

Contrasting climate variability and meteorological drought with perceived drought and climate change in northern Ethiopia

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ABSTRACT: The rationale of this paper is to investigate peoples' perception of climate variability, climate change and drought frequency and compare it with measurements of rainfall variability and anomalies in northern Ethiopia. Statistical analysis of rainfall chronologies was performed and contrasted with qualitative data collected through a survey and questionnaires. Fieldwork studies showed that local authorities, farmers and pastoralists perceived regional climate to have changed during the last few decades. Farmers explained that they have been changing their farming strategies by shifting to more drought-resistant crops as well as to a shorter agricultural calendar. They attributed this to a loss of the spring rains since 'their father's time' (20–30 yr ago), as well as a shorter main summer wet period. The recent 2002 drought appears to have confirmed peoples' perceptions that there has been a shift in climate towards more unfavourable conditions. However, rainfall measurements do not show a downward trend in rainfall. Reasons for divergence between perceptions and rainfall measurements were explored. Some can be associated with changes in peoples' need for rainfall or be linked to various environmental changes which cause reduced water availability. Others can be related to the paucity of available daily data in a dense station network which could better support peoples' perceptions of change. In exploring these reasons, focus was given to the disagreement between optimal rainfall (i.e. amount and distribution sufficient for crop or pasture growth) and normal rainfall (i.e. the long-term statistical mean and its variation).

KEY WORDS: Climate change · Rainfall · Perceptions · Ethiopia

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1. INTRODUCTION

Human perceptions of climate, its variability and its potential change have become an important challenge in understanding climate–society interactions, as more attention is given to studies of human adaptation to climate change (Lindskog 1994, Dahlberg & Blaikie 1996, Rebetez 1996, Ovuka & Lindqvist 2000). Peoples' subjective observations of climate may be confirmed by statistical data, but extreme events may sometimes be interpreted as a confirmation of ongoing human-induced climate change. Perceptions of climate change could also be affected by the overlooking of other social and environmental factors such as deforestation, population growth, or soil erosion. This would

result in ascribing specific impacts to climatic causes instead of to the actual causes, which are often a combination of climatic, environmental and social factors.

This paper presents a study of peoples' perceptions of rainfall conditions and compares them with observed rainfall data. As a case study, northern Ethiopia was chosen because of its historic rainfall variability and the sensitivity of communities in this region to food and water security during times of drought (and other pressures). Today, 85% of the country's 65 million people are still engaged in subsistence agriculture, and 16 million people live in what are classified as dryland areas (Terrastat, FAO¹). Chronic (long term) and acute (episodic, associated with dry conditions) starvation has not been defeated

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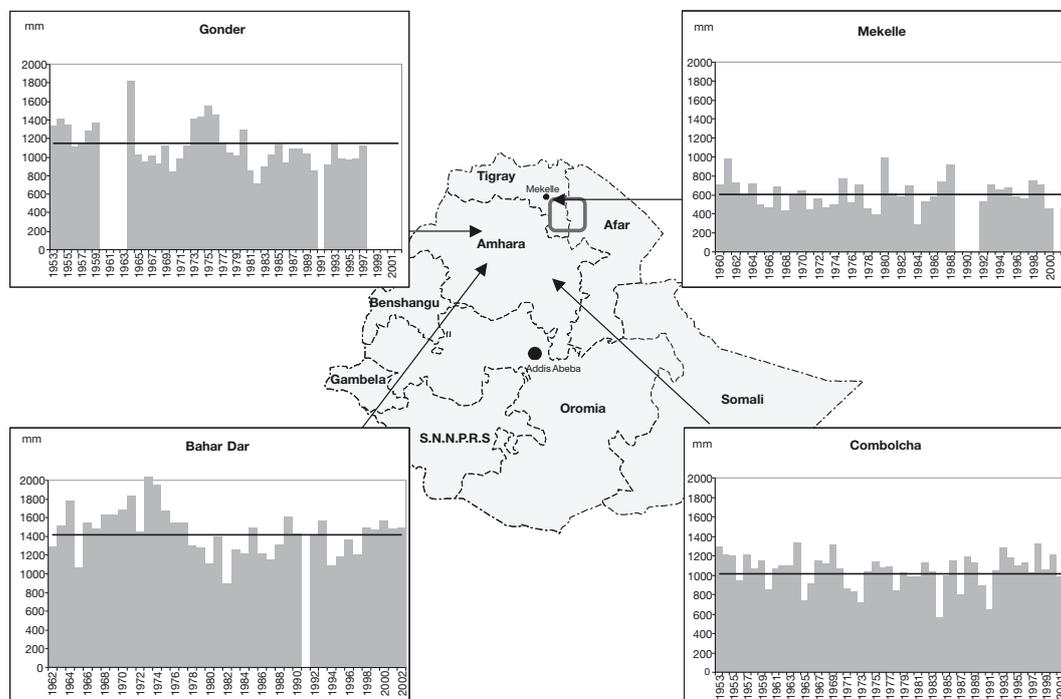


Fig. 1. Four rainfall stations in North Ethiopia with continuous annual rainfall data since 1953 or 1960/62. The study area in southern Tigray/North Afar is marked on the Ethiopia map with a square. The solid line represents the 1971–2000 mean. Missing bars are missing data

since the events of the 1980s. Thus, recurrent rain deficits cause repeated crisis situations with nearly permanent dependency on international food aid. The drought of 2002–03 sets the context for this paper. Widespread famine required international aid on a scale much larger than in previous years. The harvest was reduced by up to 80% regionally, and hundreds of thousands of animals died. Between 12 and 15 million people are currently affected by food and water shortage (e.g. Ethiopian Government 2002, FEWS Net 2003, WFP Emergency Report 2003). Results from interviews and discussions in focus groups during 1999 and 2002 are compared with historical rainfall data. The author in no way wants to play down the extremely difficult situation many Ethiopians are in periodically. Nor is the intention to give the impression that local people's perception of rainfall behaviour is invalid, or not useful, but to emphasise the fact that it is a subjective manifestation of their experience.

More than 25 yr ago, Glantz & Katz (1977) published a paper asking 'When is a drought a drought?' They indicated clearly the complexity of finding a suitable definition of drought and critiqued the application of the statistical mean to define an index of normal rainfall. After the poor rainy season in 2002 and subsequent famine in the Horn of Africa (alongside the complexity of contemporaneous drought and food security problems in Sub-Saharan Africa), it seems highly relevant to revisit this old question. The overarching aims of the paper are to contribute to the literature on climate and society linkages, to provide empirical evidence of their complexity and to describe the difficulties associated with deterministic approaches to understanding and predicting the human impacts of climate extremes and climate change.

2. CLIMATE, DATA AND QUALITY CONTROL

Rainfall observations, qualitative data based on questionnaires and group and in-depth interviews with local farmers and pastoralists in northern Ethiopia

¹Available at <http://www.fao.org/ag/aql/agll/terrastat/wsroul.asp?wsreport=2b®ion=7> (accessed 28 April 2004)

form the basis of this paper. Northern Ethiopia is characterized by mono-modal rainfall with pronounced summer maxima. Nevertheless, the climate type is often referred to as bi-modal, due to short rains in the spring in some areas (March–June, referred to as 'Belg') which increase in the summer to 'Kiremt' rains (July–September) without a pronounced dry period in between (for examples of a detailed climatology, see Griffiths 1972, Gamachu 1977, NEDECO 1997). Much focus has been placed on finding empirical evidence of climate change in Ethiopia (e.g. Hailemariam 1999, Kovats et al. 2001, Legesse et al. 2003, Steffen et al. 2003). Monthly rainfall data are as used in Conway (2000), with updates to 2002. Fig. 1 shows annual rainfall series for northern Ethiopia (Gonder, Combolcha, Bahar Dar and Mekelle). These stations represent key sites with the longest records for much of northern Ethiopia. Missing monthly data resulted in an exclusion of that year from the rainfall chronology, except if single months in January or December were missing (dry season, little or no rainfall). Data for Gonder showed abnormally high rainfall for 1998–2002. Cross-validation with its neighbouring station Bahar Dar did not confirm this; other attempts to verify the data quality were unsuccessful. Therefore, although data were available until 2002, the record shown only includes data until 1997.

What is apparent for all stations is the high inter-station rainfall variability. The coefficient of variation in Table 1 shows that during the spring (Belg) rains variability is highest, between 31 and 55%. For the summer (Kiremt) rains, variability decreases for all stations to between 19 and 31%. As expected, the coefficient of variation is lowest for annual rainfall (17 to 25%). A trend analysis for 1961–1990 and 1971–2000

(Table 1) allows comparison between stations. It also shows that in the last 10 yr rainfall trends have changed. The trend is very sensitive to the period over which it is calculated. While Bahar Dar and Gonder have negative trends for both periods, Mekelle and Combolcha show a strongly positive inclination for 1971–2000. The negative trend in Gonder may be explained by the lack of valid data in recent years. To summarize, there has been no uniform shift or trend in annual rainfall in northern Ethiopia. After individual dry years during the mid-1980s, rainfall recovered in the late 1990s.

For the case study, the gauge values for Mekelle have been used as a proxy for the study sites in Adi Gudum (30 km south of Mekelle) and Abala (50 km southeast of Mekelle). Mekelle is the only station in a study area of approximately 2500 km² which has a continuous record for the last 40 yr. Both sites have similar seasonal rainfall regimes, but differences in annual rainfall (Mekelle has 610 mm, while Abala has 422 mm) can be explained by variations in altitude. Mekelle is located on a high plateau (2000 m), while Abala is at 1500 m above sea level. The 8 yr of total yearly rainfall which were available for Abala in the North Afar zone are shown in Fig. 2 (Alemu et al. 1999).

3. PERCEPTIONS OF CLIMATE CHANGE— A CASE-STUDY FROM NORTHERN ETHIOPIA

3.1. The fieldwork area: southern Tigray and North Afar

Field-work was carried out during spring 1999 in Adi Gudum, southern Tigray, and in summer 2002 in

Table 1. Rainfall statistics for 4 stations analysed in northern Ethiopia. MAR: Mean annual rainfall, SD: standard deviation, IQR: interquartile range, CV: coefficient of variation, Belg: March–June rainfall, Kiremt: July–September rainfall, Trend: mm decade⁻¹ and in % decade⁻¹ from MAR

Stn	Latitude	Longitude	Altitude (m)	Years recorded	Missing months
Mekelle	13.5	39.30	2212	1961–2002	31
Combolcha	11.05	39.43	1916	1953–2002	2
Bahar Dar	11.36	37.24	1805	1962–2002	5
Gonder	12.32	37.26	1966	1953–1997	42

Stn	MAR (mm)	SD	Median	IQR	CV Belg	CV Kiremt	CV total	Trend 1961–1990	Trend 1971–2000
Mekelle	625	155	611	205	55	31	25	-7 (-1.1%)	+35 (+5.6%)
Combolcha	1041	175	1073	211	37	23	17	-33 (-3.17%)	+82 (+7.9%)
Bahar Dar	1435	247	1445	330	38	19	17	-112 (-7.8%)	-102 (-7.1%)
Gonder	1124	225	1088	314	31	21	20	-94 (-8.36%)	-114 (-10%) ^a

^aFor 1971–1997

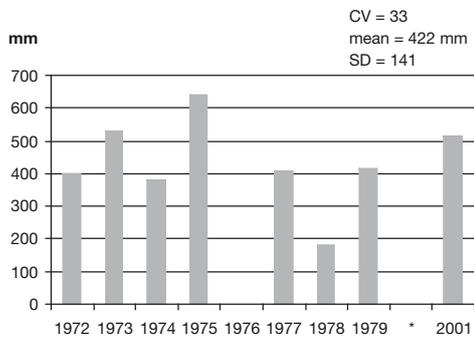


Fig. 2. Rainfall in Abala, North Afar. The asterisk denotes the period between 1980 and 2000 in which no or incomplete yearly data sets are available. Data are missing for 1976

Abala, North Afar. The major focus in this paper is given to the latter region. Adi Gudum is located in the highlands and Abala in the mid-lands adjacent to the escarpment (see Fig. 1 for location of study area). The landscape is characterized by large flat plains lying between smoothly rolling hills. Average annual temperature is 29.8°C in Abala, which is associated with high evapotranspiration. In Adi Gudum, 104 standard interviews were performed with local farmers and agro-pastoralists in a rapid rural appraisal, with a focus on environmental change since their 'fathers' times' and memory of past droughts (outlined in Meze-Hausken 2000). In North Abala, qualitative data were collected from farmers, pastoralists, extension workers and local government institutions. This was done by group discussions and 45 open interviews. Information was gained on—among other issues—people's rainfall needs, changes in farming behaviour due to perceived rainfall changes, and views on the ongoing drought episode in 2002. The area hosts 2 separate ethnic groups, Afar and Tigrinians. Tigrinians are either agro-pastoralists or farmers, Afar are pastoralists. Most of those Afar informants, who called themselves agro-pastoralists, are in reality engaged in pastoralism only and a land area given to them during land reform is often leased to others in return for a fixed share of the harvested crops (usually 50%). For crop production and pasture growth, the agro-pastoralist society depends on local rainfall as well as on floods coming from the Tigrinian highland through rivers. Afar pastoralists have been living in this dry hot region for many generations, whereas Tigrinian farmers and agro-pastoralists have been moving into the area since the 1950s and 1960s. Driven by scarcity of land in the highlands, they were encouraged by the authorities to move to the adjacent Afar zone and to clear large for-

est areas for agricultural purposes. The area is known for its good soils of sandy and silty alluvial deposits. The majority of Afars live in rural areas, whereas the Tigrinian population lives mainly in towns and villages.

3.2. Optimal rainfall—peoples' needs

In order to understand why people may declare one year as a drought year, it is important to recognise their needs in terms of rainfall. It is hypothesised here that peoples' needs are used as a kind of benchmark when they compare individual years. Drought per se is a very diffuse concept and the threshold identified for defining it is set somewhat arbitrarily (Agnew & Chappell 1999, Wilhite 2000). Meteorological drought, a statistical measurement of negative rainfall anomaly, is normally defined in terms of some percentage reduction from the average annual or seasonal rainfall. It differs for each country and purpose chosen (Heim 2000, Wilhite 2000). The Ethiopian National Meteorological Services Agency (ENMS) defines 50 to 75% of a 30 yr average as 'below-normal' rainfall and 0 to 50% of average rainfall as 'much-below-normal' rainfall. This definition is extremely crude as it gives little information about the temporal distribution of rainfall (Wilhite & Glantz 1985). On the other hand, one could define optimal rainfall as sufficient rainfall in amount and distribution over time and space to meet the needs of specific livelihoods. For the people in southern Tigray and the North Afar zone, this would be related to satisfactory crop and pasture growth to enable economic security for supporting their families.

The 2 groups of people in the study area, Afar and Tigrinians, have different rainfall needs which represent general tendencies rather than individual cases. Afar pastoralists generally hope for an early start of the spring rains for pasture growth and water for livestock. Their animals become weaker during the dry season and need grazing areas by early spring. Heavy showers, which are very common in this region, are not a problem for them, as the rather flat landscape reduces the risk of water runoff. A Tigrinian farmer in the same region has 2 main options for producing yield; either planting long maturing crop varieties such as sorghum, which—if rain is sufficient—produces high yield; or shorter maturing crops such as wheat or teff (*Eragrostis abyssinica*), with lower productivity but high economic value. In group discussions, most farmers stated that during the last few decades they have been choosing a risk-aversion strategy using quickly maturing crops for the sake of good production. This provides them some yield even when there is failure or delay of the spring rains, as long as the summer wet period continues well

into the early autumn. This underlines the importance of the end of the rainy season. Legumes are planted as a last strategy if rains, which fail during the summer season, arrive in September. Additionally, farmers are concerned about the intensity and distribution of rainfall. Erratic and highly dispersed rains within the rainy season can damage the crops.

Under these conditions there might always be at least one group, farmers or pastoralists, managing well through a dry spell, depending on whether the dry spell concerns the early or late rains. But there are shortcomings. Farmers need oxen for ploughing. If the oxen are too weak due to a late start of the spring rains, then the farmers cannot plough their fields. Pastoralists experience high grain prices during years of yield failure, which means that they have to sell a large proportion of their animals to get the necessary cash for buying grain.

3.3. Perceptions of rainfall over time

During fieldwork in the North Afar zone, the local people gave a clear impression that they have lost one rainy season (Belg) since their fathers' times. Additionally, they stated the main summer rains have shortened in duration and concluded that some kind of climatic change must be underway. This was an explanation for them why they experienced frequent harvest failures and managed only smaller animal stocks during the last 1 to 3 decades. Although not exceptional in climatic terms, the 2002 drought was described by the local farmers and pastoralists as the worst in human memory and observations confirm their perception of a downward trend in rainfall. However, as group discussions showed, there was little agreement about the precise start of the perceived climate change. When asked specifically about when they first perceived a change, people felt either since the mid-1970s, the mid-1980s or only since 1997, with the majority tending towards since 1984. Clearly, when indicating changes since the mid-1970s and 1980s, a disastrous famine episode affecting much of the country was chosen as the turning point in rainfall performance. A below-average rainfall year was 1997 in Mekelle. However, since no observations for Abala were available, it is difficult to corroborate the presence of a major drought and famine episode. The Afar saying 'while it rains on one horn of the ox, it can be dry on the other' indicates the importance of localized showers, which can benefit one farming area while leaving the neighboring area completely dry.

As an explanation for the considerable reduction in rainfall, the people cited extensive local deforestation as a main cause. This rapid and considerable change in

vegetation has been very visual for them and provides a reason close at hand. A study by Alemu et al. (1999) on grass and woodland vegetation change supports these claims. As such, the local peoples' solution to the problem of recurrent drought is quite obvious, namely exhaustive afforestation.

In adjacent Adi Gudum, southern Tigray, of 104 informants, two-thirds felt that rainfall was better during their fathers' time compared to today, 26% considered the situation better today, and 7% had no opinion about that issue. Only 1 person admitted that there were problems during his fathers' times as well. The ability of people to recall extreme events can be very high even if many years back in time, due to the impact individual years had on family life. Peoples' remembrance of drought (Fig. 3) shows some differences between southern Tigray and the North Afar zone. In Adi Gudum, 52 respondents remember only the drought of the year in which they were forced to migrate due to starvation (mostly 1984-85 season). One respondent concluded that there is drought every year. Otherwise, results show a wide spread of years considered as drought years in the interviewees memory. In Abala, 35 out of 45 remember the drought in 1984-85. The 10 who did not remember it were either too young at the time, living abroad, or were fighting in the resistance movement TPLF (Tigray Peoples Liberation Front). The reason for not mentioning drought before 1984 (except one Afar pastoralist) may be due to either better rainfall conditions in the area during earlier decades in the North Afar zone compared with southern Tigray, or age or due to the fact that many Tigrinian in-migrants arrived after 1984.

3.4. Changes/trends in agricultural practice

Evidence for peoples' perceived changes is reflected in changes and adaptations of different farming strategies. Marque & Rosenwald (1997) compared the agricultural calendar from 1930-1950 with the present agricultural calendar in a village in southeastern Tigray (Fig. 4). They found a tendency towards fewer crop varieties and a shorter planting season, indicating that most crops are planted today during mid- to end of June, and are often harvested some weeks earlier as well. Sorghum, as a long-growing-season crop, wheat, and barley tend to be planted 2 wk later than during the 1930s to 1950s. Barley is harvested 2 to 3 wk earlier, and wheat up to 6 wk earlier. This could indicate a shift towards faster-growing varieties with higher drought resistance (such as *chahan* in the local language, a variety of soft wheat), which utilize the shorter summer rains. One species (*kinkina* wheat) has become almost abandoned since the 1970s in the vil-

lage, due to the perceived lack of residual moisture in the soil after the generally poor spring rains, as well as possibly due to a decline of long-term fallow practices in the village (and in most of the region).

Similar trends are also apparent in Abala, where farmers mentioned that they switched from long-cycle

crops such as maize and sorghum varieties locally called 'Degalit', 'Haveso Jiru' and 'Humera', which had been sown in April and May, to short-cycle crops such as wheat and barley. Dry-season teff has also become practically abandoned, because it is highly vulnerable to dry spells. Although reasons for these

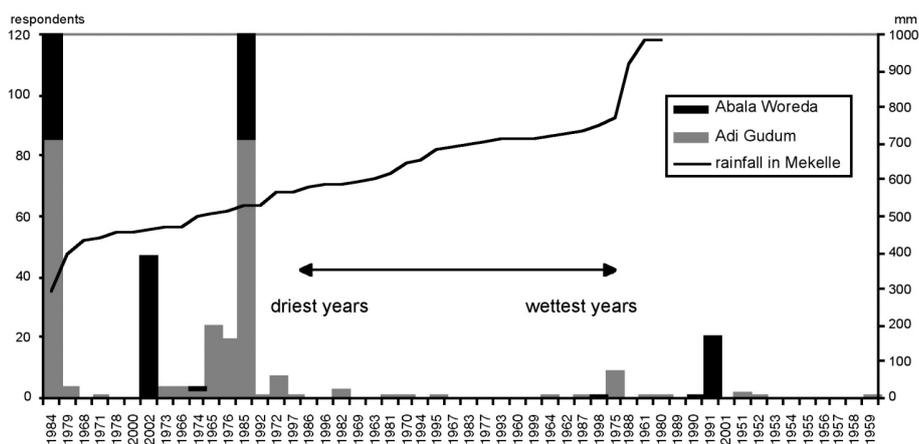


Fig. 3. Drought years remembered. Number of respondents in 2 villages remembering individual years as drought years. For 1984, the driest year, and 1985, both the same number of respondents are shown due to the fact that it was the harvest season 1984/85 which was mentioned as a drought year. In general, due to the delayed effect of rainfall failure on food-security problems, the year mentioned as drought is sometimes the one following a poor rainfall, rather than the years being mentioned as identically the same. For the years shown on the very right side of the graph, no rainfall data are available. The survey in Adi Gudum on remembered drought years was performed in 1999, thus does not include 2000–2002. Years are arranged in order of rainfall amount

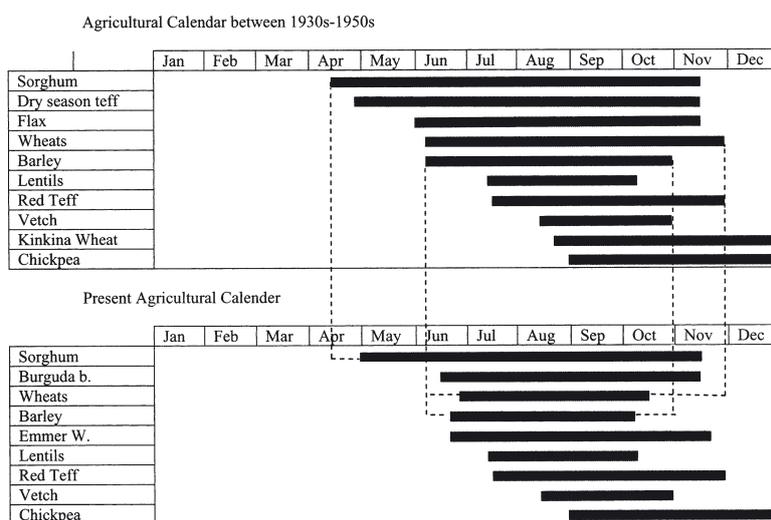


Fig. 4. Comparison between the agricultural calendar in the 1930s to 1950s and the present. Based on Marque & Rosenwald (1997)

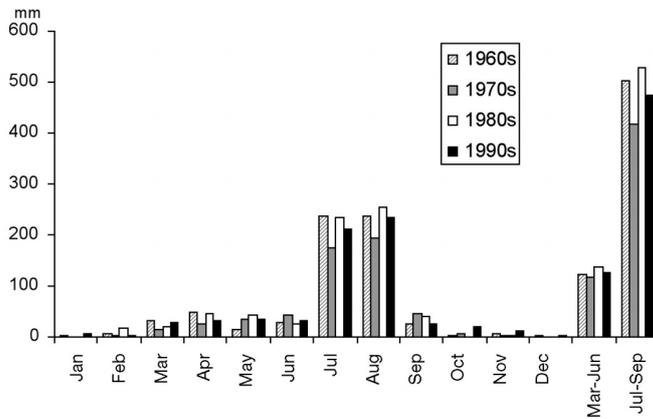


Fig. 5. Decadal monthly and seasonal average rainfall in Mekelle. For a full explanation see the text

major shifts in crop choice were consistently stated to be related to rainfall, it is very likely that climate is interacting with many other pressures on this change in agricultural practices (e.g. land-holding size, market prices, and seed availability). While soil erosion could be a factor for southern Tigray, it was denied by the local people to be a problem in the North Afar zone flood plains.

3.5. Rainfall observations contrasted with peoples' perception

Perceptions of rainfall decrease were compared with rainfall observations from the last 40 yr. The 1980s, normally remembered by most because of the large-scale famine conditions, were on average the wettest years during the last 4 decades, whereas the 1970s had the lowest summer rains (Fig. 5). Indications for a 'loss' of the spring rains have not been found. The 1960s had the wettest spring rains, followed by poor early spring rains in the next decade. Conditions improved during the 1990s. This absence of a shift in seasons (at least for the rainfall station closest to the study area) is also shown in Fig. 6 by a mass curve. Over time, the mass curve of Mekelle shows for both the spring and summer rainfall a relatively even incremental growth, indicated through no change in steepness, which relates to compar-

atively stable rainfall. A break-up of the mass curve into individual months (not shown here) indicates some variations of rainfall in periods, but again no trend for the months of March, June and September.

Extreme droughts have a central position in peoples' memory when referring to past events such as political regime shifts or family birth. Actual climate in a specific year was described by people as a deviation from the ideal (not from the most predominant) during a poor wet season, but as normal, when the rainfall was exceptionally good. This gives a strong indication that perception of climate is linked to the utilitarian aspect of it: pastoralists in Abala described the 1984 and 1991 drought

as less devastating for them compared with farmers in the same area, because the economic and thus social impacts were less dramatic. Grazing conditions were not too bad during these years compared to 2002, resulting in more and healthier animals. Thus, they could feed their children with camel milk and other dairy products when farmers had already run out of food. The year 1979, which was the driest in terms of summer rainfall during the last 40 yr period, was mentioned by only 4 informants in southern Tigray, and none in the North Afar zone (see again Fig. 3). Speculation could be raised about how far the abnormally high rainfall in the spring during that year compensated for the nearly complete absence of the summer rains (Fig. 7).

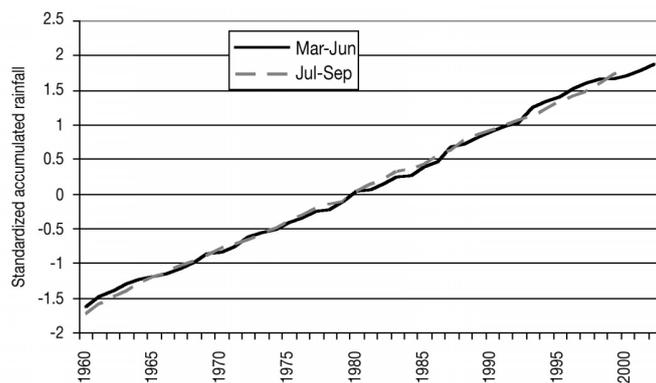


Fig. 6. Mass curve: Standardized accumulated seasonal rainfall for Mekelle. A mass curve is a simple graph of accumulated standardized rainfall plotted chronologically which is used to investigate long-term trends

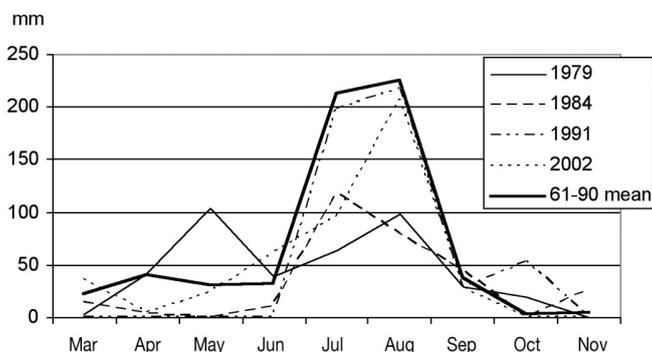


Fig. 7. Rainy season in Mekelle during extreme drought years according to human memory. 1979, which could be defined as a drought year in meteorological terms, but which was not regarded as such in peoples' perception, is included in the figure. It is evident that 1984 has a far-below-average total precipitation, and the lack of rain is especially visible during July and August. 1991 is very close to the mean, although missing spring rainfall data do not give indication of the rainfall for early animal pastures. 2002 shows a late start of the rains and a lack of rain in April and May

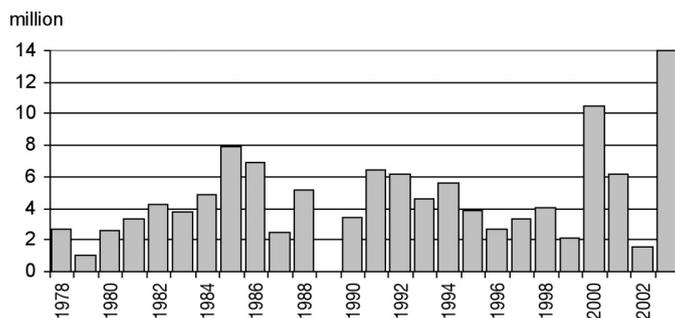


Fig. 8. Number of people affected by natural disasters in Ethiopia. Source: World Food Program for Ethiopia, Addis Ababa. Data from 2000 to 2003 stem from FEWS-Net (available at www.fews.net/current/monthlies/index.cfm) and are valid for January. As a result, 2002 seems to be relatively good in terms of the number of affected people, and 2003 appears to be bad. 2000 may also include people affected by the Eritrean crisis. Data are missing for 1989

3.6. The 2002 event in North Afar

The 2002 rainy season has been described in reports of international donor agencies and the media as one with a complete lack of rain in many parts of the country during the spring, and insufficient and highly delayed rains in the summer (e.g. Federal Democratic Republic of Ethiopia Disaster Prevention and Preparedness Commission and United Nations 2002). 'The magnitude of this crisis (2002) ... is more widespread than any previous drought to affect Ethiopia' (Oxfam 2003). In terms of the number of people affected it was the worst drought since assessment began by the World Food Program, with 11.5 to 15.0 million people² in urgent need of food and water (Fig. 8). In southern

Tigray and the North Afar zone alone, more than 3 million people were at risk due to delayed rains (Ethiopian Government 2002). For the pastoralists and farmers in Abala, 2002 was the worst year in human memory. Based on peoples' descriptions and the authors' observations in the field, the spring rains in 2002 came only in negligible sparse showers and the summer rains started in late July, occurring in a few sporadic showers and ending shortly after. This pattern was similar over most of northern Ethiopia (CPC/FEWS³). The gauge station in Mekelle, Tigray, measured the sixth lowest summer rains since the start of measurements in 1960, but the spring rains ranked at number 22, ranking number 7 for the yearly totals. Rather than the absolute amount of rainfall, it was the distribution during the season which made 2002 unusual compared to other years: a short Belg season followed by a prolonged dry spell and a 3 to 6 wk delayed, and shorter than normal, Kiremt season.

For local people, both in Abala and in other drought-stricken regions, this 2002 long dry spell between the spring and summer rains resulted in adverse preparation of the fields for the main season, delayed sowing dates and reduced seed amounts through replanting. Pastoralists in Abala and neighbouring areas had problems with watering their animals and searching for sufficient grazing areas. Animals were already weak from the previous spring, as many suffered from tuberculosis and scabies. When the rains finally arrived, it was already too late for many animals. Highly depressed grain prices during previous years reduced incentives to invest in farming (WFP Emergency Report 2003). The few grazing grounds providing fodder, often more than 100 km away from pastoralists homes, became invaded by all those who still had some animals. This caused immediate overgrazing and even violent conflicts between different pastoralist groups.

²Figures vary according to source chosen

³CPC/FEWS Climate Prediction Center—Famine Early Warning System (available at [ftp://ftp.ncep.noaa.gov/pub/cpc/fevs/newalgo_est_dekad](http://ftp.ncep.noaa.gov/pub/cpc/fevs/newalgo_est_dekad); accessed 28 April 2004)

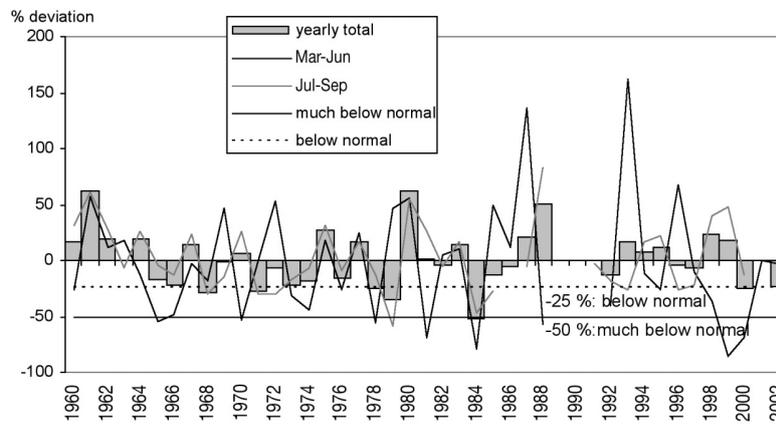


Fig. 9. Mekelle—seasonal deviation of rainfall based on the 1971–2000 mean. With reference to the Ethiopian National Meteorological Services (ENMS) definitions of dry and very dry years, the below-normal line (–25% line) and much-below-normal line (–50%) are shown

4. DISCUSSION: THE 'NORMAL' RAINFALL MYTH AND ITS LIKELY ORIGIN IN THE CASE-STUDY AREA

4.1. Different interpretations of normal rainfall

In general, weather cycles tend to be idealized and simplistic, giving people the feeling of predictability and reliability (Stehr 1997). This relieves them from immediate concerns about climate and permits them to plan everyday life. Any deviation from this expected outcome creates insecurity. It is reasonable to assume that any year in which production drops to a level which threatens family welfare is classified by local people as a drought year. The cause of poor economic performance may not necessarily be linked to rainfall but can include many other factors. It is the impact to livelihood that counts, rather than the cause, in defining drought from the viewpoint of local people (Abu Sin 1985). Although their perception comes closest to the classical definition of agricultural drought⁴, this would not include market, political, and institutional failure (Hoben 1995), which can lead to poor economic performance of a household, or even famine. Drought may serve for them as a synonym for starvation. But it is wrong to use the word misperception when someone declares a drought year where output failure occurs due to non-environmental reasons, if one defines drought based on physical *and* social components (Glantz & Katz 1977). Perceptions cannot simply be wrong as they are social constructs (Stehr & von Storch

1995, Stehr 1997). They may have just a statistically low correlation with the underlying meteorological conditions. Even if 2 separate drought years are identical in intensity, duration and spatial characteristics from a meteorological perspective, impacts will probably be different due to societies' vulnerability to drought at that particular moment (Wilhite & Glantz 1985).

Rainfall in semi-arid zones shows high year-to-year variability, a fact which is particularly valid for the study region as well as for other parts of Ethiopia (Table 1). Semi-arid rainfall is mostly positively skewed, although some data from northern Ethiopia indicate negative skew (Combolcha, not shown). An asymmetric distribution of a dataset indicates that the mean is larger (positively skewed) or smaller (negatively skewed) than the majority of the values. If the outliers, which draw the distribution outwards, appear in years close to each other, it may be viewed as the 'normal' or expected situation in the case of positive events. In the case of adverse conditions, it might confirm a change towards more unfavourable climatic conditions. But what is defined as 'normal', a mathematical average of a bulk of data, should not be confused with weather extremes or short-term atmospheric anomalies. According to the definitions of dry and very dry years by the Ethiopian National Meteorological Services Agency ENMS (see Section 3.2), the probability of a 'below-normal (poor)' rainfall year/spring/summer in Mekelle is 10.3/17.5/20.5%, respectively. The probability of a 'much-below-normal (very poor)' rainfall year/spring/summer is 2.6/20/2.6%, respectively. Fig. 9 shows that since 1960 only 1984 would be classified as a 'much-below-normal' rainfall

⁴Defined through meteorological drought, evapotranspiration, soil-water deficiency during different stages of crop growth and water reduction in groundwater reservoirs

Table 2. Different stakeholders' views of 'normal' rainfall and drought

Stakeholder	Normal	Drought
Statistician	Mathematically calculated value	A period of negative rainfall anomalies in respect to the mean
Farmer/pastoralist	Desired situation in respect to harvest/ economic outcome	Situation leading to economic and social problems (not necessarily due to environmental conditions)
Media	Idealised weather cycle based on monthly averages neatly fitted to each other	Adverse condition to be highlighted in respect to international attention

year. Spring rains are frequently poor or very poor and could be assumed to be part of the normal cycle of that region. Summer rains can be frequently poor, but for the overall year the probability of both below-normal and much-below-normal rainfall years is very low.

The different views on normal rainfall and drought conditions are summarised in Table 2. Statistics, according to the ENMS definitions, would not classify 2002 as a dry year due to rainfall deviation of (–)24 to (+)5% from the mean in northern Ethiopia (range of the 4 gauges in northern Ethiopia, whose values lie above what would be called dry or even a very dry year). The people in the North Afar zone considered 2002 as the worst drought year in human memory, even worse than 1984–85 due to the combination of high loss of animals and yield. The media declared 2002 as a devastating drought year, due to the huge amounts of food aid needed. Both 1996, with summer rains much below average, and 1997, with both poor spring and summer rains, could have been described as meteorological drought years in statistical terms. However, the impacts were less dramatic; thus these years were not considered as drought years, at least not in the eyes of the rural people and therefore the media.

4.2. Possible sources of divergence between rainfall measurements and perceptions

Studies of northern Ethiopia have shown no specific change in climate, including rainfall, during the last 4 decades (e.g. Conway 2000). However, local people as well as international aid organisations involved in famine relief are strongly focused on changes in climate, abnormal rainfall, and extraordinary drought years, such as recently in 2002 (evidence based on author's observations, newspaper articles and pledges of government and aid organisations, e.g. BBC News, 8 October 2002⁵, Ethiopian Government 2002, Federal

Democratic Republic of Ethiopia Disaster Prevention and Preparedness Commission and United Nations 2002, German Red Cross, 20 December 2002⁶, Oxfam 2003⁷). This gives room for speculation about the origin of such perceptions:

(1) *If there is no proven change, has the need for rainfall changed during recent decades?* It could be assumed that, while the supply of rainfall has been stable during recent decades, demand for it has increased. This may be due to different reasons. The population in Ethiopia has grown nearly 3-fold between 1960 and 2000 from 24 million to 65 million (US Census Bureau; available at www.census.gov), with a current growth of 2.7% a year, leading to higher food requirements. Increased demand for staple food can be met by intensification or extensification of agriculture (e.g. Holden & Sankhayan 1998). The dependency on sufficient spring and summer rains to meet a household's demand for food means that any negative rainfall anomaly in either season will result in a lower-than-expected supply.

While this study focused mainly on rainfall alone, many other natural and human factors can affect water availability (Wilhite & Glantz 1985), whether for crop growth, pastures or household use. The interconnectedness of changes in temperature, evapotranspiration or other physical factors such as soil fertility, vegetation cover and water availability may result in farmers perceiving rainfall decline without any actual measured change in rainfall itself (Lindskog 1994, Dahlberg & Blaikie 1996). Extension of marginal land for farming and grazing purposes, as well as a reduction in fallow, has led to considerable soil degradation in many Ethiopian regions (Kuru 1986). Thus, in the long term, although the overall situation is complex and difficult to generalise (Elias & Scoones 1999), the consequence has been reduced output per hectare. In the

⁵<http://news.bbc.co.uk/2/hi/africa/2307369.stm> (accessed 28 April 2004)

⁶http://www.drk.de/a-internettagbuch/startseiten/2002/1220_aethiopien/bericht.htm (accessed 28 April 2004)

⁷Oxfam (2003) Oxfam press release, 13 February 2003. Available at http://www.oxfam.org/eng/pr030213_Ethiopia.htm (accessed: 28 April 2004)

western border region of the North Afar zone, a steady immigration of Tigrinian farmers during the last 40 yr has resulted in a considerable decrease in woodland and bush vegetation due to land-use change (Alemu et al. 1999) and firewood demand.

Another possible reason for increased rainfall needs in the North Afar zone is the fact that the immigrating farmers started to cultivate the few floodplains in the region. Increased competition for land with the local pastoralists may have led to higher needs for stable and sufficient rainfall. Pastoralists have to move to purely rain-fed areas away from the floodplains, where there is a lower probability of sufficient soil moisture in the case of rainfall failure.

(2) *If there is no 'normal' rainfall, is there just a created demand for it? Is it a western perceptual construct?* In drylands, successful resource management is often characterized by high levels of diversity, flexibility and adaptability (Mortimore & Adams 1999). Nevertheless, Ethiopia has a long history of devastating droughts and famines (e.g. Degefu 1987, Pankhurst 1988, Rahmato 1994), indicating the limits of adaptability during all epochs. Regardless of whether local peoples' recent perception of environmental and especially rainfall change (such as the loss of a rainy season) may not be supported by available data, the actions they take based on these perceptions and resulting consequences are real (Glantz & Degefu 1991). Most Tigrinian farmers migrated into the North Afar zone during the 1950s and 1960s. This was a more humid period, with reliable rainfall in many parts of East Africa (Conway 2000, Nicholson 2000). They started to plant maize, sorghum and teff as they used to in their former homesteads in the highlands. At that time people may not have taken into consideration that these rainfall conditions were exceptionally good. Thus, it could be argued that, while the North Afar zone was appropriate for long-cycle crops during the 1950s and 1960s, over longer periods it might not be suitable to grow crops for subsistence as a single-income source. This is due to the high natural variability of rainfall in the region and the non-existence of advanced irrigation schemes necessary for reliable crop performance. It would thus be unfair to blame a shift in climate for frequent harvest failures. This may explain farmers' perceptions of the lost short rains, as they refer changes in rainfall to a period with sufficient rain some decades ago which they or their fathers experienced. A pure glorification of the past can therefore be excluded.

With respect to similar views on recently reduced rainfall from pastoralists, who have been in the area for centuries, other explanations of their rainfall perceptions have to be sought. One could be that they simply adopted the view of immigrating farmers or extension

workers. Even in highly remote regions people told us that they heard about a changing climate from educated agricultural extension officers. Thus, the sparse and delayed 2002 rainfall confirmed their opinion that this was just another signal of climate change. Instead of stressing the importance of traditional survival strategies during drought, they pointed out the exceptional emergency situation they were facing. The repeating of opinions from extension officers can be referred to as an expatriate narrative (Roe 1999). These are rules of thumb, arguments and other scenarios about rural development derived from non-local (scientific) sources, aimed at making the listener believe in the story with its causal chains of actions, explanations and solutions. It is not necessarily that expatriate sources intend to create misperception, just that others may have interpreted their results in an (un-)wanted direction. Scientific 'truths' of global climate change may have been turned into myths of environmental change on a local level (Leach et al. 1996). This includes local peoples' views in the North Afar zone that an afforestation of the closest hillsides would turn the seasonal rainfall back to normal, defined as what they were used to in the 1950s and 1960s.

(3) *Maybe facts are hidden in the underlying data?* Farming practices have changed in northern Ethiopia. Crops with a shorter growing season are more widely grown and have higher drought resistance. The monthly rainfall series used here do not reveal change in rainfall, either in total amounts or in seasonal distribution. This may lead to one questioning the validity of the data and whether they are representative. One shortcoming of just using monthly or annual data is the detection of potential changes in daily rainfall. As Agnew & Chappell (1999) point out, normal as well as optimal rainfall has to be seen not only in terms of quantity, but in respect to timing (seasonal occurrence, delays in start of rainy season, occurrence in relation to crop demand), duration, amount, intensity, and region-specific distribution. Nevertheless, for northern Ethiopia, the paucity of available data, in terms of both a dense gauge network and daily records, does not allow a more detailed analysis. Only recently have daily rainfall data in Ethiopia become available across extensive areas, mostly as estimates of combined satellite information and rain gauges (CPC/FEWS). But they do not correlate well with the available daily rainfall records (E. Meze-Hausken & D. Conway unpubl.).

Monthly data from Mekelle may underestimate the possibility of changes in the number of rainy days and intensity of rainfall within a single shower; thus it may hide possible changes in seasonal rainfall patterns. In Uganda, for example, people's perceptions of rainfall decline during recent decades have been verified through comparison with daily rainfall records: while

the total monthly and seasonal rainfall amount has been stable, the dry spells in months critical for crop growth have increased (Ovuka & Lindqvist 2000). As such, partial agreement between perceptions of change and scientists' findings from data has been reached.

5. CONCLUSION

Through a case study in northern Ethiopia this paper has presented how a divergence between climate data and perceptions on climate may arise. Key findings were that, although perceptions of change from wetter to drier conditions may have some foundation in underlying climatological data, at least some of these perceptions are derived from peoples' actual rainfall needs and are judged against them.

Research in Abala has given an especially useful example of the complex and diverse rainfall needs of different livelihoods. Many people in that area have experienced temporal and spatial changes in rainfall by migrating during a wetter period to a normally drier region than their previous homestead. They contributed to large-scale land-use change and deforestation, which may have reduced the availability of rain-fed moisture for pastures and fields. It is difficult for individuals without statistical information to place extreme events such as the recent 2002 drought or smooth climate change into a wider context. The result is that peoples' perceptions about climate are in fact a combination of various environmental aspects.

The implications of these findings are that any analysis of subjective observations about weather and climate requires a deeper investigation of the socio-economic, cultural and environmental conditions experienced by the affected people. Given the complexity of factors, this will challenge any predictions of potential human impacts of climate change, as they vary for different groups due to diverse needs.

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LITERATURE CITED

- Abu Sin MH (1985) Man's socio-economic response to drought in the White Nile. In: Davies HRJ (ed) Rural development in White Nile Province, Sudan. The United Nations University, Tokyo. Available at www.unu.edu/unupress/unupbooks/80579e/80579E00.htm
- Agnew CT, Chappell A (1999) Drought in the Sahel. *Geo-Journal* 48:299–311
- Alemu DT, Farah KO, Nyariki DM (1999) Influence of settlements on land use and vegetation in the rangelands of northeastern Ethiopia: application of aerial photographic technique. *J Human Ecol* 10:349–356
- Conway D (2000) Some aspects of climate variability in the north east Ethiopian highlands—Wollo and Tigray. *SINET—Ethiopian J Sci* 23:139–161
- Dahlberg AC, Blaikie PM (1996) Changes in landscape or in interpretation? An environmental history from North East District, Botswana. In: Dahlberg AC (ed) Interpretations of environmental change and diversity: a study from North East District, Botswana. Dissertation No. 7. Naturgeografiska Institutionen, Stockholm University
- Degefu W (1987) Some aspects of meteorological drought in Ethiopia. In: Glantz MH (ed) Drought and hunger in Africa: denying famine a future. Cambridge University Press, Cambridge
- Elias E, Scoones I (1999) Perspectives on soil fertility change: a case study from southern Ethiopia. *Land Degrad Develop* 10:195–206
- Ethiopian Government (2002) Emergency assistance requirements & implementation options for 2003—a joint Government—UN appeal.
- Federal Democratic Republic of Ethiopia, Disaster Prevention and Preparedness Commission, and United Nations (2002) Situation update and joint flash appeal.
- FEWS Net (2003) Ethiopian Network on Food Security 5/20/2003. Famine Early Warning System Network of USAID. Available at <http://www.fews.net/current/monthlies/report/?submit=y&m=1000918&f=et&l=en> (accessed 28 April 2004)
- Gamachu D (1977) Aspects of climate and water budget in Ethiopia. Addis Ababa University Press, Addis Ababa
- Glantz M, Degefu W (1991) Drought issues for the 1990s. In: Jäger J, Ferguson HL (eds) Climate change: science, impacts and policy. Proceedings of the Second World Climate Conference. Cambridge University Press, Cambridge
- Glantz MH, Katz RW (1977) When is a drought a drought? *Nature* 267:192–193
- Griffiths JF (1972) *Climates of Africa*, Vol 10. Elsevier, Amsterdam
- Hailemariam K (1999) Impact of climate change on the water resources of Awash River Basin, Ethiopia. *Clim Res* 12: 91–96
- Heim RRJ (2000) Drought indices: a review. In: Wilhite DA (ed) Drought: a global assessment, Vol 1. Routledge, London. Available at www.drought.unl.edu/whatis/indices.pdf
- Hoben A (1995) Paradigms and politics—the cultural construction of environmental-policy in Ethiopia. *World Develop* 23:1007–1021
- Holden ST, Sankhayan PL (1998) Population pressure, agricultural change and environmental degradation in the western Himalayan region of India. *Forum for Development Studies* 2:271–300
- Kovats RS, Campbell-Lendrum DH, McMichael AJ, Woodward A, Cox JS (2001) Early effects of climate change: do they include changes in vector-borne disease? *Phil Trans R Soc Lond B* 356:1057–1068
- Kuru A (1986) Soil erosion and strategic state policy: the case of Ethiopia. Thesis, University of Helsinki
- Leach M, Mearns R (eds) (1996) *The lie of the land: challenging received wisdom on the African Environment*. The International African Institute in association with James Currey, Oxford
- Legesse D, Vallet-Coulomb C, Gasse F (2003) Hydrological

- response of a catchment to climate and land use changes in Tropical Africa: case study South Central Ethiopia. *J Hydrol* 275:67–85
- Lindskog P (1994) Land degradation, natural resources and local knowledge in the Sahel zone of Burkina Faso. *Geographical Journal* 33:365–375
- Marque C, Rosenwald V (1997) The agrarian systems in a small region of Northern Ethiopia. Diploma, Institut National Agronomique de Paris-Grignon
- Meze-Hausken E (2000) Migration caused by climate change: how vulnerable are people in dryland areas? *Mitigation and Adaptation Strategies for Global Change* 5:379–406
- Mortimore M, Adams WM (1999) Working the Sahel: environment and society in northern Nigeria. Routledge, London
- NEDECO (1997) Netherlands engineering consultants. Tekeze river basin integrated development master plan project. Report No. 1, Climatology. Federal Democratic Republic of Ethiopia, Ministry of Water Resources, Addis Ababa
- Nicholson S (2000) Land surface processes and Sahel climate. *Rev Geophys* 38:117–139
- Ovuka M, Lindqvist S (2000) Rainfall variability in Murang'a District, Kenya: meteorological data and farmers' perception. *Geogr Ann Ser A Phys Geogr* 82:107–119
- Pankhurst A (1988) Social dimensions of famine in Ethiopia: exchange, migration and integration. In: USSR Academy of Sciences–Africa Institute: Proceedings of the 9th International Congress of Ethiopian Studies, 26–29 August, 1986, Vol 2. Nauka, Moscow
- Rahmato D (1994) Neither feast nor famine: prospects for food security. In: Zegeye A, Pausewang S (eds) Ethiopia in change: peasantry, nationalism, and democracy. British Academic Press, London, p 192–208
- Rebetez M (1996) Public expectation as an element of human perception of climate change. *Clim Change* 32:495–509
- Roe E (1999) Except-Africa: remaking development, rethinking power. Transaction Publishers, New Brunswick, NJ
- Steffen P, Amer S, Asfaw A, Senay G, Rowland J, Funk C (2003) Rainfall in Ethiopia is becoming increasingly erratic. FEWS Net, 19 June 2003. www.fews.net/risk/report/?gc_id=1000293&f=al&d=0&i=1020, accessed 16 June 2004
- Stehr N (1997) Trust and climate. *Clim Res* 8:163–169
- Stehr N, von Storch H (1995) The social construct of climate and climate change. *Clim Res* 5:99–105
- WFP Emergency Report (2003) 2/2003. World Food Program. Available at <http://www.wfp.org/index.asp?section=2> (accessed 28 April 2004)
- Wilhite DA (2000) Drought: a global assessment. Routledge, London
- Wilhite DA, Glantz MH (1985) Understanding the drought phenomenon: the role of definitions. *Water Int* 10:111–120

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