory behavior, crops cultivated, and livestock and assets owned. Information was also collected about the types of climate hazard faced by the household in order to determine whether climate-related hazards are indeed perceived as significant problems. Second, information was elicited about the choice of adaptation strategies. What strategies have been adopted in the past, in response to which hazards, and what were the required levels of investment? Finally, questions were asked about the forms of assistance various institutions provide in helping facilitate adaptation. Which institutions did assist, what type of assistance did they provide, and was this assistance helpful?

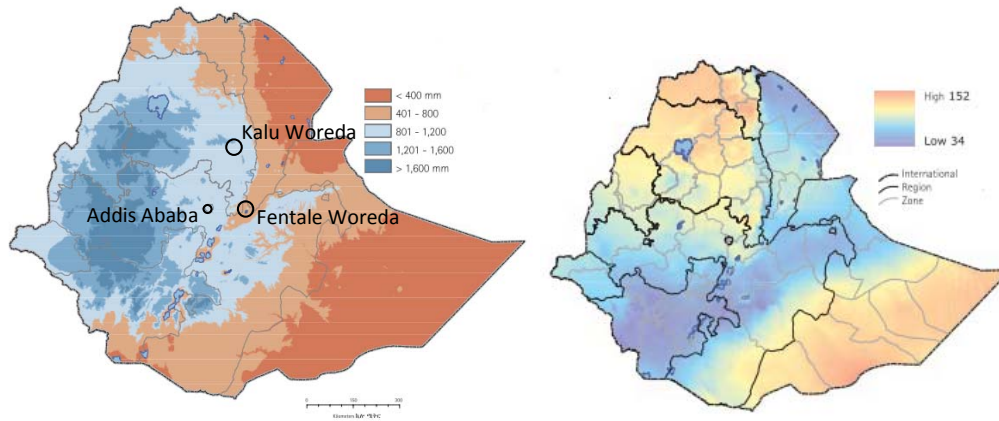
The institutional stakeholder interviews focused on the types of service each institution provides, their role in assisting households with adaptation, their linkages with authorities, and the main constraints limiting their activities. Finally, in each village, a focus group discussion was organized with a group of around 15 to 20 people. These group discussions gave additional information on: perceptions of the main climate hazards and their dynamics over time; the reasons for pursuing various adaptation strategies; the advantages, disadvantages,

³ See Ruijs et al.(2010), De Bel et al. (2010) and Linderhof et al. (2010) for detailed descriptions of the context, methodology and results of the field surveys in Ethiopia, Mali and Yemen, respectively. These country reports can be accessed from: <http://go.worldbank.org/X0BFK90GX0>.

⁴ The study draws on observations from six villages in each country. The results cannot be extrapolated to the national level or be construed as representative of the country as a whole. Many of the observations and recommendations made on the basis of the findings, however, do apply to other regions as well and therefore have relevance beyond the study villages alone.

bottlenecks, strengths or weaknesses of different adaptation options; the institutions facilitating the adoption of strategies; and differences in strategy adoption among socio-economic groups.

Figure 1: Study sites and annual rainfall (left) and rainfall variability (right) in Ethiopia.



Source: *Atlas of the Ethiopian Rural Economy*, 2006.

Country Profiles and Study Villages

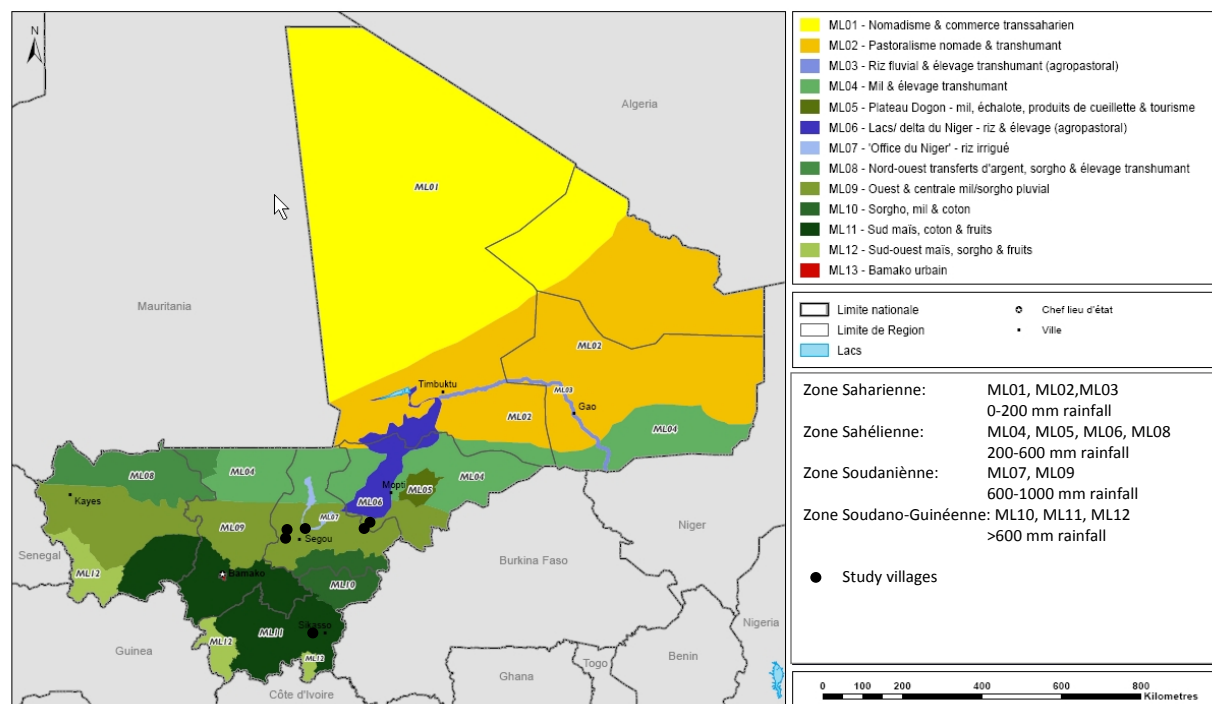
This section provides an overview of the main characteristics of the study countries and regions in which field surveys were carried out. **Ethiopia** is vulnerable to climate variability owing to its low adaptive capacity (i.e. low level of socioeconomic development, high population growth and inadequate infrastructure) and heavy reliance on natural resource-based activities. The north- and south-eastern parts of the country experience lower rainfall and higher temperatures than the rest of the country (Figure 1). Climate variability is mainly manifested in highly variable rainfall against a generally falling trend, and a rising trend in average temperatures as observed in recent decades (NMA 2001, 2007). The major climate-related hazards include drought, flood and – indirectly – livestock and human diseases (LIU/DMFSS, 2009). Although flood is more a lowland phenomenon, floods occurring in the lowlands are partly attributable to activities in the highlands. Generally, owing to variable rainfall and temperature, the arid, semi-arid and sub-humid lowlands are more vulnerable than the highland areas (Admassie et al. 2008, Deressa et al. 2008). If the trend of warming and drying continues, rural livelihood vulnerability is expected to increase.

The field surveys were conducted in four *kebele* in Kalu *woreda* and two *kebele* in Fentale *woreda* (Figure 1). In Kalu, villages were selected from the highland and midland agro-ecological zones. The mountainous area is highly degraded and has a bimodal but erratic rainfall pattern. The midland areas have relatively reliable rainfall which feeds several major rivers. Rain-fed crop production mainly during the *kremt* season (June to mid-September) and livestock are the main economic activities. Fentale is predominantly a lowland area. Crop production is only a recent phenomenon in this predominantly pastoralist region. The main hazards include drought owing to erratic and delayed rainfall, crop pests and floods. In Fentale, two villages were selected: one remote, pastoral village, and a second village which is currently in transition from pastoralism to sedentary farming.

Mali experiences extreme climate variability with periods of severe drought particularly during the 1970s and 1980s. Climatic zones more or less prescribe the agricultural potential of the country (Figure 2). An exception is the fertile Inner Niger Delta wetland straddling the Sahelian and Sudanian climate zones which stretches along the River Niger and its tributary the Bani. The country has one rainy season which lasts six months in the South to three months in the northern regions. The country has become hotter and drier over the last decades. Projections show that rainfall is expected to decline still further and become even more variable and that average temperatures are likely to increase (Butt et al. 2005, Parry et al. 2007). As a result, both drought and flood probabilities increase. Although climate variability has an important effect on the rural environment and rural livelihood security, other factors also have a significant impact, such as increasing population pressure leading to agricultural intensification; and changes in social structures such that the role of trust, kinship networks and the 'moral economy' in reducing vulnerability through mutual assistance has diminished considerably.

Field surveys took place in three regions, covering four farming systems (Figure 2). In Ségou region, three villages were selected. Two represented the southern Sahel, millet-based cropping system. Households in these two villages practice rainfed, cereal-based farming as is commonplace in the Sahel region. The area is threatened by desertification. In the third village, households apply irrigation by controlled flooding (*submersion contrôlée*), managed by the Office du Riz Ségou. In Sikasso region, in the Northern Guinean agro-ecological zone, one village was selected. This village lies in a more favorable rainfall zone, faces lower drought risks than the other villages, and is located in the area where the cotton cooperative CMDT is operating. In Mopti region, in the Inner Niger Delta, two villages were selected, representing the receding flood farming system (*agriculture de décrue*), watered by the Bani and Niger rivers. The area faces a higher flood risk but productive water resources permit rice cultivation and fisheries.

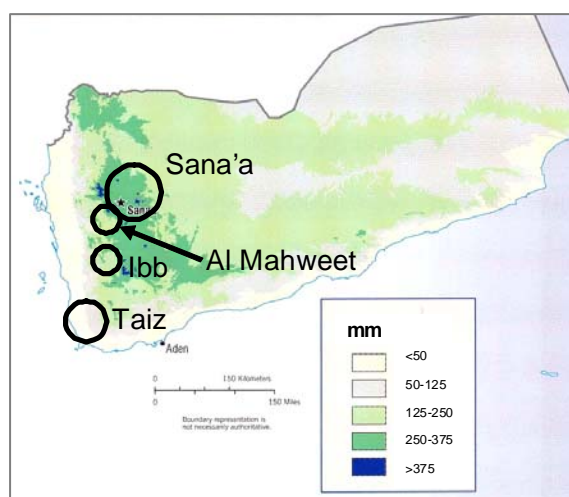
Figure 2: Agro-ecological zones and study sites in Mali.



Source: FEWSnet livelihood zones Mali

In **Yemen**, rainfall patterns vary widely across the country (Figure 3). Precipitation occurs primarily in spring and summer. Not only has rainfall declined over much of the country, but the timing of rainfall, the intensity of individual storms, the intervals between periods of rainfall, and the degree of inter-annual variability have all begun to change in recent decades. The combined effect of projected annual changes in rainfall and potential evaporation mean that a new climate regime for Yemen is likely to be in effect by 2050 (World Bank, 2010c). Yemen can be divided into five agro-ecological regions: Mountain Massif, Eastern Plateau, Desert Regions, Coastal Plains and Yemen Islands. In most areas, the reliability of rainfall is of critical concern, reflected by the fact that little or no truly rainfed agriculture is practiced. There is virtually always some form of moisture supplementation in agriculture, whether through tube-wells, hand-dug wells or flood-water harvesting.

Figure 3: Annual rainfall and study sites in Yemen.



The villages selected for the study were in four governorates: Sana'a and Al-Mahweet governorates in the central mountain massif and Ibb and Taiz governorates in the southern mountain massif (Figure 3). The southern and western coastal plains and lower mountain slopes have an arid tropical climate which is characterized by high temperatures and low annual precipitation (0 to 400 mm). The lower and upper mountain slope areas and the eastern plateau region (Taiz, Ibb and Al-Mahweet governorates) have an arid sub-tropical climate with average temperatures between 16 to 28°C and precipitation ranging from less than 100 mm to 800 mm. Finally, the high mountains, ranging from 1,800 to 3,700m above sea level (Sana'a), have a temperate climate with relative low average

temperatures (10-18°C) and precipitation varying from 200 mm to 1,200 mm. The field survey was conducted in three villages with rainfed agriculture in the Sana'a, Ibb and Al Mahweet governorates; two villages in the highlands with rainfed agriculture supplemented by spring irrigation in the Sana'a and Taiz governorates; and one village with mixed agriculture in a dryland area of Taiz governorate. The rainfed village in Sana'a governorate is relatively close to the capital. Both highland villages are rather difficult to reach. Even though all villages face drought risk, this risk is highest for the low lying, dryland village in Taiz.

3. Comparing Adaptation Practices in Ethiopia, Mali and Yemen

This section presents the main results of the field surveys. Analysis of differences both within and among the countries helps to explain how climate hazards are perceived in each context and what actions are taken accordingly. First we characterize and explain observed differences in vulnerability profiles. Next we describe differences in the adaptation strategies adopted and suggest reasons why different categories of adaptation strategy are adopted in different settings. We then discuss differences in the observed roles of institutions and finally consider to what extent the costs of adaptation options can be borne by households themselves or whether external support is needed.

Vulnerability Profiles

In order to characterize and explain differences in levels and patterns of household vulnerability within and among the three countries, comparative analysis was undertaken both at the level of villages and for clusters of households independently of their place of residence. Differences in vulnerability at the village level may be explained by differences in exposure, sensitivity and coping capacity. However, since both exposure and options to reduce sensitivity tend to be location specific, household clusters were also distinguished on the basis of coping capacity characteristics alone. This shows why and how some households are better equipped than others to deal with climate-related hazards.

The **Ethiopian** study villages show clear differences in levels of vulnerability. Generally, households in the lowland villages are more vulnerable to climate shocks than those in the mid- and highlands. Exposure to drought risk is higher and coping capacities are more limited owing to large household size and low levels of income diversification and education. High rates of soil erosion render highland areas sensitive to climate variability. For all villages, drought is the main climate hazard. Prolonged periods of drought and reduced rainfall levels have occurred more frequently in the highlands over the last decade. However, not all hazards are directly related to climate. High food prices, soil erosion and animal diseases are also significant sources of insecurity in rural livelihoods.

Vulnerability in **Mali** depends to a large extent on exposure to climate variability. Exposure to drought is highest in the rainfed study villages in the Sahelian rainfall zone of Ségou region. Sensitivity to climate variability is also high in this area owing to low agro-ecological capacity combined with dependence on agriculture and livestock. Even though exposure and sensitivity are relatively low in the study village in the climatically more favourable Sikasso region, households there have limited coping capacity owing to heavy reliance on agriculture. The other three villages in Mopti and Ségou regions, practicing receding-flood farming or controlled-flooding systems, currently have medium exposure to climate variability. Their coping capacities are higher than in the other villages owing to their higher rates of migration, cash crop earnings, and income diversification (e.g. from fisheries).

In **Yemen**, the village that is most highly exposed, most sensitive and with the lowest coping capacity is the one in the coastal plains of Taiz. It scores low on agro-ecological capacity and households have low cash crop earnings, low income diversification and relatively low educational levels. The more exposed villages, however, are not necessarily the most vulnerable. The least vulnerable village seems to be the rainfed agriculture village in Sana'a governorate. It is highly exposed but compared to most other villages, has greater coping capacity and a lower level of sensitivity owing to higher cash crop earnings (from *qat*,

fruits and vegetables), higher land holdings, more livestock, more assets and higher education levels. Least exposed are the two villages in the highlands with relatively high precipitation, but they differ significantly in level of vulnerability. Coping capacity is relatively strong in the village of Sana'a governorate, with relatively large land holdings, income from livestock and migration, and relatively high levels of education. But coping capacity is significantly lower in the highland village of Taiz governorate, with smaller land holdings and lower income levels. Vulnerability in the Yemeni study villages seems to be less a function of exposure to climate hazards and more related to other factors. For example, proximity to the capital Sana'a ensures that villages in Sana'a governorate are less vulnerable.

Two broad conclusions can be drawn from the comparison of vulnerability characteristics at the village level. First, exposure to climate variability plays an important role in shaping the vulnerability of rural households. All three countries lie in semi-arid regions and are regularly threatened by prolonged periods of drought. The lower and more erratic the rainfall, the more vulnerable agrarian livelihoods become. Villages in the lowlands of Ethiopia, the Sahelian zone of Mali, and the coastal plains and low mountain areas in Yemen are therefore at an initial disadvantage compared with villages in areas with more reliable rainfall. There is little or nothing that climate adaptation policies can do to change this difference in levels of exposure.

Second, many of the other hazards faced by rural households involve some degree of interaction between climate variability and a variety of human-induced factors. Increased levels of soil erosion, high domestic food prices, and increased incidence of human, animal or crop diseases are all indirectly related to rainfall variability. Other hazards, which are seemingly climate related, may in fact have underlying human causes. Flood hazards of villages along Malian rivers are partly a result of inappropriate construction activities in low-lying, flood-prone areas. Floods in one of the villages in the Ethiopian lowlands were caused by dikes built to prevent water from freely flowing towards lower-lying areas in order to protect neighboring sugar estates. Flood hazards in Ethiopia's highlands and in Yemen are partly caused by declining rates of water infiltration and higher surface runoff as a result of deforestation and soil erosion. Not all of these hazards may be attributed solely to climate-related factors. An integrated approach is called for in which other, development-related stresses are accounted for as well (Smit and Wandel 2006, Stringer et al. 2009, Wilby et al. 2009, World Bank, 2010a).

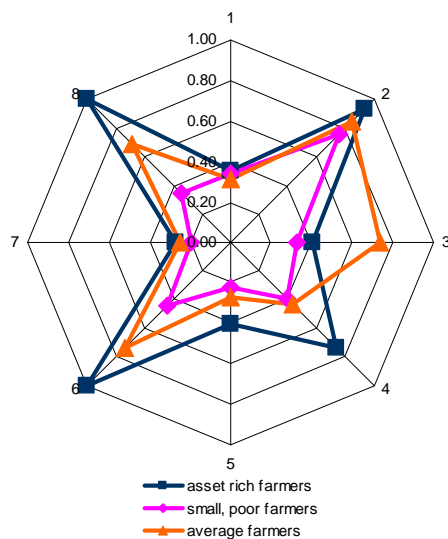
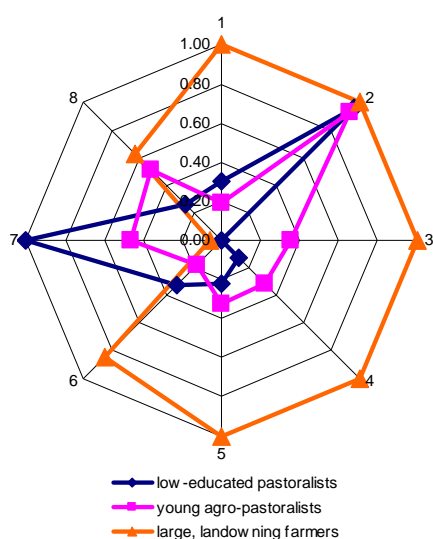
The second step in the vulnerability analysis was to identify clusters of households sharing similar coping or adaptive capacity characteristics, and to isolate this set of factors from those relating to exposure and sensitivity. This cluster analysis provides a clearer picture of the types of households that are better able to deal with climate-related hazards, independently of the role played by agro-ecological or climatic factors which are broadly similar for all households in given region.

Within each country, six clusters of households were distinguished using cluster analysis, performed on household data pooled from across all the study villages in each country. The clusters emerging from the analysis are described in Table 1. The main characteristics of each cluster are illustrated in the spider diagrams in Figure 4. The diagrams are scaled in such a way that the larger the spider web, the less vulnerable households are said to be. The analysis does not estimate absolute values of vulnerability, but clearly shows relative differences among the distinct household clusters identified in each country. Note, however, that it is not possible to compare household types across countries. Overall, the diagrams in Figure 4 show that virtually all household types are vulnerable to some degree, but they also show the multifaceted character of vulnerability, which takes on a different profile in different contexts.

Table 1: Household types resulting from the cluster analysis.

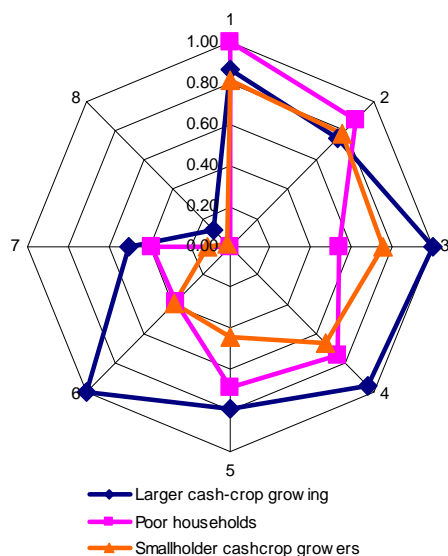
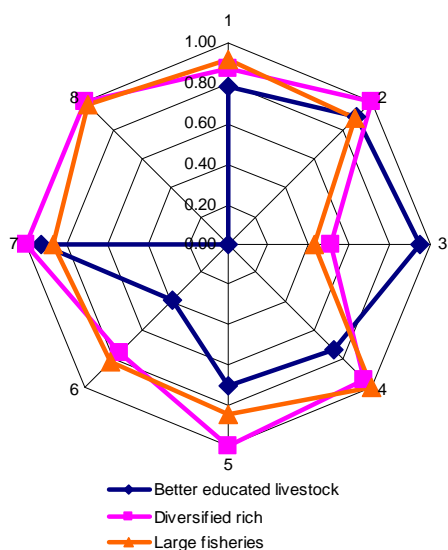
<p>Ethiopia</p> <ol style="list-style-type: none"> 1. Low-educated pastoralists: lowland pastoralist households, having a large household size and low migration rates, low education levels and asset ownership and cultivating few plots; 2. Young agro-pastoralists: agro-pastoralists, having a high dependency ratio, little temporary migration, low education levels and cultivating average acreages of land; 3. Large, landowning households: farmers cultivating a relatively large acreage, having few children, relatively high education levels, and high migration rates; 4. Asset-rich households: farmers with average household characteristics, but relatively high levels of education and ownership of assets, and owning many fruit trees in particular; 5. Small, poor households: farmers with a high proportion of female-headed households, low education levels and low levels of asset, land and livestock ownership; 6. Average household: average farm household having an above average migration rate, cultivating cereals in particular, and some <i>qat</i> as cash crop.
<p>Mali</p> <ol style="list-style-type: none"> 1. Educated, wealthy livestock farmers: better-educated livestock farmers, owning large flocks of small ruminants and herds of cattle, and producing cereals and cash crops. 2. Diversified, rich farmers: households that are rich in assets, land holdings and livestock, and which have a diversified income. 3. Large fisheries households: households producing cereals and few cash crops, involved in fisheries, and having a high percentage of permanent out-migrants. 4. Larger cash-crop growing households: better-educated cash crop producers with low migration rates and a high percentage of cash crops. 5. Poor households: households having especially small ruminants, producing cereals and some cash crops, having low levels of education, a relatively high dependency ratio, and low migration rates. 6. Smallholder cash crop growers: smallholder cash-crop growers, cultivating cereals and cash crops and owning few animals.
<p>Yemen</p> <ol style="list-style-type: none"> 1. Diversified, wealthy farmers with livestock who are better educated, own large herds of cattle, and produce cereals and cash crops (especially <i>qat</i>); 2. Highland smallholders in the southern highlands with relatively small land holdings, moderate levels of asset ownership, and which mainly produce grains; 3. Diversified households with a high share of female members and a low dependency ratio, rich in land holdings, producing herbs and legumes, and a high rate of out-migration; 4. Highly educated cash-crop growing farmers with a high dependency ratio, small land holdings, many assets and producing cereals and cash crops (<i>qat</i>); 5. Fruit and vegetable farmers producing cereals, vegetables and fruits, with some livestock, a relatively high dependency ratio and relatively low levels of education. 6. Dryland farmers with large landholdings, producing cereals but no cash crops, low in education, owning few animals and having a high dependency ratio. 7.

Figure 4: Vulnerability characteristics of household clusters in Ethiopia, Mali and Yemen.



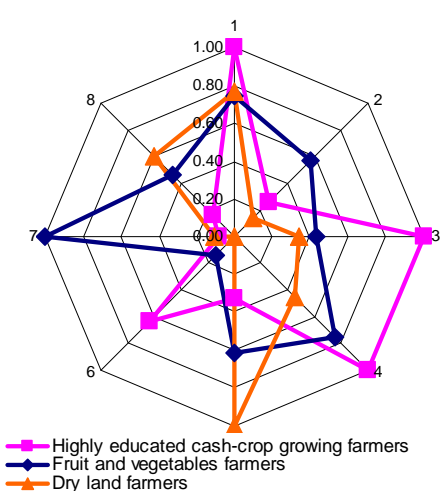
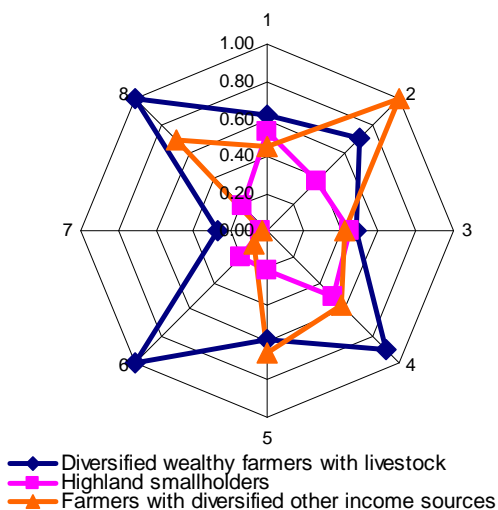
ETHIOPIA

- 1 inverse of dependency ratio
- 2 % of male headed hh
- 3 % of hh with migrated members
- 4 average years of education
- 5 average acreage per hh
- 6 Acreage cash + oil crops and trees
- 7 Livestock (in Tropical Livestock Units)
- 8 Mean asset score



MALI

- 1 Inverse of dependency ratio
- 2 % of hh with migrated members
- 3 Average years of education
- 4 Average asset score
- 5 Average acreage
- 6 Cash crop earnings
- 7 Livestock (in Tropical Livestock Units)
- 8 Involvement in fisheries



YEMEN

- 1 Inverse of dependency ratio
- 2 % of hh with migrated members
- 3 Average yrs education (male > 15 yrs)
- 4 Average asset score
- 5 Average acreage per household
- 6 Cash crop earnings from Qat
- 7 Earnings from fruits and vegetables
- 8 Livestock (in Tropical Livestock Units)

Some noticeable differences among the different household clusters within each country may be highlighted (Figure 4). For **Ethiopia**:

- Most household types are dependent on only one source of income and have limited fall-back options.
- The large herd size currently places the 'low-educated pastoralists' in a relatively strong position, but climate change may quickly diminish their situation, which would be difficult to alter due to their narrow dependence on livestock and low education levels.
- The 'small, poor farmers' are in the most difficult position with limited income-earning possibilities, few fall-back options and a higher proportion of female-headed households.
- The 'large, landowning farmers' have the highest coping capacity; however, they account for only 2 percent of the total sample.
- The 'asset-rich farmers' are in a relatively strong position as they can fall back on their assets in difficult years and their scope for future improvement is positive due their above-average education levels.
- The 'young agro-pastoralists' are currently in a vulnerable situation. But as their children grow older in the normal household lifecycle, their scope for exploiting a more diverse range of income-earning activities will improve.

Overall, the differences among household clusters identified in Ethiopia are substantial on virtually all parameters, and it is difficult to distinguish those parameters that have the dominant effect on vulnerability. It is therefore equally difficult to derive more precise or targeted recommendations on which development interventions should focus.

For **Mali**:

- The 'poor households' and the 'smallholder cash-crop growers' are the most vulnerable to climate variability. The 'diversified rich farmers' and the 'large fisheries households' are the least vulnerable. Their income is more diversified, they have higher cash crop earnings and own more land and livestock.
- For Mali, the dependency ratio and rate of out-migration are not determining factors of household vulnerability. All households score more or less the same. Education, cash crop earnings and livestock are important characteristics explaining the differences between the clusters. Involvement in fisheries is important for increasing income diversification and thus for coping capacity.
- From the analysis it follows that the 'better educated, wealthy livestock farmers' and the 'poor households' are living in the three study villages in the Ségou area. In these villages there seems to be a social divide between the better-off and worse-off households. Furthermore, the fishing community in the Mopti area is divided into two groups (clusters 2 and 3), both of which are relatively well off.
- The 'large, cash-crop growing households' cluster is a relatively small group. They have a less diversified income, but their higher education levels and higher cash earnings put them in a less vulnerable situation.

From this it follows that sensitivity to climate variability and coping capacity are the two principal determinants of vulnerability in Mali. Even in regions with lower sensitivity to climate variability, however, those with low coping capacity are still in a vulnerable situation.

For **Yemen**, the household clusters vary across villages as follows:

- The 'diversified, wealthy livestock farmers' and the 'highland smallholders' account for two-thirds of the respondents in the survey. The first group is the least vulnerable and they are present in all six villages, although most of them are from the village nearest to Sana'a. The second group

is most vulnerable. They score much lower on all parameters, which is a sign that villages are divided between better-off and worse-off households.

- Most households in the vulnerable dryland village in Taiz are 'fruit and vegetable farmers' or 'dryland farmers'. They are in a vulnerable situation. The 'fruit and vegetable farmers' are somewhat better off as they have a higher and more diversified income. Both household types, however, have low education levels, which gives them few prospects for improving their livelihoods on their own.
- The situation of the 'highly educated cash crop-growing farmers' is difficult to assess. Their low dependency ratio and high levels of education and assets suggest that they may be capable of deciding for themselves about adaptation options. Their small landholdings and low income-earning capacities, however, leave them in a relatively vulnerable situation.

From this it follows that in Yemen, as in Ethiopia and Mali, the social divide between better-off and worse-off households is based to a large extent on coping capacity and the capacity to reduce sensitivity to climate variability. The worse-off groups appear to be locked in a vicious cycle in which they are hit hardest by climate variability but have the fewest opportunities to change this situation.

The cluster analysis shows that high levels of exposure to climate variability need not necessarily result in a high level of vulnerability. Low sensitivity to climate variability and high coping capacity can protect households against the threats from high exposure. In Mali, villages close to water resources and able to use irrigation face lower sensitivity to rainfall variability. Their dependence on flood irrigation, however, still renders them more sensitive than households that are part of multi-village irrigation schemes or use independent, on-farm irrigation systems. Note, however, that communal schemes require solid institutional backing to be assured of sustained operation. In Ethiopia, as we discuss in the next section, many households adopt sensitivity-reducing measures in order to become less dependent on variable rainfall. Similarly, in Yemen, many farmers apply groundwater pumps to reduce their sensitivity to rainfall variability, while those living nearer to urban areas have more opportunities to improve their coping capacity.

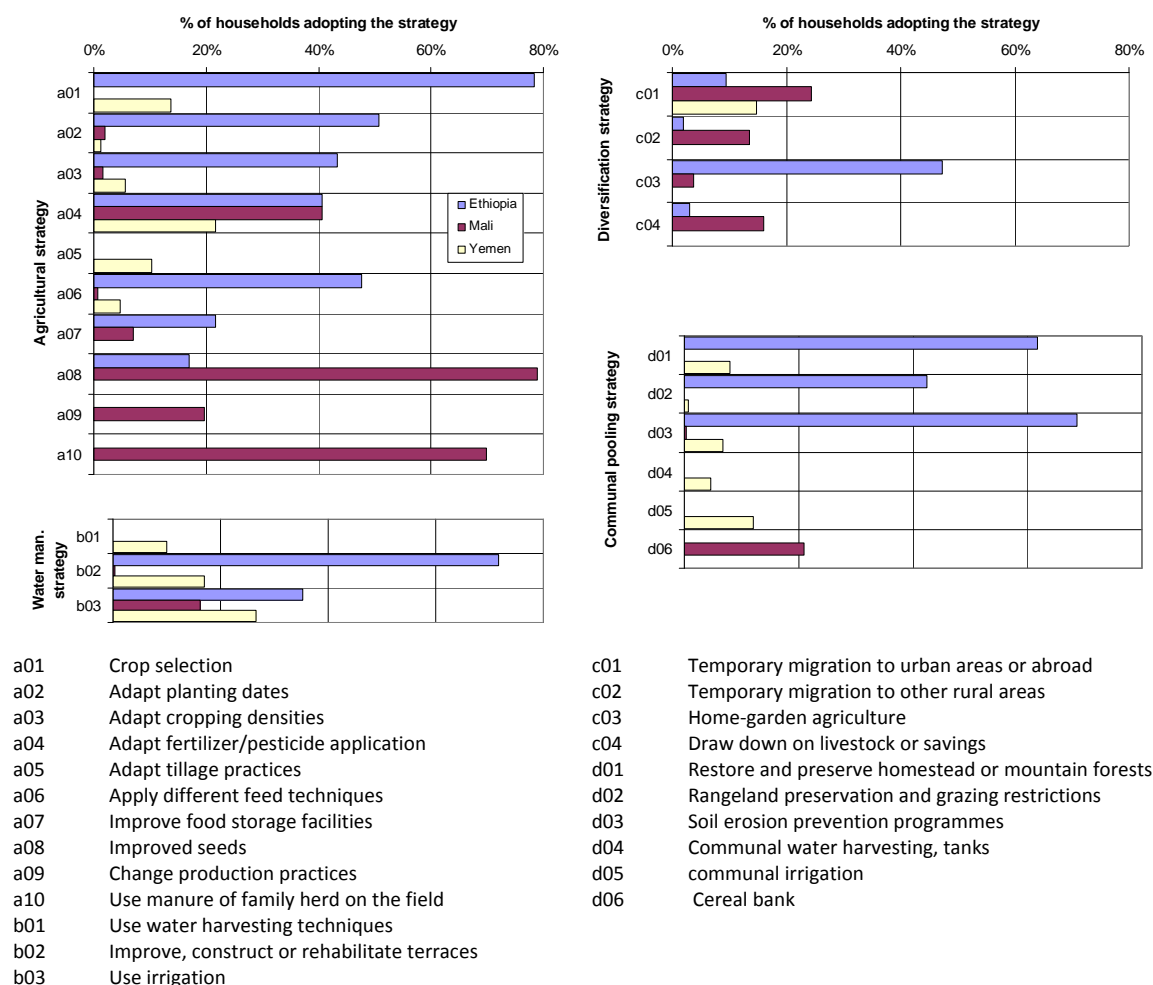
The analysis also shows that households in areas with low exposure to climate variability may still be vulnerable if their coping capacity is also low. Many of the households in the Sikasso region of Mali are vulnerable because of their narrow dependence on income from agriculture. If harvests fail, they have few fall-back options and limited capacity to repay debts incurred in purchasing inputs for cotton production. Households receiving remittances from migrating household members, owning more assets and having more diverse income sources (e.g. from fisheries, livestock, or trade) have more options for responding to income shocks. Households with higher levels of education also have greater opportunities to explore alternative livelihood sources.

The spider diagrams show that inter-household differences in Ethiopia and Yemen are greater than those in Mali. As a result, not all groups can be reached with general development interventions in these countries and more tailored programs are likely to be needed, focusing on the needs of distinct groups. On the other hand, the coping capacities of Malian households appear on the whole to be greater than those of Ethiopian households. Households tend to be larger, migration is more commonplace, more households own at least some cattle and (in the study villages) almost all households cultivate some cash crops. In Ethiopia, the lowland households in transition from pastoralism to a sedentary, mixed farming-livestock system acknowledge the importance of income diversification. In many of the other villages, households still focus narrowly on either livestock or agriculture rather than broadening their range of

income sources. In Yemen, differences among households are also large. Proximity to the capital city Sana'a is clearly advantageous for the many households that derive cash incomes from *qat* sales and remittances from migrating family members. Within villages, differences may also be large. In order to design appropriately tailored development assistance programs, attention needs to be paid to the particular constraints households face. Since better-educated households are generally in a stronger position, improving school enrolment remains an important development priority.

Finally, based on the household survey findings, it is difficult to assess whether there are significant gender disparities in levels or forms of vulnerability among household members in the various household clusters, since the household was taken as the principal unit of analysis. Some general observations can be made based on focus group discussions, however. A disadvantage of the generally small household sizes in Ethiopia is that women tend to have few fall-back options if they become single. On the other hand, the results suggest that Ethiopian women have a greater influence over household decision-making than in the other two countries. In Mali, the significantly larger household sizes may serve as a form of safety net for women to support each other in difficult times. However, there is also evidence of hidden poverty within extended households because of hierarchical differences. In Yemen, for cultural reasons, women tend to have only a marginal say in household decisions even though their role is important in nearly all household tasks.

Figure 5: Share of households adopting adaptation strategies in study villages (Ethiopia, Mali and Yemen).



Adaptation Strategies

Figure 5 shows the range of adaptation strategies adopted by households in each of the three study countries, grouping them into the four categories of adaptation identified earlier: agricultural, water management, diversification, and communal pooling. Figure 6 then further classifies these adaptation strategies on two dimensions: *communal* versus *individual* strategies (x-axis) and *coping capacity-increasing* versus *sensitivity-reducing* strategies (y-axis). This typology produces a 2x2 matrix of possible strategies (communal, coping capacity-increasing; individual, coping capacity-increasing; communal, sensitivity-reducing; individual, sensitivity-reducing).

In **Mali**, the strategies selected tend to be mostly individual strategies, while in Ethiopia and Yemen households pursue a combination of individual and communal strategies. In Mali, only one of the top five strategies is a communal strategy (cereal bank). Water management strategies, for example, which tend almost by definition to be communal, are rarely used in Mali, even though they might be expected to yield positive benefits in climatic zones in which drought is one of the major threats to livelihood security⁵. Communal activities appear quite rare in the Malian study villages, and households seem to operate somewhat independently of others. Well-functioning individual strategies may spread throughout the community, but jointly implemented strategies, which require cooperation between neighbors and among community members, are not common⁶.

For **Ethiopia**, three of the top five strategies are communal strategies that have to be implemented jointly with other households and often with the help of outside institutions. External institutions are observed to play an important role in improving rural livelihoods in Ethiopia, consistent with research findings elsewhere (Deressa et al. 2008, Bryan et al. 2009). The general level of attention paid to adaptation is higher than in Mali or Yemen, and is reflected in a more diverse range of adaptation strategies pursued.

In **Yemen**, although a combination of individual and communal strategies is pursued, very few adaptation strategies are adopted at all and differences among households are large. Impressions from the field are that few innovations are used in household-level efforts to reduce vulnerability, and there is much less government or donor attention to climate adaptation in Yemen than in the other two countries. A number of donor-supported programs have recently begun to focus on this issue, notably in the context of the Pilot Program for Climate Resilience. But owing to the near-absence of institutional support, Yemeni households are left largely to their own devices, which particularly disadvantages poorer households.

Communal strategies may also play an important catalytic role, beyond their direct benefits, in creating the conditions under which individual strategies can become more efficient. Soil erosion control, reforestation, communal irrigation, and terrace rehabilitation are all adaptation strategies with public-good characteristics. All community members benefit from improved agro-ecological conditions and no one can be excluded. However, effective, external institutions are often needed to initiate such activities, in order to raise awareness, build capacity, and create commitment among community members while discouraging free-rider behaviour. Close attention may also need to be given by external institutions to

⁵ Note that the irrigation techniques used in the study villages are mainly flood dependent which only require limited management.

⁶ However, this finding may in part simply reflect the generally much larger average household size in Mali than in Ethiopia or Yemen, so that what appears as an individual strategy in Mali may in fact require collective action among households in the other two countries, and even in the Malian context may require significant intra-household bargaining to bring about collective action within the household.

ways of reducing the constraints (e.g. labor) that poorer households may face in engaging in communal strategies.

Figure 6: Typology of adaptation strategies adopted.

Coping capacity increasing	
Individual strategy	<p>Ethiopia</p> <p>7. Home garden agriculture (47%)</p> <p>Mali</p> <p>4. Temporary migration to urban centres (24%) 7. Reduce livestock/savings (16%) 9. Temporary migration to other rural areas (14%)</p> <p>Yemen</p> <p>4. Temporary migration to other rural areas (15%)</p>
	<p>Ethiopia</p> <p>5. Communal cereal bank (21%)</p> <p>Yemen</p>
	<p>Ethiopia</p> <p>1. Crop selection (78%) 5. Adapt planting dates (51%) 6. Adapt feed techniques (zero grazing) (48%) 8. Adapt cropping densities (43%) 10. Adapt fertilizer/pesticide application (41%)</p> <p>Mali</p> <p>1. Improved seeds (79%) 2. Use of manure of family herd on the fields (70%) 3. Adapt fertilizer/pesticide application (41%) 6. Change production practices (20%)</p> <p>Yemen</p> <p>1. Use irrigation (26%) 2. Adapt fertilizer/pesticide application (22%) 6. Adapt tillage practices (10%) 7. Use water harvesting techniques: roof water collection, tanks (10%)</p>
	<p>Ethiopia</p> <p>2. Improve, construct or rehabilitate terraces (72%) 3. Soil erosion prevention (69%) 4. Restore and preserve forests (69%) 9. Rangeland preservation / management (42%)</p> <p>Mali</p> <p>8. Use irrigation (16%)</p> <p>Yemen</p> <p>3. Improve, construct or rehabilitate terraces (18%) 5. Communal irrigation (12%)</p>
Sensitivity reducing	
Communal strategy	

Note: Only strategies adopted by at least 10% of surveyed households are shown.

Figure 6 shows that in all three countries, households rely most commonly on individual, sensitivity-reducing strategies. The actual sensitivity-reducing strategies pursued are also quite similar across the three countries, even though the share of households adopting them may differ substantially. Most such strategies aim to introducing improved agricultural techniques at the farm level. Although the broad aims of these individual strategies may be similar (e.g. crop selection, improved seeds), there are significant differences in the actual crops selected or the type of seed improvement that best meets local needs. Optimal crop rotations, planting dates, cropping densities and fertilizer/pesticide applications are all dependent on regional and local characteristics. Similar observations are made by Stringer et al. (2009) for case studies in southern Africa.

By comparison with Ethiopia and Yemen, greater emphasis is placed in Mali on coping capacity-increasing strategies, of which the dominant forms involve migration. Owing to low incomes, the resulting low level of household demand and poorly developed private sector institutions (e.g. micro-credit institutions, input suppliers, transportation services), there is limited scope for broadening the range of strategies Malian households can choose from to diversify their income. This is an important reason why migration is such a commonly used coping strategy. Some 38 percent of households in the

village surveys have family members that have migrated to urban or other rural areas. This singular focus on sensitivity-reducing strategies means, paradoxically, that households are likely to remain dependent on a narrow range of income sources which are highly sensitive to climate variability. In order to reduce vulnerability still further, investments need to be made in improving coping capacities and removing the obstacles that prevent households from adopting these strategies.

Finally, the results show that strategy choice is both gendered and wealth dependent. In Yemen, men make most decisions and the role of women is marginal. In Mali men make most decisions as well, but women play significant roles in certain activities such as handicrafts and petty trade. In Ethiopia, women play a substantially larger role. They make decisions relating to trade, handicrafts and home-garden agriculture in particular, but are also involved in more general decisions concerning agriculture. Results for all three countries also show that the more marginalized and remote villages and the more marginalized households within all villages invest less in adaptation strategies than do better-off households. Better-off households invest more resources not only in individual, adaptive livelihood activities, but also invest more money and time in soil erosion control and collective water management strategies. They have better access to institutional assistance and are better able to mobilize community members to jointly initiate activities. To ensure that interventions benefit the intended target groups, it is therefore important that institutions orient their support towards those groups actually making the decisions and implementing the strategies in practice. For certain strategies, women rather than men will need to be involved as the principal agents of change, and particular attention may need to be paid to the needs of marginalized groups.

Institutional Assistance

The extent of institutional coverage and the types of institutions present differ significantly among the three countries studied (Figures 7 and 8). The most prevalent type of institution in each country is partly explained by government policy. In Ethiopia, for example, public extension services have a strong and extensive network of agencies covering a large part of the country, with the support of large-scale, integrated rural development programmes. Those regions not or only marginally covered by public extension services tend to host a higher number of NGOs. In Mali, the extension services have a much weaker and less extensive network, covering fewer regions with fewer resources and reaching fewer farmers. They also seem to have less well-coordinated development assistance programs.

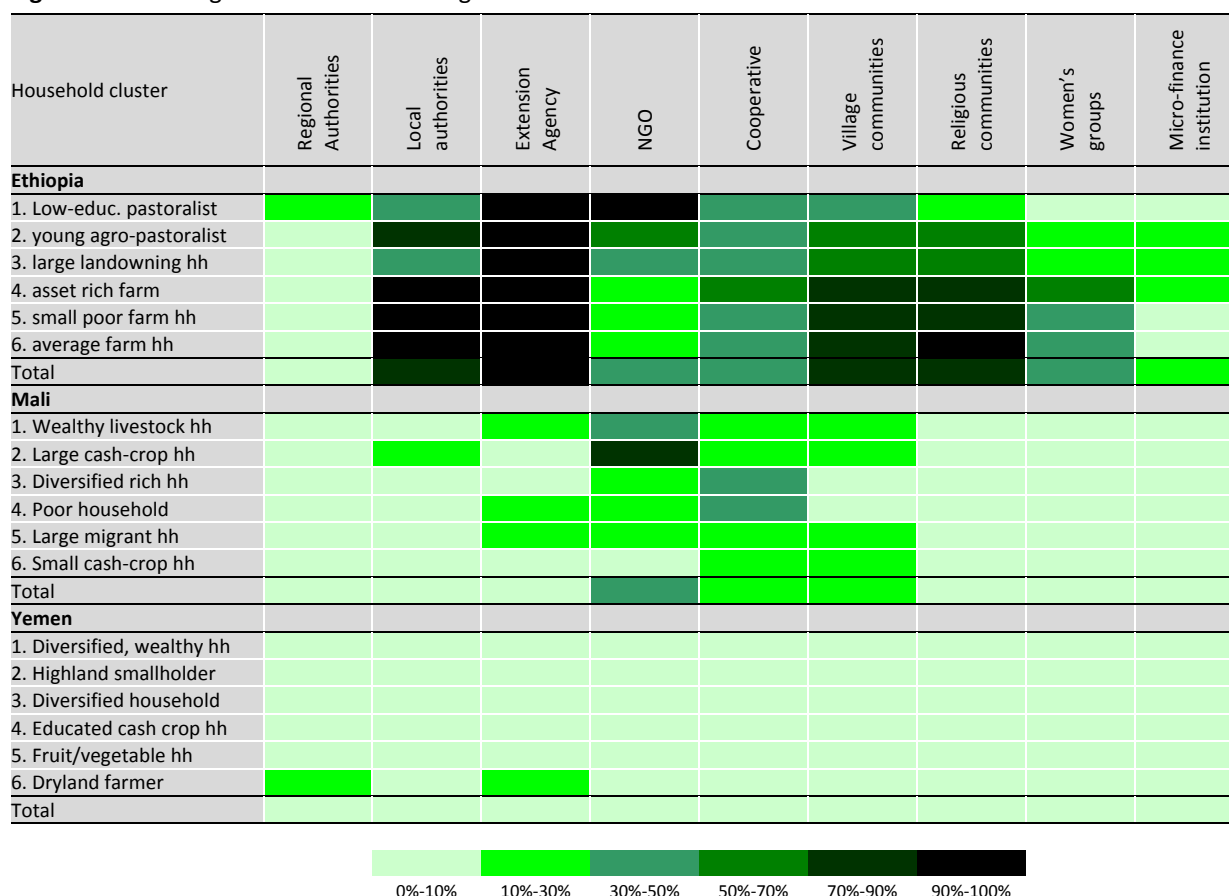
In Yemen, households in the study villages have hardly any contact with government institutions, yet nor are NGOs widely present or regularly contacted. Yemeni households are left largely to their own devices without much help from any institution, other than informal, kinship-based or community institutions. Community institutions in Ethiopia also play an important role. In Mali, communities seem to be much more loosely organized. Owing to the substantially larger households and high rates of out-migration, strong intra-community links seem to have declined in importance.

Micro-finance institutions, whether represented through formal banking institutions or as part of community institutions, are important in Mali and Ethiopia. In Yemen, the financial capacities of individual households seem to be greater, in part owing to the cultivation of *qat* and other cash crops. The growing role of formal micro-finance institutions may be a sign that the financial requirements of modern adaptive livelihood strategies exceed the capacity of informal institutions to meet demand. As more

innovative and costly strategies become more widely adopted, the role of micro-finance institutions may become increasingly important in mediating support for adaptation.

Differences among the three countries in the significance and role of institutions are partly explained by historical and political factors. The presence of public authorities in rural areas has always been much more prevalent in Ethiopia than in Mali or Yemen. As a result, the diffusion of knowledge and planning for development assistance tend to be better coordinated in Ethiopia. In Mali, the funding and delivery of development assistance is fragmented among a large number of donor organizations and NGOs, and government coordination is generally much weaker than in Ethiopia. For Yemen, the strong clan culture and inter-ethnic divisions explains why public authorities play only a minor role in some parts of the country. Recent initiatives to establish integrated, nationwide development programs will continue to face significant obstacles as long as long-term finance and support for extension agencies with minimal political interference remain elusive.

Figure 7: Percentage of households having contacts with institutions.



In all three countries, there is evidence that better-off households have easier access to the services provided by various institutions. In Ethiopia, the relatively better-off, 'large, land-owning farmers' and 'asset-rich farmers' clusters have more contacts with the village community. Consistent with the finding that they also engage more frequently in communal adaptive strategies, this suggests that they occupy strong positions within informal community institutions and that they enjoy greater success in having

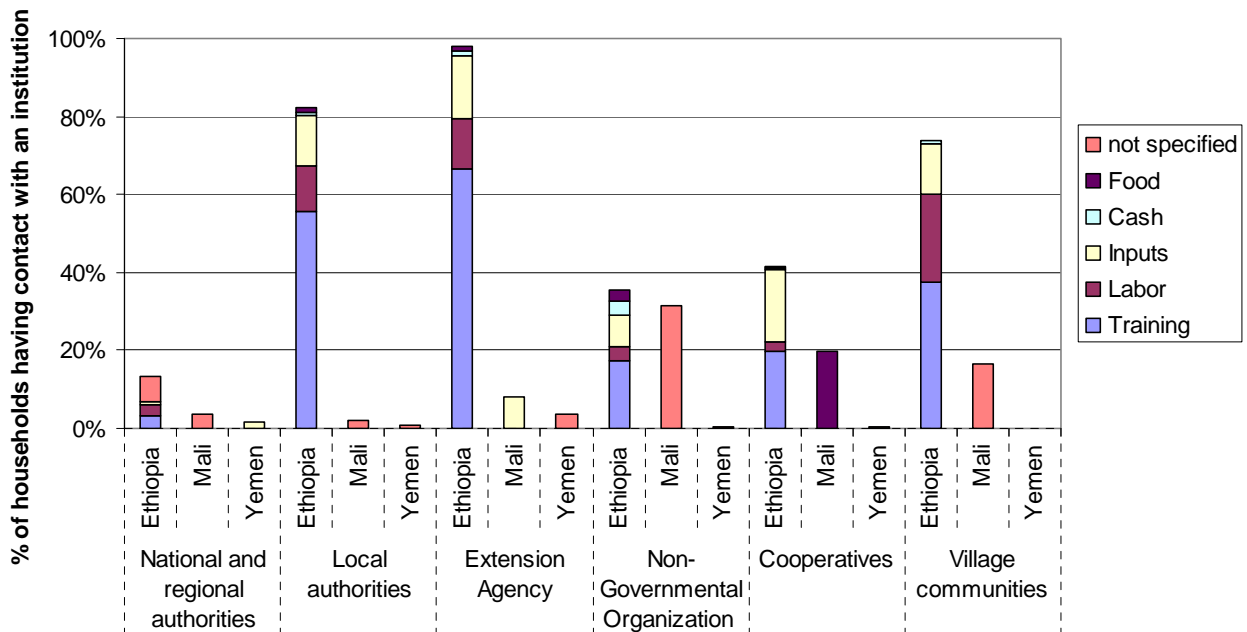
their needs and priorities addressed. Access to community institutions is, almost by definition, more difficult for marginalized groups such as female-headed households. Such groups may also lack information on the kinds of assistance that the village community could offer.

In Mali, NGOs and village communities in particular provide adaptation-related assistance to the poor households cluster. International donors, national authorities and religious communities are not mentioned as institutions that have any contact with households. However, interviews with institutional stakeholders revealed that many of the institutions that are in contact with the households themselves receive financial and sometimes technical support from national authorities and international donors.

In Yemen, it appears that better-off households (clusters 1 and 5) have relatively greater contact with institutions than worse-off households, although these results are not statistically significant owing to the very small number of observations. In addition to the few 'outsiders' who provide help to some households, some respondents indicated that they receive some help from or cooperation with neighbors or fellow clan members. Even though these represent community-level, informal institutions, respondents apparently did not consider them to be an 'institution' as such. Low institutional coverage and reliance on kinship networks is a well known phenomenon in rural Yemen, where the role of national government is often contested and officials are treated with suspicion.

The results also show that institutional access is gendered. In both Ethiopia and Mali, female-headed households and households with a larger share of adult women are observed to adopt fewer adaptation strategies than do male-headed households. Adoption rates are lower for all strategies but particularly for more demanding, communal strategies such as irrigation. Female-dominated households tend more often to adopt individual strategies such as handicrafts and charcoal sales, but they also receive less assistance from institutions. In Ethiopia, this is particularly true in the case of assistance from local authorities and extension agencies but also applies in the case of community institutions and even women's groups. This relative neglect is partly compensated through the extra attention paid to female-dominated households by religious and micro-finance institutions. In Mali, extension agencies provide noticeably less assistance to female-dominated households. In targeting adaptation assistance, donors therefore need to pay special attention to ways of reaching female-dominated households.

Figure 8: Percentage of households having contact with an institution, by type of institution



Note: The subdivision of the bars shows the breakdown among the types of assistance households receive.

The type of assistance provided by institutions differs across countries. In Ethiopia, extension agencies focus primarily on the provision of training, which improves the skills of household members to improve their own situation. Other forms of assistance, such as input provision, are provided particularly by cooperatives, and financial assistance by NGOs and formal microfinance institutions. Informal, community-based micro-credit institutions appear less important as a source of cash, perhaps because they are unable to meet demand.

In Mali, institutional assistance primarily takes the form of inputs such as seeds, fertilizer and pesticides. Training is virtually absent from the list of assistance received by households. Although training was mentioned in institutional stakeholder interviews as an activity provided to households, households do not appear to perceive the support they receive as including training. Development assistance in the Malian study villages tends to be channelled through top-down initiatives and input provision, along with maintaining traditional cooperative institutions. Trade associations such as the Compagnie Malienne pour le Développement des Textiles (CMDT) focus more on input provision than on training to enhance peoples' capabilities, which primarily benefits those with above-average levels of education who are capable of identifying for themselves various opportunities to improve their livelihoods.

In Yemen, most adaptation strategies pursued were financed and realized by households themselves using their own resources. Formal institutions provided hardly any assistance in terms of training, inputs or cash. The only form of supra-household assistance reported was mutual assistance and collective action with other community members in mobilizing labor for terrace rehabilitation, and establishing irrigation or other water resource management schemes. The small number of strategies adopted may partly be explained by low institutional coverage. Households adopt the strategies they are already aware of, and which have been traditionally applied for centuries. Very few modern innovations have been adopted.

Households often lack the knowledge, awareness or financial means to adopt new strategies. The virtual absence of formal institutions makes it difficult to correct for market failures through policy or institutional means.

The analysis shows that for many strategies, some degree of coordination is needed between households and institutions. Even for low-cost, individual strategies such as seed selection or adjusting planting dates, better outcomes are expected where institutions provide complementary support in the form of training or knowledge transfer. Extension agencies play such a role in Ethiopia, for example (see Figure 8). In Mali, very little training is offered but institutions do perform other functions such as input provision. In Yemen, institutions are conspicuous by their absence and households are more or less left to their own devices.

Communal strategies require a strong sense of commitment and ownership on the part of all stakeholders and the will to cooperate with one another. Training and knowledge transfer concerning the costs and benefits of alternative strategies may help to build such a sense of ownership and encourages households to make informed choices. Some communal strategies also require substantial investments in terms of cash or labor which, depending on the strategy in question, may be provided by institutions or financed wholly or in part by households. The most commonly observed barriers to the adoption of all strategies are financial constraints, including the difficulty of obtaining affordable credit on the part of households, and managerial or budgetary constraints on the part of institutions. Reducing these constraints requires intervention from higher-level institutions.

Different institutions play different roles depending on the level at which they aim their intervention. Institutions generally do not operate in isolation but are part of a network of institutions that support and depend on each other. Central government plays an important role in creating the enabling infrastructure for markets to function (e.g. roads, telecommunications, dissemination of meteorological information, and sometimes plays a role in input, output and credit markets, or in veterinary services). Other institutions, such as NGOs, extension agencies and community organisations, target their interventions at the household level, whether in terms of training, financial support, awareness of techniques and the provision of inputs.

Institutions need to be aware of their role and their position and responsibilities in the network of nationally operating institutions. Where these roles and responsibilities are clearly spelt out, institutions are more likely to be held accountable for their actions. It can also more easily be verified whether institutions articulate with one another, both horizontally and across scales, so that a more holistic approach to development can be taken. In Ethiopia, for example, the ramified network of extension agencies covering virtually all households in the villages in which they operate, supported by integrated development programs operating at the national level, provides just such an integrated institutional framework. It provides authorities with the ready means to reach households. Moreover, the broad scope of public investment programs in Ethiopia, which make investments both in public (roads, irrigation canals) and in private domains (assisting households with individual adaptive strategies), strengthens both the enabling environment and households' individual capabilities to improve their own situation.

Costing Adaptation

The household surveys provided additional insights into the types of investments that stakeholders need to make in implementing adaptation strategies. Households often lack the knowledge, skills, labor or financial means to select and implement adaptation strategies on their own, without institutional assistance. Given the general lack of information on the costs of adaptation strategies, however, together with a degree of reluctance on the part of respondents to answer somewhat sensitive questions regarding costs, it was not possible to elicit reliable quantitative data on the costs of different adaptation strategies in absolute terms. Corroborative data on such costs from other sources are also practically non-existent. For these reasons, we chose to apply a qualitative method for assessing the relative costs of various adaptation strategies at household level.

In order to properly interpret the findings of the qualitative cost assessment, it is important to bear in mind the extremely limited investment capacity of most of the households surveyed in all three countries. Average annual household incomes in Ethiopia and Mali range between US \$150 and US \$250 equivalent. In Yemen, with average annual household incomes of around US \$1,000 equivalent, investment capacities are significantly higher. Across the three countries, rural households spend 50 percent to 80 percent of their income on food, leaving little surplus for making productive and/or adaptive investments.⁷

Against this background, observed annual costs for adaptation strategies in Mali were in the order of XOF 110,000 (US \$200) per household, mainly as a result of the high upfront investments required for cereal banks (without cereal banks average costs are XOF 63,000 or US \$120).⁸ For Ethiopia, average annual costs were in the order of Birr 780 per household (US \$57). Excluding communal adaptation strategies, costs per household for individual strategies were in the order of Birr 575 (US \$43). For Yemen, irrigation schemes were the costliest strategies (YER 680,000 = US \$3000), while other strategies are much more inexpensive, in the order of YER 40,000 per household (US \$182). These figures do not represent the net costs of investments in adaptation, however, as they also include regular expenditures on seeds, fertilizer and other 'normal' inputs. They also do not take into account the opportunity cost of household labor, as this was generally not regarded as a 'cost' on the part of respondents. But for Mali and Ethiopia in particular, it is clear that adaptation-related costs actually incurred by households already represent a relatively high proportion of household expenditures.

The results show that low-cost strategies from which households can expect immediate gains are already widely adopted. This is especially true of sensitivity-reducing agricultural strategies (e.g. seed selection, adjusting planting dates, changing cropping densities) for which little institutional assistance is required, although with additional training the effectiveness of these strategies may be increased. Institutions can also play a role in removing some of the barriers to adoption, such as market rigidities that may inhibit the purchase of inputs or sale of proceeds. Without institutional assistance, rates of strategy adoption may quickly reach a point of saturation, and more innovative and costly strategies (e.g. to deal with more severe climatic extremes) may not be developed at all. The low adoption rates of communal strategies in Mali and Yemen already provide some evidence for this. In order to better prepare households in Mali and Yemen to deal with future climate extremes, greater cooperation between households and institutions is likely to be necessary in order to develop innovative strategies capable of meeting the new challenges.

⁷ For Yemen, food expenditures are estimated to be around an average of 45% of household income, rising to 60% for the poorest quintile (WFP 2010). For Mali and Ethiopia, average food expenditures reach 75% of household income, rising to 82% for the poorest quintile (Kpodar 2006, World Bank 1998).

⁸ Exchange rates for December 2010.

A number of other low-cost, individual strategies, such as handicrafts or sale of non-timber forest products, are selected by only a few households. Home-garden agriculture, for example, could potentially benefit many more households if it were more widely adopted, and might be expected to yield high returns in terms of both cash earnings and nutritional status of household members. But there may be several possible barriers to its wider adoption:

- markets for home-garden produce may be too distant or unknown;
- inputs may be difficult to acquire if markets are missing (e.g. for seeds or irrigation/ watering equipment);
- households may lack the requisite knowledge (e.g. of post-harvest storage techniques); and
- periods of peak labor demand in home-garden agriculture may coincide with those for other farm activities.

Alternatively, households may not perceive certain individual adaptive strategies as being significant in improving livelihood security even if the net benefits can be shown to be positive. For many respondents, agriculture has always been the principal income source, with very few supplementary sources of income other than, perhaps, remittances from migrant family members (whether seasonal or longer-term). There have been few incentives to innovate in order to further diversify livelihoods, particularly where levels of education or awareness of potential opportunities are low; and where institutional support in the form of training, awareness raising, or dissemination of good practice examples may be lacking.

The adoption of more costly individual adaptation strategies such as water harvesting, improved food storage, or the use of individual (e.g. pump or borehole) irrigation is also hampered by knowledge and credit constraints. While such strategies may have positive expected net benefits they also require higher levels of skills and financial investment. In many areas of Yemen, the use of pumps for irrigation is a basic necessity in crop cultivation. Households finance this necessary investment with income from the sale of cash crops. But as a result they also run the risk of not being able to operate and maintain their pumps if revenues are lower than expected owing to a poor harvest in a given year, which may create new forms of vulnerability through indebtedness. Owing to the possibility of default, rural households are not always keen to take on additional debt (Stringer et al., 2009). In Ethiopia, several of the costlier adaptation strategies were adopted through cooperation between households and local authorities or locally active NGOs. In Mali, the more expensive individual strategies were barely used, since the required institutional assistance to support such strategies was lacking.

The adoption of communal strategies requires strong coordination among households in order to avoid free-rider behavior and share the costs and benefits in a fair and equitable manner. While the expected net benefits of such strategies are in many cases positive, their adoption may be constrained by lack of investment financing and managerial skill. Such strategies often carry high costs which are beyond the means of participating households themselves, and which may only be recovered over several years. Close involvement of public institutions or NGOs may be needed to facilitate access to skills or credit. Of the three study countries, only in Yemen are strategies that require significant financing adopted without significant assistance from formal institutions.

Communal strategies often require technical or organizational skills that most households do not possess. Informal, community institutions may play an important role in catalyzing the necessary levels of collective commitment among participating households. But under pressure from changing economic or

political circumstances in each of the three study countries, the character and strength of social networks have also changed. Social cohesion has often declined, thereby reducing the likelihood that collective agreements can be reached to undertake joint investments. Training and awareness-raising on the part of institutions to disseminate knowledge on the costs and benefits of various strategies may help to improve this sense of collective responsibility, and perhaps encourage households to choose higher-risk, higher-reward communal strategies rather than individual strategies alone. Finally, institutional support usually needs to be provided in a consistent manner over extended periods, whether from public authorities, NGOs or informal, community institutions. Well coordinated, longer term and consistent commitments from international donors may also have a role to play.

Three broad conclusions can be drawn from the above analysis of the costs of adaptation at household level. First, individual strategies with lower demands in terms of financial cost, labor and skills are already widely adopted by virtually all respondents in the village surveys in Ethiopia, Mali and Yemen. While the direct, monetary rewards of such strategies may be limited, they nonetheless play an important role in reducing household-level sensitivity to climatic extremes.

Second, there may be significant barriers to the adoption of other strategies, even if net benefits are expected to be positive, owing to their financial, labor, knowledge or skill requirements. But the particular barriers to adoption differ widely among alternative strategies. Wealthier household clusters with higher cash income, more assets, and more diversified income sources may be able to pursue more costly strategies to reduce their sensitivity to climate extremes or increase their coping capacity in the face of such variability. Larger households, with many productive household members, can adopt more labor-demanding strategies. Better-educated households, having a larger share of household members with at least primary school education, may be better able to select strategies that best fit their distinct livelihood profiles. Various forms of support from formal and informal institutions may lessen some of these constraints, but carefully targeted and tailored approaches to relieving such constraints will often be required.

Third, the successful implementation of communal adaptive strategies usually requires facilitation or support from formal and/or informal institutions in the form of awareness-raising, efforts to catalyze collective commitments, technical expertise, financial support or managerial leadership. Each of these individual cost elements may impede the adoption and successful implementation of communal adaptation strategies in different circumstances. Long-term commitments on the part of international donors may help to lessen some of these constraints. Some of the requirements are specific for particular strategies, while others call for more general investment in the public goods necessary to create an enabling environment for adaptive livelihood practices to be sustained over time.

4. Conclusions and Recommendations

Village surveys in Ethiopia, Mali and Yemen generated a number of insights into differences in household-level vulnerability to climate variability, types of adaptation strategy adopted, barriers to adoption, and types of assistance that institutions do or do not provide. These insights allow a number of conclusions to be drawn on the patterns observed, and recommendations to be made on possible future directions for development intervention, both at the level of household strategies and at the level of institutions that can mediate forms of support.

First, household characteristics are often more important determinants of vulnerability than physical exposure to climate hazards. In the three study countries, drought is the most prevalent climate-related hazard and is regarded by most households as a larger threat than flood, extreme rainfall or extreme temperatures. Nonetheless, even those households less exposed to drought may still be very vulnerable if they are highly sensitive and/or have low coping capacity. External intervention therefore needs to encompass both sensitivity-reducing and coping capacity-increasing measures. Sensitivity to climate variability can be reduced in mountainous areas by investing in measures to reduce the rate of surface run-off and improve infiltration rates (e.g. soil erosion prevention, terrace rehabilitation) and in water resource management (water storage and irrigation). Coping capacities can be increased through expanding income-earning opportunities and improving levels of education.

Second, interventions need to be tailored to meet the particular needs and priorities of distinct groups. In Yemen and Ethiopia, differences in household characteristics within and between villages are considerable. As a consequence, a diverse set of strategies needs to be pursued within each village, taking into account the different characteristics of households. In all three countries, asset-poor households generally have greater difficulty in overcoming barriers to the adoption of the more demanding and costly communal strategies. Strategy choice is also quite strongly gendered, albeit in different ways among the three countries. While men make virtually all decisions in Yemen and Mali, the role of women is relatively more important in Ethiopia. However, women generally receive less assistance from institutions than do men. Interventions therefore need to be targeted in such a way that they reach the most vulnerable groups, including women. Even low-cost, sensitivity-reducing strategies (e.g. seed selection, modification of planting dates) or low-cost strategies to increase coping capacities (e.g. home-garden agriculture, petty trade) may yield lower returns unless institutional support is targeted towards those groups that need it most.

Third, the results confirm that effective institutions are needed for the successful implementation of new adaptive strategies. Well-functioning formal and informal institutions can help improve the effectiveness of even traditional, low-cost strategies that have already proven their value (e.g. uptake of drought-resistant crops). Formal institutions and public investment can help overcome the market-related, financing and knowledge constraints that may prevent new initiatives from being sustained, such as through the supply of affordable credit, and infrastructure including roads, electricity and telecommunications.

These results point to four conditions as being important for the effective institutional mediation of household-level strategies to adapt to increasing climate variability: (a) strive for a high degree of coverage of formal institutions at national level and a strengthening of informal institutions at village

level; (b) ensure the long-term presence of institutions at village level; (c) facilitate coordination and cooperation among institutions both horizontally and between local, sub-national and national scales; and (d) prioritize investment in training and awareness raising over input provisioning and financial assistance.

First, more complete institutional coverage at national and village levels leads to the adoption of both a higher number and a more diverse set of adaptation strategies. The share of households adopting strategies and the number of strategies adopted per household varies significantly among the three countries studies. Rural households in Ethiopia tend to use more community-based and more innovative strategies. In Mali and Yemen, where support through institutions ranges from limited (Mali) to negligible (Yemen), households tend to choose more individual and proven strategies that can be pursued without the need for external resources. Where institutional coverage is higher, the likelihood is increased that more vulnerable or marginalized households can be identified and supported.

Second, longer-term institutional presence within villages is necessary for building relationships of trust and for galvanizing collective commitments among households. This is particularly necessary for joint activities to improve livelihoods and in realizing additional gains through cooperation in more demanding, communal strategies. For asset-poor households in particular, the adoption of more demanding strategies such as communal irrigation, reforestation, soil erosion control and terrace rehabilitation is hampered by managerial, knowledge and technical constraints which can only be overcome through the sustained mediating role of institutions over the long term.

Third, coordination and cooperation among institutions makes it easier to reach more households. Promoting effective adaptation requires institutional articulation on each of three levels, and among these levels.⁹ At the community level, informal institutions play an important role in creating the conditions for inclusive forms of collective action and for the diffusion of knowledge about good practice examples. In Mali, community institutions play a much smaller role than in Ethiopia, perhaps because Malian rural households tend to be so large as to constitute collectivities in themselves. In Yemen, the strong clan culture explains why communal strategies such as terrace rehabilitation and irrigation can be applied without much outside assistance. At the regional level, coverage of a large number of villages is likely to require the engagement of public extension agencies or NGOs. The network of extension agencies in Ethiopia is a good example. In Mali, regional-level institutional assistance is fragmented among a number of NGOs, which inhibits effective coordination and institutional articulation. At the national level, formal coordination of interventions can help avoid duplication of effort; makes it easier to disseminate good practices and lessons learned; and makes it more likely that macro-level constraints can be addressed on the part of the relevant authorities. It depends on the country context whether this is best achieved through formal, government extension agencies (as in Ethiopia) or through non-governmental channels (as in Mali).

Fourth, in spite of its importance, institutional support in the form of training is conspicuous by its general absence. Training and awareness-raising are important ways to impart to households the knowledge and skills to make their own informed choices and to create a sense of ownership over the strategies adopted. Without such a sense of ownership, households will tend to remain dependent on external institutional

⁹ A parallel study by the World Bank's Social Development Department also concludes that assistance to households in facilitating adaptation to climate change should include cooperation among community-based organizations, local administrative and technical services, traditional rulers and civil society organizations (World Bank 2011b).

assistance. In both Yemen and Mali, institutional support in training is virtually absent. The Ethiopian network of extension agencies is a notable exception in that it does invest in training, particularly in helping to realize communal strategies (e.g. irrigation schemes, community reforestation).

To conclude, the results of this study provide support for the view that climate change adaptation strategies need to go hand-in-hand with integrated approaches to sustainable development (cf. Schipper 2007). Single-issue focused approaches are unlikely to yield strong results. This is because a variety of constraints, operating at household, village, sub-national or national level, may differently prevent households from preparing adequately for changing climate variability, depending on the particular characteristics of those households and their livelihood strategies. It is important that further steps are taken to mainstream climate change adaptation at the policy and program level across all the relevant sectors within developing countries, and to ensure that climate change adaptation is not left the responsibility of a single ministry or agency nor a parallel structure (see also Kok and de Coninck 2007, Stringer et al. 2009). Owing to the rich diversity in the circumstances that prevail among vulnerable households in most countries, there can never be a single, one-size-fits-all adaptation strategy. This study adds to the growing literature that supports the view that in order to develop appropriately tailored adaptation strategies, institutional presence at different scale levels and institutional articulation across scales are critical ingredients of success.

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