MIGRATION CAUSED BY CLIMATE CHANGE: HOW VULNERABLE ARE PEOPLE IN DRYLAND AREAS?

A Case-study in Northern Ethiopia

ELISABETH MEZE-HAUSKEN
Department of Geography, University of Bergen, 5020 Bergen, Norway

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Abstract. Climate change has been presented as a likely trigger for migration of people, especially in dryland areas of less developed countries. The underlying research questions focus on the strength of adaptation capacity of subsistence farmers in Northern Ethiopia, and evaluate historical experiences gained from drought-induced migration. Through a survey of 104 peasants who had to migrant due to persistent drought, vulnerability to climate change has shown to be a complex issue, including the multiplicity of factors comprising a household environment. Still, to be vulnerable does not make someone a potential climate migrant, as people in marginal regions have developed a great variety of adaptation mechanisms, which strengthen their ability to cope with both, slow climatic changes and extreme climatic events.

Keywords: climate change, Ethiopia, historical analogy, migration, vulnerability

1. Introduction and Objectives

The fact that climate can trigger waves of migrants is not a new notion. Throughout the whole human history, weather-related human movements have left their traces. Wood (1995) reminds us that *Homo erectus*' ancestors migrated out of Africa some million years ago, maybe driven by (un)favourable climate in the home- or receiving area. Ancient populations settled in North America after crossing the Bering Strait to Alaska during the milder periods of the middle of the last ice age. And tribes invaded prosperous Egypt 4000 years BP while pressed by drought and resource deficits in their own countries (Lamb 1995). It is evident that past climatic changes have contributed to a considerable extent in shaping today's population distribution on the globe.

Since the first report of the Intergovernmental Panel on Climate Change in 1990 (Houghton et al. 1990) research emphasis has been placed on two issues, (1) how anthropogenic emissions have and will in the future contribute in changing global climate, and (2) how this human-induced climate change might affect human life and nature. Although climate change, especially on a regional scale, is, in many respects, uncertain (Mitchell and Hulme 1999), it involves a potentially serious threat to vulnerable populations. Reactions to extremes in climate variables such as temperature, precipitation and wind, as well as simple preferences or dislike and stress, might find their outermost expression in human migration to more suitable

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regions. The IPCC (Houghton 1996) has identified a number of potentially serious climatic changes, including an increase in the incidence of drought in regions like Africa. Pessimistic predictions estimate many millions of refugees by the middle of next century, driven by hunger, drought and climatic extremes such as hurricanes or flooding as a result of global climate change (Myers and Kent 1995; Martin and Lefebvre 1995; Trolldalen et al. 1992; Ayres and Walter 1991). This raises speculations about dramatic population movements in the decades ahead.

Research in climatic-induced migration involves three broad thematic areas of discourse: climatic reconstructions as the documentation of short- and long-term chronologies in climate change, analysis of impact of climate on social life, and the investigation of climate as a motivating factor for migration. But so far much of the literature considers environment-migration relations at a very general level. The arguments are often Malthusian and draw on little localised empirical research on migrant coping strategies (McGregor 1993). Gosh (1992) and Lohmann (1994) present a typology of migrants based on four root causes of migration.

- survival migration
- opportunity-seeking migration
- environmental migration
- flight due to persecution and conflict

In the first three causes or motivations, climate could be a driving force for population movement, and in the fourth, climate and environmental degradation could trigger resource conflicts resulting in migration. When analysing historical and contemporary cases, climate *per se* is seldom found to be the root of migration, but rather one that exacerbates difficult living conditions at the margin of subsistence (Kritz 1990). Therefore, other influences like political, economic or ethnic conditions should not be neglected when dealing with impacts of environmental and climatic change on migration.

In the underlying study, I investigate empirical consequences of climatic perturbations on human adaptation and migration in dryland Africa. Particular focus in placed on subsistence farmers in mixed agricultural systems, living in regions characterised by aridity (low rainfall or evapotranspiration exceeding precipitation most of the year) and high interannual rainfall variability (for a comprehensive discussion on dryland definitions, see Mortimore 1998). The hypothesis is that experience from past drought behaviour during the last decades can serve as an analogy for impacts under future climate change. It is evident that there are multiple, dynamic and complex factors involved in motivating migration. However, within the limited framework of this study, I will mainly concentrate on elaborating the links between climatic events and people's vulnerability to it, and how people cope with such crises in reducing the risk of climatic induced migration. In specific, the paper will discuss (1) how severity of climate variability can be assessed, (2) what indicators describe vulnerability of households to climate change and the relationship between climate vulnerability and number of months after onset of a drought until a household migrates, and (3) how survival strategies contribute

Figure 1. Site map.

in withstanding a crisis as well as the importance and chronology of individual survival strategies adopted during drought.

2. Material and Method

The approach is based on a historical analogy with data derived from a field-study in Tigray, North Ethiopia (see Figure 1) and from findings in the literature. The analogy approach, although providing only rudimentary approximation of regional impacts in the future (Glantz 1991) serves to identify societal response to regional climate change. Analogies can also be drawn between physical changes that have occurred (e.g. dry periods) and those likely under future anthropogenic global warming. Although acknowledging the non-linearity of human reactions to recurrent events, it is based on the premise that households will in the near future conduct adaptation strategies similarly to those in the recent past. According to Glantz (1991), 'historical studies have an air of reality that gives their findings a level of credibility that computer generated scenarios of the future lack'. The information gained by analogy approach is based on real events and cannot easily be dismissed as mere theorising or scare tactics (Glantz 1996). In such lies its potential value in identifying society's strengths and weaknesses in dealing with

climate events by analysing the recent climate history, regardless of the cause (Cortner 1990, quoted in Glantz 1996).

Forecasting potential human impacts by analogy requires baseline information on recent climatic conditions which have some probability of representing the situation under future anthropogenic climatic change. The importance of good analogies is not so much the number of similarities between a chosen past situation and a likely future, but rather the significance of the similarities (Jamieson 1988). Ethiopia is known for its generally high rainfall variability. The well-known droughts of the 1970s and 80s prevailing over the whole Sahel including large parts of Ethiopia serve as an especially useful baseline. Abundant documentation, particularly the countless empirical-technical reports on famine and farm coping strategies which have been produced by aid organisations and research institutes during the late 1980s and early 1990s, assess the extent of the great famine years between 1983–85. When giving recommendations about adaptation actions to reduce the likelihood of famine, these reports do not incorporate the possibility of a future climate change with long-term consequences on farming systems. Still, they serve as a highly valuable resource for baseline information on drought vulnerability and impacts at the household level. Knowledge gained by analysing them and comparing them with first-hand information of drought migrants and aspects of future climate change can provide some key information to policy makers on likely impacts regarding human outmigration from areas with unreliable rainfall. Still, the possibility of surprise of either climatic situations or human response should be included.

During the fieldwork in southern Tigray, a rapid rural appraisal on 104 former drought migrants was performed, as well as interviews with administrative personnel and project planners for disaster prevention. The task was to investigate how an individual becomes a climate migrant. Distinguishing a ‘climate migrant’ from a political migrant demanded that the former migrant himself personally perceived drought or the climatic situation as the main, and often only reason for migration. Due to the fact that the drought episodes during the 1970s and 80s in Ethiopia coincided with civil war, the interviewees had to be selected carefully in order to exclude those for whom the political situation had been a driving force and climate instability only an exaggerating factor for their migration decision. My interest was to characterise such migrants by the features making them vulnerable to drought disasters and to follow chronologically the actions they undertook from the onset of drought to avert famine until migration. The aim was to develop qualitative impressions rather than to obtain a quantitative and statistically representative sample. Statistical data on migrants during past drought decades state questionable and inconsistent numbers (Wolde Mariam 1994) ranging from 116,000 to 1.32 million of the 2.4 million Tigrinian population in during the beginning of the 1980s and 5.6 million internal Ethiopian migrants. (Office of the Population and Housing Census Commission 1991). It would be misleading to declare the majority of them as purely climate migrants, due to coinciding political instability. Still, as rural Tigray

has mostly mixed farming systems, based on rain-fed crops such as wheat, barley and teff (*E. abyssinica*, a main cereal in Ethiopia), as well as grazing animals, they all were at least partially affected by harvest failure and water scarcity. It can be assumed that the further they lived away from roads, the less civil war was an influence factor for their migration decision.

These 104 former drought migrants were originally from subsistence farming households, living today within a one-hour drive from the main road between Addis Abeba and Eritrea in South Tigray. The questionnaire collected data on individual in- and return-migrants. In-migrants were those who moved to the area from another region due to drought and stayed there. Returnees came back to the place of origin, some right after the drought, most a couple of years later. Those who ended up in Eritrea returned in 1998 forced by the ongoing conflicts between the two neighbouring countries. The people were asked about living conditions before the drought which resulted in migration; the onset of drought, resulting coping mechanisms and migration process; experiences of earlier droughts; perception of current environmental degradation; and expectations regarding the future of their children. For the in-migrants only, additional information regarding reasons for not returning, as well as revisits to and impressions of the place of origin were investigated. The survey was not restricted to behaviour during a specific drought period but covered drought and migration during the memory span of a person. The rationale was to have the general process of migration in mind, regardless of influences by ongoing political conflicts, land reform etc. One shortcoming of this approach could be neglect in the analysis of how people's behaviour was affected by the political changes from a monarchical to a dictatorial and finally a democratic system. Still, as for the future, the political situation cannot be predicted at all and the climate condition only with some amount of uncertainty, it is mainly the broad and general response of households to climate events, which makes sense to be evaluated and possibly extrapolated into future climate change scenarios.

Ethiopia has a very fragile environment, characterised by high level of soil erosion (e.g. Kuru 1986; Transitional Government of Ethiopia 1992) and deforestation (Transitional Government of Ethiopia 1992), a process which slowly but surely has occurred over large stretches of the country since medieval times (Pankhurst 1992). With its long agricultural history (Wudassie 1991), natural resource depletion and environmental degradation by progressive occupation of marginal lands has occurred, producing a society which is very sensitive to fluctuations in natural events. The reason for choosing the Tigray area was that the region has had a comprehensive history of droughts and famines (see Table I further below), the earliest recorded one occurred in 253–242 BC (Degefu 1987). Even if the accuracy of dating famine events might be lacking in the early years of the records, it certainly gives clear indication of the deep-rooted experiences people have in averting famine. Since the land reform in 1975, all land has been owned by the state and distributed to the people according to household size (difficulties arising from this are described by Wolde-Georgis 1993). In Tigray, land holding size is currently

about 0.3ha per capita (based on population and housing census 1994 for Tigray Region) with average yield for all the crops in the region of about 5 quintals/ha (Ezra 1997; 1 quintal ≙ 100 kg).

Tigray has two types of rainfall regimes, monomodal in the western and central parts and a bimodal one in the east (Transitional Government of Ethiopia 1992; Degefu 1987). Here farmers have registered a gradual reduction in the short spring rains and a tendency towards a more frequently delayed main rainy season since the seventies (Marque and Rosenwald 1997). This trend has been corroborated, when studying the agricultural calendar, by a generally shorter growing period since the 1970s compared to the 1930–50 period (Marque and Rosenwald 1997). Total amount of rainfall lies between 400 and 800 mm per year in most parts of Tigray with precipitation exceeding evapotranspiration only during July and August. Nearly all land is rain-fed agriculture. Nevertheless, farmers have adapted to the long-term water supply conditions and are successful in coping with short-term rainfall deficits.

3. The Conceptual Framework

Deducible from the paper title, the topic covers several disciplines and as such could be approached from a variety of angles. Although investigating a specific climate impact, this research should not be considered as a traditional climate impact assessment (IPCC 1994; Parry and Carter 1998) following a seven step framework beginning with definition of the problem (drought migration) to development of scenarios (for example 30% outmigration due to 40 percent reduction of rainfall by 2030) through to the establishment of adaptation strategies for averting the impact in the future. Instead, the focus is set on understanding and analysing the links and processes between climate and human actions in a more general perspective rather than describing specific states.

Migration is considered to be a second order climate impact having its roots in directly affected processes such as agricultural yield and growth, water supply, soil formation, and pest infestation. As such, the cause-effect relationship between climate and migration is not so obvious to allow a straightforward approach. There are two explanations for this. First, climate change, and in specific drought is obviously only one out of many factors causing migration. And second, drought-induced migration is in many cases a result of famine. But not every drought necessarily leads to famine, and conversely, not every famine has its roots in drought. In addition, even during a famine, people have many possibilities other than migration for coping with such disasters.

Much research has been done on the causes of famine in Ethiopia, although no definite conclusion exists about its origin. Perceptions of the problem differ with reference to the relative importance of war, policy failure, food distribution problems, poverty, subsistence farming, environmental degradation, population in-

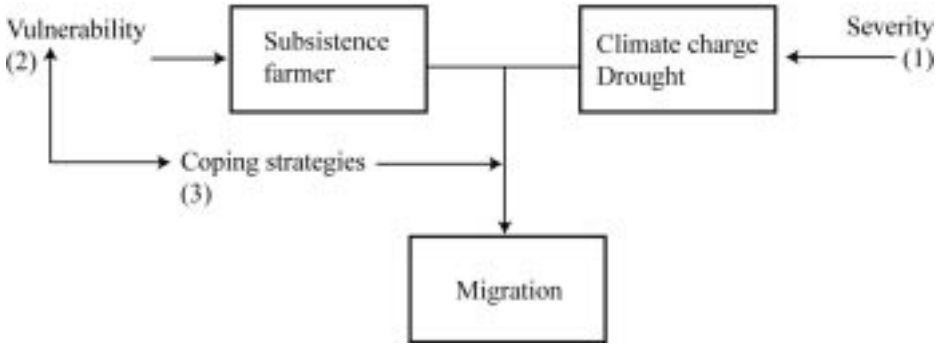

Figure 2. Climate change and migration framework.

crease, land holding policy, entitlements, etc (Wolde Mariam 1994; Wolde-Giorgis 1989; Alemneh 1990; Pankhurst 1988). It would be tremendously difficult and subjective again, to rank these factors, as their importance varies from region to region and from household to household. Still, for most farmers, the link between rainfall failure, pest and disease on the one side, and agricultural output on the other side is indisputable.

The following presents a simplified model of migration as a response to climate change. The framework consists of three components, each with one contributing variable (Figure 2). The components include a farmer, his exposure to climate, and a possible migration. Still, how a farmer then finally reacts to changes in climate, depends on the severity of the change, his vulnerability and the available strategies in order to avert the worst impacts. The components and variables are first described theoretically, then empirical results from Tigray – as an example of a dryland agricultural region – are presented.

The first component concerns the individual in question, a subsistence farmer in dryland Africa. He or she is tied intimately to the land of his ancestors, the culture and social traditions of the place of origin. Still, the farmer is permanently preoccupied with attempts to alleviate the nagging daily hunger (Wolde Mariam 1994). The familiarity with high year-to-year variability in rainfall has made one's life well-adapted to such marginal lifestyle, either by holding animals to be sold during dry years, by off-farm livelihood activities or by seasonal migration. It should be noted that the environmental context within which a farmer has historically adapted is not simply climatic, but includes other perturbations like disease, erosion and weed infestation. Although in some cases self-supporting, the contact to the local market for buying and selling crops is vital. Rarely more than the basic human needs can be covered, thus even in years with sufficient rainfall, the farmer struggles in securing food for his family. During 1994–95 where rainfall was considered sufficient, not more than 18% of the people in Tigray were self-supporting (Wolde-Georgis 1993). Still even this does not necessarily mean adequate food but rather

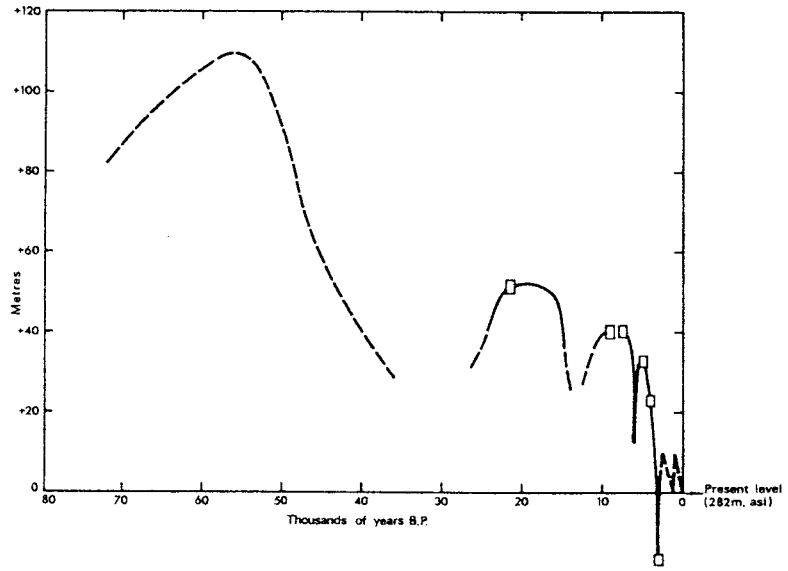

Figure 3. Variations of the level of Lake Chad over the last 80,000 years (Lamb 1988, with permission).

chronic undernourishment. Fifty-six percent of the population had a food shortage of between four and nine months (Planning Office Tigray 1997).

The second component relates to climate with rainfall variability as the most critical characteristic of African climate for resource application (Hulme 1992). We have to distinguish between, but not necessarily separate, two types of climatic issues: single drought events and long-term change in climate, whereby short-term instability (drought) can be superimposed on longer-term transitions (Mortimore 1998). Changes for African dryland climate can result in

- a shift towards warmer, colder, wetter or drier conditions
- narrowing or widening in the rainfall variability
- a decrease or increase in the range of occasional events (Lamb 1988).

Climatologically, droughts are slowly evolving phenomena, and their arrival cannot be determined with precision. They can be described as a continuous period during which a cumulative rainfall deficit exceeds the drought threshold, a level pre-defined by a deviation of the rainfall mean (Tarhule and Woo 1997) and includes the temporal distribution of rain within a rainy season. Whether rare and long dry spells lasting a succession of years or even decades can be ascribed to a transitional phase in climate change, depends on the historical time span (10 years–1000 years) in focus. So-called 'normal' rainfall in the semiarid tropics is perhaps fictional. For subsistence farmers with rain-fed agriculture variability is the current norm (Watts 1983). Mortimore (1998, p. 180) defines dryland ecosystems as '(a) unstable and disequilibrial in the short term, and (b) transitional in the long term, fluctuating on a historical time scale between humid and dry climates over large regions'.

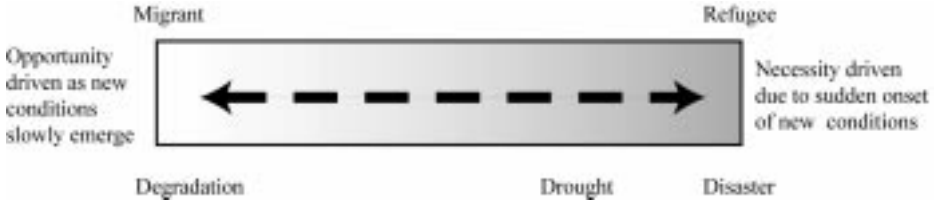

Figure 4. Labelling of relocated people under different types of environmental change.

Predicting future climate raises questions regarding determinants of past climate in Ethiopia. Long term changes over the past 10,000 years have their main causes in external factors such as changes in the earth's orbit around the sun and internal factors related to global atmospheric concentration of carbon dioxide (e.g. Houghton 1994). But except for the last 150 years, CO_2 concentrations have been relatively stable during the last 4000 years (Hulme 1990 in NEDECO 1997). A study aimed at deriving sub-Saharan precipitation from variations in the level of Lake Chad (see Figure 3), shows that there have been considerable shifts between wet and dry climates, sometimes sharp, sometimes smooth, explained by changes in the global energy budget and manifested in changes of the atmospheric and oceanic circulation. Specifically, for Ethiopia, rainfall regimes have been mainly determined by large-scale circulation changes such as the movement of the Intertropical Convergence Zone (ITCZ), bringing the monsoon rains, and less regional-scale phenomena such as desertification (Nicholson 1989).

Migration is the third component, defined in this case, when a farmer leaves his home due to climatic-induced reasons. Conceptually, we distinguish climatic disasters such as drought from environmental degradation and long-term climatic changes. Emanating from this, one could logically refer on the one end of a continuum to migrants as those displaced by slow environmental change (e.g. land degradation, deforestation), where migration is mainly driven by better opportunities somewhere else, and on the other end of the continuum to refugees who are driven from home by necessity, as their pure survival is at stake (see Figure 4). Refugees, in the context of environmental change, are exposed to natural disasters with rapid onset and rather unexpected occurrence (e.g. tornadoes, tsunamis). But within this article, out of practicality the term 'migrant' refers to both, slow and sudden changes in climate, whereby the notion 'distress' migration relates to the specific emergency situation.

Burton et al. (1993) show four characteristic patterns of behaviour of people living in a hazard zone: (1) deny the hazard, ignore it, (2) tolerate the prospective loss without taking countermeasures, (3) take action to prevent impacts in their location and (4) take significant action including abandoning the hazard zone.

Under elemental and rapid-onset disruption, migration can be considered as the final, and often desperate step in a chain of actions to avert starvation and death. In such cases, push factors are the dominating driving force for moving. The flight

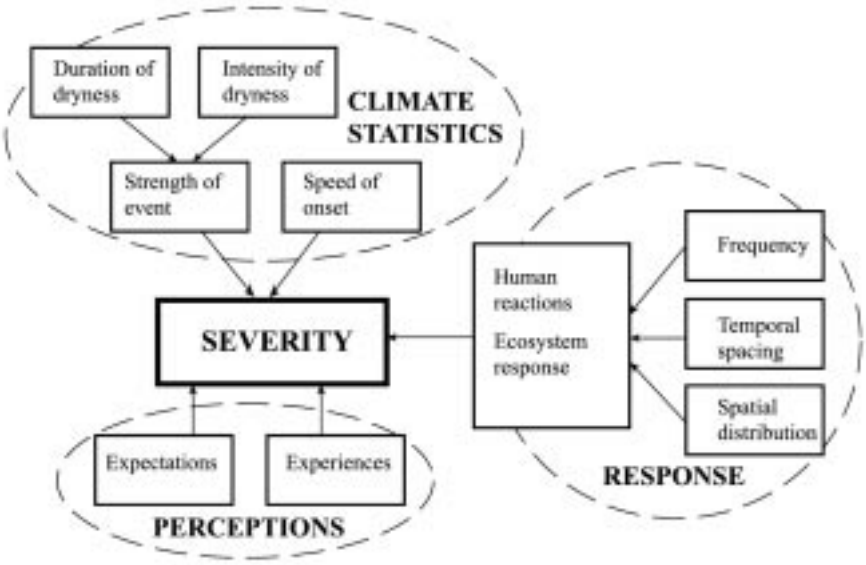

Figure 5. Operationalization of the severity of a climate event.

towards camps, towns and relatives is often linked with the strong hope to return as soon as the conditions allow it. But when migration follows slow-onset changes in climate and environmental conditions, it is often associated with the abandonment of one's land. The migrant's action then is to search for a better living somewhere else as prospects of sustainable farming income cannot be guaranteed any more. Pull factors such as labour demand, land availability and fertility and reliability in rainfall attract the migrant. Slow and rapid-onset disruptions have in common that migration involves a deliberate choice, where individual costs and benefits of relocation are evaluated. But it includes a good proportion of personal perceptions, emotions and pessimism about future climate and living conditions at the place of origin.

3.1. SEVERITY OF EVENT

When reports or newspapers describe the severest drought in human memory or damages caused by a prolonged and severe drought, it is essential to understand the deeper meaning of severity. The severity of an event has a time and a space component, whereby space can be, but not necessarily is, correlated with the number of people affected by the event. The difference between a climate event and a climate change is one of time span. An accumulation of events or an increase in duration of events above a pre-defined threshold could be considered as a climate change, depending on the aspect in focus and relative to some time frame. Still, among climate scientists there is no widely accepted theory about what time frames should be preferred for distinguishing a climatic change from climate events or

climate variability (Jamieson 1988). Operationalizing the term (see Figure 5) can be done by indicating the 'strength' and the 'speed of onset' of a climatic event.

'Strength' in this drought study refers to the duration of dryness, and the intensity of dryness, for example a percentage of rainfall reduction from the mean. 'Speed of onset' could be expressed by how fast the changes in climate occur, for example a slow reduction in rainfall over a long-term period, compared to a sudden switch towards drier conditions. These variables, strength and speed, can be determined by standard statistical analysis of climate data. But climate statistics are not enough to capture the true implications of such events. Instead, the ecosystem and human response arising from climate events have to be included when describing severity. And this depends on the frequency of events (the number of events per period), the temporal spacing (how closely the events lie to each other in time) and the spatial distribution within a region. It can be argued that annual rainfall deficits have a cumulative effect (Tarhule and Woo 1997) such that a succession of drought years will lead to a worsening of a drought overall, especially related to agriculture, but less in hydrological or climatological terms. A regionally restricted drought will lead to much less dramatic impacts than, for example, the 1984–85 Ethiopian drought prevailing over large parts of the country.

But drought is not simply a climatic anomaly, but the social perception of a natural phenomenon (García 1981). Perceptions are to a considerable extent formed by expectations one has about a certain issue, and experiences from similar past events. An Irish farmer would probably consider a month without rainfall as a drought; whereas people in Ethiopia might have quite different views about such weather phenomena. The reason for this might be that when we speak about drought we do not think about natural conditions objectively, but in terms of their effect on man. Based on this, the 'severity of an event' can be equivalent to 'damage', the 'loss or harm resulting from injury to a person, nature, property or reputation'. Damage stems less from a straightforward reduction of rainfall, but from a combination of natural as well as socio-economic, technological *and* perceptional conditions. Perceptions can aggravate a situation and even 'produce' a drought even if the seasonal quantity and distribution of rainfall is sufficient, as people do not recognise that the causes for reduced water availability stem from for example increased river runoff due to deforestation (Du Toit 1985).

3.2. VULNERABILITY

Human vulnerability is the second precondition determining the impact drought might have on migration. Vulnerability is a widely used and often arbitrarily applied term referring to the weakness or inability to cope with a specific situation or event. The IPCC (Watson et al. 1996) describes *vulnerability* as 'the potential for negative consequences which can be defined at different scales, including yield, farm or farm sector, regional economic or hunger vulnerability'. Vulnerability is the product of a system (Wolde Mariam 1994) and – for assessing human welfare

– derives from aggregating environmental, social, economic and political exposure (Downing et al. 1996; Downing 1991). The concept refers to the consequences of harmful perturbations and attempts to investigate the reasons and sources of this weakness. Garcia (1981) mentions the high structural vulnerability imposed on a society by unstable socio-economic and political situations and low levels of infrastructure and technology. A more radical view relates vulnerability to the theory of marginalization (Susman et al. 1983). It emphasises that vulnerability differs between social classes, implying that some people have to move to or live in risky areas because of a lack of choices. Created by social forces, vulnerability is exacerbated by intervening adverse effects of a physical nature (Wolde Mariam 1994). Depending on the structural situation, vulnerability can be chronic, such as deep-rooted malnutrition, or transitory (Crawshaw and Shaw 1995), presuming that the precarious period can either be overcome by either itself or by external intervention. Resilience as a loose antonym for vulnerability increases the capacity to cope with stress or perturbations (Maxwell and Frankenberger 1992; Adger 2000). But under significant stress, population displacement is often an indicator of the breakdown of social resilience (Adger 2000).

To be vulnerable presumes to be in risk of (1) exposure to a crisis, (2) severe consequences, and (3) inadequate capacity (Bohle et al. 1994; Downing et al. 1996). The risk of exposure covers the physical side of an event, here a climate disaster or long-term change. The consequences and capacity cover the social/organisational and motivational/attitudinal aspect, respectively (Wolde-Georgis 1993), describing the contribution of the community to ameliorate the impact, as well as their perception of the event and willingness to avert possible consequences.

3.3. SURVIVAL STRATEGIES

Survival strategies are actions which a person, household or societal system undertakes to avert and cope with a crisis *after* a disruptive event. They have to be distinguished from risk minimising strategies which are often, but not necessarily applied *in expectation* of a certain event. Such risk minimising strategies are a kind of insurance mechanism. For example, a farmer may try to diversify his income between peasantry, animal husbandry and seasonal off-farm work to assure one income source should one or more of the others fail. Survival strategies are applied both in order to avert starvation, and in a later stage, to prevent migration even under famine conditions. Rahmato (1991) distinguishes anticipatory and crisis survival strategies, whereby the difference between the two is one of degree and crisis survival strategy is often an extension of anticipatory survival strategies. Survival strategies under famine have been exhaustively treated in the literature, in both general and specific terms (Maxwell and Frankenberger 1992; Rahmato 1991; Wolde-Georgis 1993; Wolde Mariam 1984; Ezra 1997; Webb 1993). They vary according to availability, subjective prospects of success, culture, ecological zones, social and political restrictions. The more stratified the human and household assets

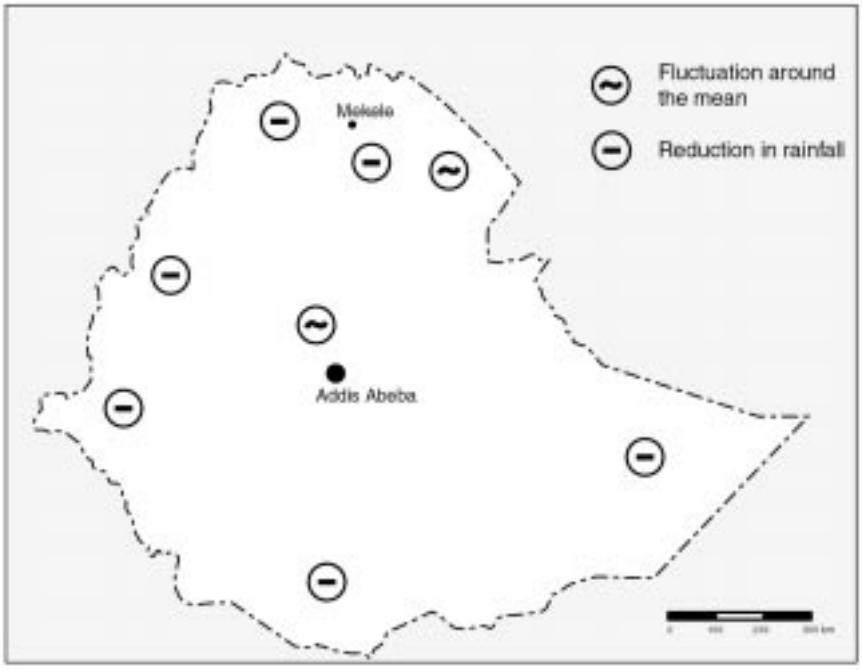

Figure 6. Rainfall development in Ethiopia from 1961–1990. Based on data from Ademe and Kinfe (1998).

are, and the greater the choice of strategies available, the longer can these strategies prolong the period of food availability even under harsh conditions. The type of strategies employed will further vary depending upon the severity and duration of the potentially disruptive condition (Thomas et al. 1989). This is also influenced by expected responses and strategies of other households (Rahmato 1991).

4. Results from the Study Area

For the Tigray study region, the previously described influencing variables for migration decisions, vulnerability, severity of an event and coping strategies, have been investigated. With reference to severe drought events, historical data have been mostly found for Ethiopia as a whole, but some information is available on those droughts impacting North Ethiopia or Tigray in particular.

4.1. Severe drought events in Ethiopia

Droughts for the last 100 years in Ethiopia are listed in Table I. Of the 18 droughts, eight were described as affecting the whole country, ten were local and regional ones. The record show 40 years of drought within a 100 year period, although one has to be aware that these are extracts from written sources which are not

TABLE I

Ethiopian droughts since 1888.

Date	Regions affected	Causes and severity
1895–1896	Ethiopia	Minor drought, failure of short (*belg*) rains
1899–1900	Ethiopia	Droughts deduced from levels of Lake Rudolf and low Nile floods
1913–14	Northern Ethiopia	Lowest Nile floods since 1695, drought, war, locust.
1920–22	Ethiopia	Moderate drought, similar to 1895–96
1932–34	Ethiopia	Deduced from low level of Lake Rudolf
1953	Tigray and Wollo	Drought and locust, severity unrecorded
1957–58	Tigray and Wollo	Rain failure, locust and epidemics. One million people affected, 100,000 migrated, 100,000 died.
1962–63	Western Ethiopia	Very severe
1964–65	Ethiopia	Said to be worse than 1973–74
1965–66	Tigray and Wollo	Failure of short and long rains; undocumented loss of humans and 300,000 livestock.
1969	Eritrea	Estimated 1.7 million people affected
1971–75	Ethiopia	Sequence of rain failures; estimated up to 1 million people dead; more than 50 percent of livestock lost in Tigray and Wollo
1978–79	Southern Ethiopia	Failure of spring rains (*belg*)
1979	Tigray	900,000 affected.
1982	Northern Ethiopia	Delay of monsoon rains by two months
1984–85	Ethiopia	Sequential rain failure, conflict; 8 million people affected; estimated 1 million dead; much livestock loss
1987–88	Ethiopia	Drought of undocumented severity in peripheral regions.
1990–92	Northern, eastern and south-western Ethiopia	Rain failure and regional conflicts; estimated 4 million people affected.

Source: compilation based on Degefu (1987), Webb (1992), Rahmato (1994), and Relief and Rehabilitation Commission (1979).

necessarily based on climatological data. Rainfall records from the last 30 years (Ademe and Kinfe 1998) show a general decrease in annual rainfall in the north, south, west and east and an oscillation around the mean in central Ethiopia and in the north-east lowlands (Figure 6). This trend towards increasing aridity has been shown not to be unprecedented within historical times (Nicholson 1994).

Predicting future development in rainfall shows great uncertainty with regard to direction, timing, variability, and extreme events, especially for the Tropics (Hulme and Viner 1998). Ademe and Kinfe (1998) have assessed climate scenarios for Ethiopia based on three global circulation models (GCMs). Projections for future

temperature show an increase of between 0.5 °C and more than 3 °C. Rainfall results do not manifest a systematic increase or decrease. In the north of the country, predicted changes in precipitation vary between a doubling and a reduction of 30–40%. For rain-fed agriculture, a reduction in rainfall as the main climatic limiting factor has similar negative impacts as an increase in temperature together with increase in precipitation. In the latter case, the effectiveness of rainfall in watering the soil will be reduced by increased evaporation. This great disparity of model predictions for the future Ethiopian climate strengthens the argument that historical information on climate events provides a solid basis for evaluating continued drought which could strike the region in the near term.

4.2. VULNERABILITY TO CLIMATE IN TIGRAY

Operationalizing vulnerability has so far proven to be imperfect. It is not associated with widely accepted indicators or methods of measurement (Downing et al. 1996). As a multi-factor assessment, the choice in selecting indicators has to be argued in a location and purpose specific setting, and will always involve elements of arbitrariness and subjectivity. A further shortcoming with such an index-based analysis relates to the weighing and summing up of the individual indicators.

My study in North Ethiopia builds upon 14 factors determining the vulnerability to climate-related migration. (See Table II). Some of the factors are more static, related to demography and household assets. Others involve dynamic elements such as the range of survival strategies involved or additional environmental disasters enhancing the effect of a climate event. The current study vulnerability, defined as a compilation of indicators means not necessarily to be female, old and widowed or engaged in a specific working environment such as rural dweller or smallholder (e.g. as described by Kloos and Lindtjorn 1994; Bohle et al. 1994). It further does not focus primarily on macro-indicators such as GDP/capita, infant mortality, illiteracy rate, infant mortality, deforestation rate, rate of soil erosion and similar regional variables, as those do not represent the specific situation of people in a certain area. Here, it is more specific location oriented, addressing relevant household data on entitlements, social structure, perceptions and physical/natural conditions, including diversification of assets, non-agricultural income, distance to water well and fire-wood, and other indicators, listed in Table II. There would certainly be more indicators relevant to describe vulnerability to climate-induced migration, such as gender differentiation of household heads or kin networks. But those presented here are considered as the most important ones with respect to food/water demand and supply and migration decision, and have been most mentioned during the interviews as ‘problem areas’ for famine, push factors for migration or restricting factors for performing coping strategies. The hypothesis behind this ‘micro-view’-approach is that impacts of drought can strike anyone concerned, not only the poor.

TABLE II

Summary of vulnerability factors influencing migration decisions during drought.

Indicator	Hypothesis	Restrictions/Problems	Classification	Weight factor
Family size, dependency ratio	The larger the household the more difficult it is to obtain the necessary quantity of food and the earlier they decide to migrate. The greater the number of children, the more likely they suffer from starvation and disease resulting from a too low calorie intake.	Large families may reflect more available labour, more options for coping strategies.	≤ 5 people	0
			> 5 people	1
Crop varieties planted	The more varieties planted, the greater the chance that some grains resist drought.	Availability of crop varieties is sometimes not very great.	$\leq$2 varieties	1
			$>$2 varieties	0
Number of oxen (to plough the fields) and number of other life-stock (cows, goats, sheep)	The greater number of animals, the greater the ability to exchange them for food grain and to avert migration.	Animals are multi-purpose: assets, milk and meat producing, prestige, draft animals and manure provision. During drought, the farmer has the option of selling them, move them to other regions, slaughter them or watch them suffer and die.	No life-stock	2
			$\leq$10 animals	1
			$>$10 animals	0
			No ox	2
			1 oxen	1
			$\geq$ 2 oxen	0
Household assets	The more assets to be sold, the more capital can be converted into food under drought.	Similar as with animals, during drought the prices drop considerably.	HH to sell	0
			Nothing to sell	1
Firewood	The longer the distance to firewood the greater the exhaustion, especially during drought.	Animal dung is used sometimes as energy source, but reduces then the availability for being used as fertiliser.	Distance $<$ 2h	0
			$\geq$2h	1
Off-farm work	The more income-diversification from non-agricultural sources, the less a household needs to rely on sufficient rainfall.	Availability of non-agricultural income is restricted during drought, people cannot longer buy home brewed beer, cloth or do not need daily labourers for farming work etc.	Has off-farm or non-agricultural income	0
			No off-farm work	1

TABLE II
Continued.

Indicator	Hypothesis	Restrictions/Problems	Classification	Weight factor
Food deficiency during normal years/Food reserved before a drought	Having food problems even in good years means no savings for drought years and reduced working performance generally.	Poor families suffer even in normal years several months before the harvest, what makes them susceptible to diseases.	deficiency	1
			no deficiency	0
			food reserves	0
			no reserves	1
Beginning of food crisis	The sooner after a rain failure the food crisis starts, the earlier people might decide to migrate.	Even if farmers have no food stored they can change assets or labour into grain or use social networks for obtaining food.	Immediate crisis	1
			Food crisis later	0
Additional disasters	Pests, diseases, or weather disasters in addition to drought reduce the likeliness of any harvest.	Under such circumstances, the planting of drought resistant crop species does not increase adaptation capability. Non-availability of pesticides and insecticides.	No additional disasters	0
			1	1
			$\geq$ 1 disaster	2
Number of survival strategies	Many coping strategies applied reduces the risk for migration, or at least prolongs the period to avert famine.	The more survival strategies available, the lower the vulnerability to migrate under drought. But vice versa, the higher the drought vulnerability, the fewer coping options available.	$\geq$ 5 survival strategies	0
			$<$5 survival strategies	1
Water availability	The longer the distance to fetch water for human and animal consumption during dry seasons and drought, the more likely people have to leave their homes because of that burden in addition to starvation.		Water less then 2h away during drought	0
			$\geq$ 2h away	1
Importance of civil war	War and political instability coinciding with drought act as an additional push factor for migration.	War reduces the options for survival strategies under drought, leads to destruction of fields, market failure etc.	war little/not important	0
			very/relative/ modest important	1

A high weight factor indicates that the classification given to the indicator contributes to an increased vulnerability of a household. For example, a weight of 1 for families of more than five persons supports the hypothesis that larger families are more vulnerable to climate events and more likely to migrate under drought conditions.

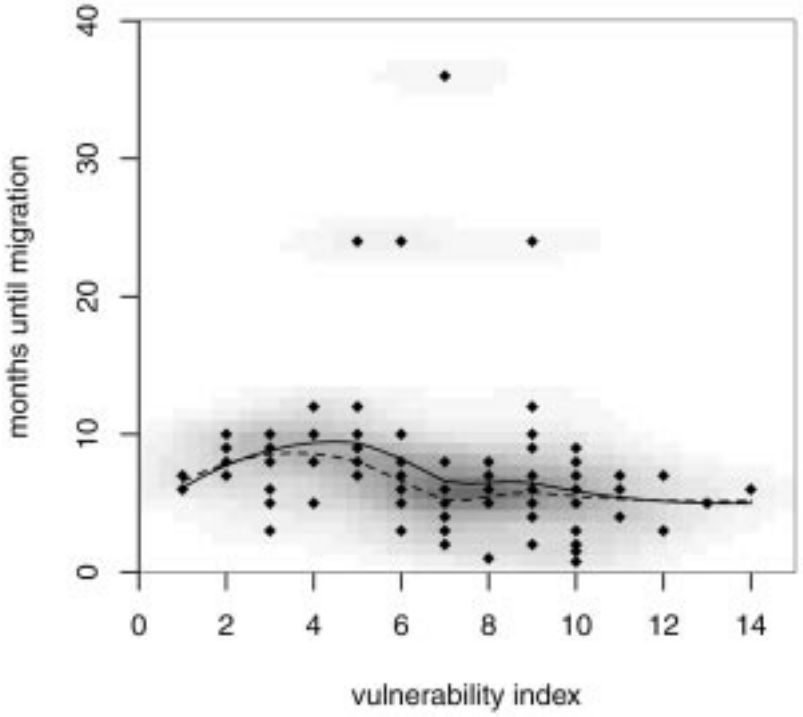

Figure 7. Relationship between vulnerability and months after onset of drought until migration, based on 102 observations during different drought episodes. Black dots show the different case combinations, the grey shading indicates the data density with in the specific fields. The bold upper curve displays the local regression curve, the line below shows the same without the four uppermost extreme cases (low statistical significance indicated by $r^2 = 0.0438$, based on a linear regression function).

In Figure 7, total vulnerability has been correlated with months until migration, after onset of a drought. The vulnerability index is based on the indicators described in Table II. The quantitative relationship, a simple addition of values given to the indicators is not necessarily the all-inclusive mathematically correct one, but is only suggested to illustrate the point. The results represented by a regression line show surprisingly that for the 104 households interviewed, there is generally no direct link between the level of vulnerability and the time of relocation. People who are most vulnerable leave after a similar number of months as those who are considered to be least vulnerable. Two explanations can be given for this performance. Those who are less vulnerable are often economically advantaged families, relatively speaking, with some kind of social network, such as relatives in towns where they could move to during a crisis. Money for enabling transport out of the disaster region is also often more available to wealthier families. Or, alternatively, it could reveal the existence of a kind of threshold, a limit within the society with respect to climate, making all people in the region similarly negatively affected by

drought, independent of their initial entitlements and household-situation. When this threshold is reached, basic survival needs such as water and food become scarce or even unavailable. Under such conditions, a farmer with big animal herds has similar difficulties in securing water for his animals as one having just a single cow, and all might die of thirst. The same threshold situation is valid for households with additional off-farm income. After a certain period when everyone's resources for acquiring food have been used up, one, for example, will no longer buy home-brewed beer or hire labourers, a clear indication of the interdependency between households in a region.

As already indicated above, no single indicator would capture the totality of vulnerability to migration. Nevertheless, when analysing individual vulnerability sub-indicators with respect to the time from the drought onset until people migrate, some findings suggest that families with more survival strategies tend to resist distress migration longer than those having only few survival strategies. Further, smaller families seem to migrate earlier than larger families. At least, many of them indicated that they were among the first ones in the village to leave. A splitting of large families, meaning that some of their members migrate earlier, was not obvious. The reason for the earlier departure of smaller households might be the better prospects to get accommodated at a new place, the availability of money for transport (many migrated long distances by bus) and fewer options for generating off-farm income, as human resources were needed for fetching water and firewood from places far away. Political instability was not found to have a direct effect on the timing of migration. Half of the survey participants stated that they were at least to some extent influenced in their migration decision by the ongoing war. But all of them stated, and that was the necessary precondition for the study, that drought was the primary reason for migration. Both groups, those who at least partially and those not affected by civil war, spent on average the same number of months from the onset of drought until migration. Therefore, the war cannot necessarily be identified directly as pushing migration forward or holding people back from leaving their homes. Still, war increased people's vulnerability to drought in that way that it affected the performance success of survival strategies which are discussed in the following.

4.3. Survival strategies of Tigrinian farmers

Most people in the survey had a wide repertoire of strategies to avert famine, mostly changing consumption patterns (reducing from three to one daily meal or switching to less valuable kinds of grain), selling animals and household assets and using up food reserves (as far as they have from previous years). For more detail, see Figure 8. Nearly every family (92 percent) performed at least three strategies for survival, and one in two families tried six different ones to prolong the period of residence in the village. This shows a marked resistance of people to the external event.

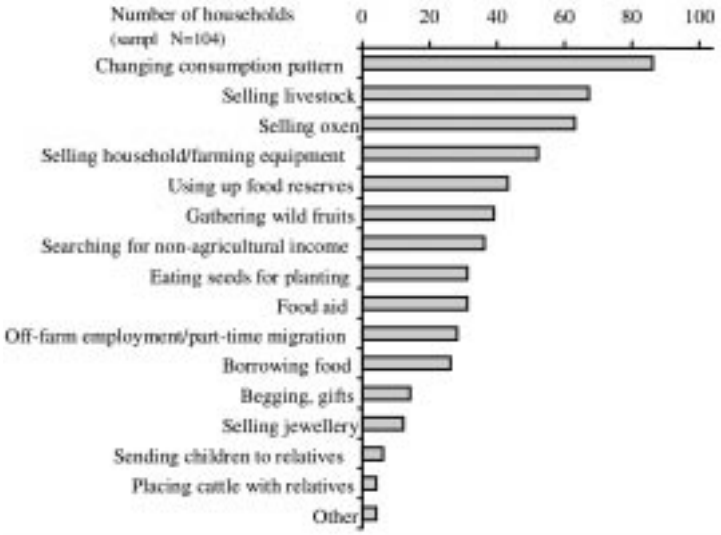

Figure 8. Number of households undertaking different survival strategies (multiple choice) after the onset of drought to prevent famine and distress migration.

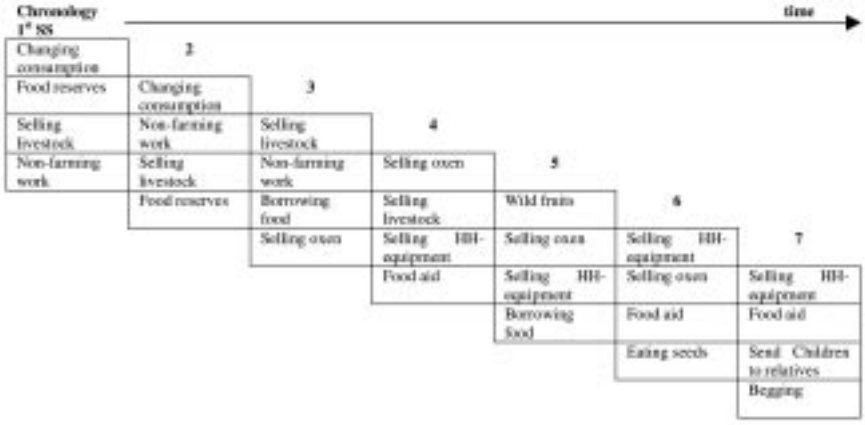

Figure 9. Chronology of survival strategies (SS). Only the four survival strategies which have been mentioned most often by the 104 households (HH), are listed for each time period after the onset of drought until the moment of migration.

The importance of individual coping mechanisms is easily revealed. The first actions undertaken ones are normally the more important ones, in the sense that they have a greater influence on food provision, or those which are easiest to undertake (see Figure 9). Due to individual differences between households, their different point of departure and situation, the chronological order of survival strategies varies from family to family.

The chronology of a drought-induced migration of an average household in Tigray might have looked like the following. Rain failure in either June/July or early cessation of the summer monsoon in August gives little hope to the family of a successful harvest. Although malnourished from before, with food stocks already exhausted 6–8 months after the last harvest, they immediately start to reduce their daily consumption of teff and might switch to lower value grain types. Wild fruits are collected, one member is sent out of the village to search for work. During September–October, the last grain reserves become exhausted, and the head of the family decides to sell livestock and then oxen. By December, liquid assets are no longer available, and household and farming tools are sold on the local market. Although of little value, they provide money for grain purchase for another 1–2 months. When these last assets are sold and people have to migrate, the chance to return soon after a drought is quite small, as farmers do not have capital to invest in new farming equipment and oxen for ploughing. By February, all possible options for obtaining food have become exhausted and the family decides to migrate together to the nearest town in hope of food aid and work. They might stay away from their home for 1–2 years, maybe even longer as they have no money for return or no information whether the situation at home has improved. They might also feel too ashamed to return to their village without oxen and a plough, as these goods represent important social status within the local community.

The application of individual strategies is often accompanied by problems, which Bovin and Manger (1990) refer to as a crisis of traditional forms of adaptation. They cannot be solely understood on the basis of environmental constraints, but also within the context of social and cultural problems (Bovin and Manger 1990). As many migrants were affected by the drought coinciding with the Ethiopian civil war, many were disturbed in carrying out off-farm activities and trading, as they were forced to stay within their local region. Food aid did not reach their villages due to political conflicts. for the people in the survey civil war was not a reason for migration but an essential influence factor for the successful performance and application of coping strategies. Selling animals at times when everyone else sold pushed prices down and was no longer beneficial (market failure). Food and water shortages reduced the performance of the animals, many were to weak to walk to the market. For the family, the sale of animals – even when considered as a way to get money for grain – meant a loss of animal by-products such as milk or manure. Selling the last ox led to a reduction in ploughing potential and was considered as a loss in personal identity within the village. Those who had nothing to sell and were poor from before were mostly those who had no food reserves either, making their situation during drought even more precarious. The last seeds were sown often in the hope that some rain would come, wild fruits did not give enough nutrition and were far away or scarce and only the most drought resistant plant species survived. Today, based on such experiences, farmers in Tigray plant cactus fences around their home areas. As a long-term strategy, this serves as a protection of the homestead and as food reserves during drought. When modifying

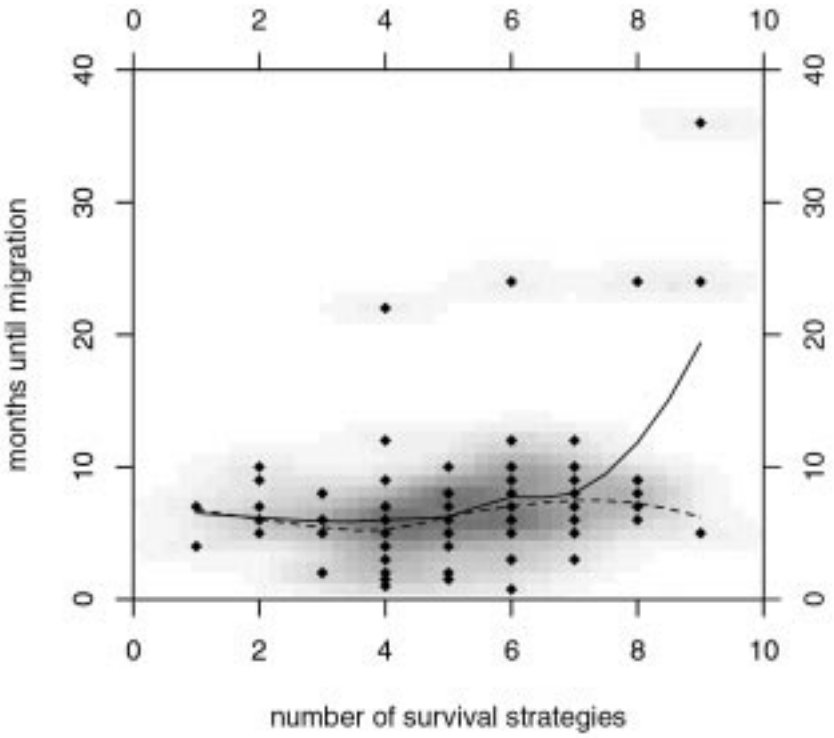

Figure 10. Correlation between the number of survival strategies and months until migration, calculated from the onset of the drought (see Figure 7).

consumption, children suffered most, making them susceptible to diseases. At the same time the work power of the older members of society became reduced as well. Those who tried off-farm work had to compete with a hundred others for one job with meagre wage. Borrowing food was sometimes possible, but only with high interests. The 1984–85 drought in particular was felt nearly over the whole country and regional exchange could not compensate for rain failure in individual regions. The resulting famine can be described as a supply driven event, as food became scarce, as well as a demand driven event where the means of procurement (money for buying) were lacking, implying total market failure (Mortimore 1998).

Figure 10 illustrates the relationship of the number of survival strategies applied and the months of resisting migration after the onset of drought. The findings do not reveal an unequivocal relationship between the two variables. Still, when investigating 'extreme' cases, interesting results have been gained. Several households with some kind of non-agricultural income and animals could manage food security for up to 10 months, and did not try other survival strategies before migration. In one case, even many survival strategies could not prevent a family from migration, as the people experienced absolute lack of water, with the next well more than a five-hour walk each way! Those who continued living in their villages for two years

under prevailing drought had either a large animal stock, off-farm employment, and/or tried many different survival strategies successfully. This leads to the conclusion that the value of applying coping strategies lies in its diversity and quality, which are the best insurance against the risk of famine and migration.

5. Discussion and Conclusion

This case-study tried to enlighten the vulnerability of sedentary farmers to climate variations in dryland Ethiopia. Within the current climate change and climate impact debate, much concern has been expressed about the high vulnerability of societies in sub-Saharan Africa. In this region, there is potential for considerable impacts on food and water availability and migration behaviour. Long-term changes in climate, as well as changes in the frequency and intensity of extreme events are difficult to predict, especially on a regional level. Impacts are also difficult to predict. But severe droughts in Africa are certainly not confined to the present and future. When looking back in time, human life has always been affected by climate, and in Ethiopia in particular, people have been always lived with recurrent drought and extreme climatic variability. For the next decades, studying Holocene fluctuations in climate may help in establishing the range within which changes can be expected in the short term.

This paper has investigated vulnerability to climate events at household levels, by analysing migrants' behaviour and living conditions before and after the onset of previous droughts. It has been shown that at the beginning of a drought not all members of a society are equally vulnerable. Differentiation in farming yield is little in times of drought, as almost all farmers cultivate in a similar ecological setting, with little irrigation and similar technology. It is a combination of different socio-economic and environmental indicators such as animal holdings, non-agricultural income or remittances, which determines how soon problems of food shortage may begin after a scarcity of rain. Nevertheless, after a certain number of months absolute limits appear, manifested through critical food- and water deficiency, reducing the primary difference in vulnerability between households. When such a threshold was exceeded during past droughts, options in coping with the crisis disappeared, making peasant farmers, regardless of their socio-economic point of departure, equally affected and forcing many of them to migrate. Such migration reflects both the failures of the response mechanisms of the households and of the relief mechanism of the state. But one has to be aware that in societies where the level of food intake and living standard is low from before, a climatic event is simply a triggering mechanism that was latent within the system (García 1981).

Still, a stratification of coping strategies can prolong considerably the period of averting famine and migration after the onset of drought. People come up with a great variety of strategies. Of course, differences in creativity, motivation and

choices of individuals differentiate the success of these survival strategies. The more vulnerable they were to harmful consequences of climate events initially, the fewer options they have in performing survival strategies. And vice versa, the fewer strategies they undertake after the onset of an event, the more vulnerable they become during the process, indicating a negative feedback spiral.

Although the knowledge derived in the study about people's adaptation and strength to cope with climate events might be a very useful policy tool for future planning, it is important to recognise the limitations of the predictive value of such information. Much of the information on household behaviour has to be interpreted in its location specific settings. Individual villages and regions have different factors making them more or less vulnerable to climate. This creates difficulties in aggregating and comparing information at the regional or national (Maxwell and Frankenberger 1992). At the same time, the chronology and types of survival strategies in the process of mitigating the impacts vary from place to place. Further, knowledge on past behaviour could be of less value when considering changes in crisis behaviour in the future. Riely (1991) revealed that people in the Kordofan region in Sudan with earlier drought experience changed the scope for coping with the next crisis. In a simple trial-and-error process the most successful strategies are repeated and others neglected. Resulting, even a quite accurate prediction of climate change is inadequate for deciding how serious the consequences for human societies will be (Rayner and Malone 1998). With changes in the characteristics of societies over time and space, consequences of climate change will alter simultaneously.

Nevertheless, bearing these predictive risks in mind, dryland livelihood has been recently described as being resilient to inter-annual climate variability, rather than adjusted to an equilibrium mechanism (Mortimore 1998). People in such geographical regions have shown considerable resistance to climatic forces, where diversity in income and coping strategies are one of their main characteristics. Even if surprise of specific climate events might be the greatest challenge for assessing and adapting to future climate, historical analogies of both climate fluctuations and human response, provide a useful starting point for further impact assessment. For the future, increasing people's strength to cope with climatic crises requires a stable socio-economic and political system to enable the successful performance of survival strategies. Droughts are not preventable, but disasters are. As such, any speculative scenario of mass migration under climate change must be rejected for dryland populations whose main strategies are built on adaptation rather than on resignation.

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