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Farmers' Perceptions of Climate Change and Agricultural Adaptation Strategies in Rural Sahel

Ole Mertz · Cheikh Mbow · Anette Reenberg · Awa Diouf

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Abstract Farmers in the Sahel have always been facing climatic variability at intra- and inter-annual and decadal time scales. While coping and adaptation strategies have traditionally included crop diversification, mobility, livelihood diversification, and migration, singling out climate as a direct driver of changes is not so simple. Using focus group interviews and a household survey, this study analyzes the perceptions of climate change and the strategies for coping and adaptation by sedentary farmers in the savanna zone of central Senegal. Households are aware of climate variability and identify wind and occasional excess rainfall as the most destructive climate factors. Households attribute poor livestock health, reduced crop yields and a range of other problems to climate factors, especially wind. However, when questions on land use and livelihood change are not asked directly in a climate context, households and groups assign economic, political, and social rather than climate factors as the main reasons for change. It is concluded that the communities studied have a high awareness of climate issues, but climatic narratives are likely to influence responses when questions mention climate. Change in land use and livelihood strategies is driven by adaptation to a range of factors of which climate appears not to be the most important. Implications for policy-making on agricultural and economic development will be to focus on providing flexible options rather than specific solutions to uncertain climate.

Keywords Drivers of change · Dryland farming · Land use change · Livelihood strategies · Senegal · West Africa

O. Mertz (✉) · A. Reenberg
Department of Geography and Geology, University of Copenhagen, Copenhagen, Denmark
e-mail: om@geo.ku.dk

C. Mbow · A. Diouf
Institute of Environmental Sciences, Faculty of Science and Technology, Cheikh Anta Diop University of Dakar, Dakar, Senegal

Introduction

There is increasing evidence that climate change will strongly affect the African continent and will be one of the challenging issues for future development, particularly in the drier regions (Adger and others 2007; Haile 2005; Huq and others 2004; Kurukulasuriya and others 2006). The challenge is composed of the likely impacts of climate change on ecosystem services, agricultural production, and livelihoods (Odada and others 2008; Sivakumar and others 2005), as well as the limited resilience and high vulnerability characterizing regions dominated by economic poverty, subsistence food production, and a low and highly variable natural production potential. An economic analysis of 9000 farmers in 11 African countries predicted falling farm revenues with current climate scenarios (Kurukulasuriya and others 2006), and using two global circulation models, a study at national level in Mali predicted future economic losses and increased the risk of hunger due to climate change (Butt and others 2005). It seems clear that the combination of high climatic variability, poor infrastructure, economic poverty, and low productivity will constitute important challenges for Africa and the Sahelian countries in particular (Adger and others 2007).

Nevertheless, rural communities in the Sahelian zone of West Africa have always managed their resources and

livelihoods in the face of challenging environmental and socio-economic conditions (Mortimore and Adams 2001). They have to a large extent been able to develop their livelihood strategies in a way which enables them to constantly cope with and adapt to an erratic climate, severe pest attacks, changing policies at local, national, and global levels, and so on.

The scientific agreement that climate change is happening and will continue well into the future regardless of the effectiveness of mitigation measures (Christensen and others 2007) has reiterated the need to understand how farmers and pastoralists in the Sahel have coped with climate variability and change in order to guide the strategies for adaptation in the future. However, there are at least two complications in arriving at such an understanding:

- First, while the climate change scenarios for West Africa point to increased temperatures in the Sahel, climate models are in disagreement regarding changes in precipitation, suggesting either increases (Haarsmaa and others 2005) or decreases (Held and others 2005). Indeed, based on 21 global model outputs, the Fourth IPCC Assessment states that "it is unclear how rainfall in the Sahel, the Guinean Coast and southern Sahara will evolve" (Christensen and others 2007).
- Second, in all rural communities, climate is only one of many factors influencing their coping and adaptation strategies to environmental changes (Adger 1999; Eakin 2000; Eakin and others 2006) and this may be even more pronounced in the relatively poor and vulnerable communities of the African drylands (Elmqvist and Olsson 2006; Reynolds and others 2007; Tschakert 2007; Ziervogel and others 2006). Seemingly marginal changes in subsidies, market conditions, labor supply, seed availability, energy supply, etc., may lead farmers with low economic resilience to radically change their strategies regardless of the climatic parameters.

This article will only address the second problem. The first, we have to leave to climate modelers in the hope that more precise climate scenarios can be established to serve as foundation for realistic impact prediction and adaptation strategies. The objective of this article is closely linked to the general objective of the human dimensions work package of the African Monsoon Multidisciplinary Analysis (AMMA) project that aims to improve the understanding of coping and adaptive capacities of natural-resources dependent societies in the Sahel. We will investigate how farmers are coping and adapting to past and current changes, recognizing that while the concept of coping capacity is more directly related to short term survival, the concept of adaptive capacity refers to a longer time frame and implies some learning (Smit and Wandel 2006). Using case studies from central Senegal, we will assess how development trends in the Sahel, such as diversification of production, new technologies, migration, off-farm activities, trade, government policies, and land and resource degradation/restoration affect the land use and livelihood strategies of households. We will assess which coping and adaptation strategies are adopted in the face of these changes or trends and to what extent these strategies are a specific response to climate change and variability (CCV). Our specific aim is to attempt a separation of climate causes from other drivers of change in order to inform policy-makers on the relevance of the increased focus on climate adaptation in development efforts.

Adaptation of Agriculture to Climate Change and Variability in Africa

The study of coping and adaptive resource management strategies is not new, particularly not in the Sahelian region, where a poor and vulnerable population has always dealt with a highly fluctuating natural environment. There are diverging opinions on how well rural populations are dealing with their environmental and economic conditions. Recent studies point to dryland populations as the most ecologically, socially, and politically marginalized lagging behind on most economic and health indices (Reynolds and others 2007) and that climate change will be yet another stress factor in a vulnerable system (Verchot and others 2007). Others stress the resilience of Sahelian farmers and their proven ability of coping with even the hardest crises, such as the droughts of the 1970s and 1980s and question the notion of persistent crisis in Sahelian households (Mortimore and Adams 2001; Snrech 1995). Moreover, it is argued that the value of local knowledge in climate change studies has received little attention. Farmers possess valuable indigenous adaptation strategies that include early warming systems (Ajibade and Shokemi 2003; Nyong and others 2007) and recognize and respond to changes in climate parameters (Thomas and others 2007), for example, by maintaining flexible strategies with short and long cycle crop varieties (Lacy and others 2006).

The complexity of identifying climate as a direct driver of change in agriculture was alluded to in the introduction. Large differences between regions, villages, and households exist as illustrated by Elmqvist and Olsson (2006), who found that in one community in Sudan drought was perceived as a key driver for change in gum arabic production, while another community was relatively unaffected and supposedly more resilient. Previous studies have pointed to the complexity of drivers of change in the Sahel (Mortimore and others 2005; Reenberg 2001; Tschakert 2007; Wardell and others 2003) as have several

studies in southern Africa (Thomas and others 2007; Ziervogel and others 2006).

There are, however, examples of good correlations between climate parameters and change. Using agent-based modeling in a vegetable garden system of South Africa, Bharwani and others (2005) showed that wealthier households benefit more than the poor from weather forecasts and that subsistence farmers are the most vulnerable to short-lived droughts even if average rains are good. Also in South Africa, dry spells caused farmers to reduce cropping efforts and focus on livestock (Thomas and others 2007), and in Mali, farmers responded to shorter rainy seasons by using short cycle varieties of sorghum, although long-cycle varieties were still farmed as they give higher yields and have better taste (Lacy and others 2006). More long term adaptation was observed in Burkina Faso and Niger, where shifts in farming location between sandy dunes and more clayey pediplains and piedmonts were related to precipitation patterns (Reenberg 1994; Reenberg and others 1998), whereas short term coping with the 1997 drought in Burkina Faso caused farm households to implement a range of food saving strategies, encourage migration, sell livestock, and even resorting to borrowing and mortgaging of the following year's crops (Roncoli and others 2001). In this case, the ramifications of one year's drought were felt in the following year in terms of lacking seed and labor for cultivation and it sparked interest in drought resistant varieties, but longer term adaptation measures were not assessed (Roncoli and others 2001).

Many of these studies provide recommendations for actions to improve the living conditions of rural populations, and there have been many efforts aimed at reducing the vulnerability of rural communities to CCV. Various early warning systems (Davies 1996; Huq and others 2004), such as FEWS (Famine early warning system), are used in Sahelian countries, and a range of support initiatives, including improvement of access to markets for inputs and products and commodity chains; promotion of investment incentives; revision of food sufficiency assumptions; supporting access to labor markets; opening of land markets; promotion of communication systems (e.g., cell phones); and supporting the most vulnerable with flexible micro-credit (Mortimore 2006) have been implemented with varying success. Not all policy instruments have been sensitive to the adaptive resources and constraints of African farming households (Lacy and others 2006; Mortimore and Adams 2001), which may be partly caused by the difficulty in measuring and finding the right indicators for the adaptive capacity (Vincent 2007) as well as the problems of determining driving forces and cause-effect relationships. Many of the development efforts only indirectly address the problem of CCV, and although policies today more frequently make explicit that they are a response to predicted climate change (Halsnæs and Verhagen 2007), it seems that they are relatively similar to past policies favoring economic development.

Study Areas and Methods

This study was carried out in the Eastern Saloum, Senegal in October 2006 and February–March 2007 (Fig. 1). The study was designed to understand past and present adaptation to CCV in the natural resource management practices, as well as the wider livelihood strategies of the farmers. Hence, it includes a characterization of agricultural land use as well as a wide range of other socio-economic data that might influence decision-making processes and hence confound possible correlations between actual practices and CCV.

Eastern Saloum is located on the verge of two climatic zones: the Sahel-Soudanian zone and the Soudanian zone. Annual rainfall averages 650 mm/year, but with quite large differences between good and bad years. Records of precipitation in the area show high rainfall variability (Fig. 2) and occasional years of drought. The rainfall variability partly explains the combination of agricultural and forestry activities dominant in the area, which is located at the fringe of the Senegalese ground nut basin. The landscape mirrors these various land use practices with vast zones of agriculture interrupted by savanna and valleys with stands of *Combretum glutinosum*, *Faidherbia albida*, *Sterculia setigera*, and *Cordyla pinnata* as the main species. Pasture land is very limited in the area and is generally confined to forest reserves. Agriculture is the main source of income and, for Senegal, it is a high potential agricultural area with ferruginous soils and some lithosols on the lateritic plateau and hydromorphic salty soils in the fossil valleys of the Saloum hydrosystem. Pearl millet (*Pennisetum typhoides*) and ground nuts (*Arachis hypogaea*) are the most important crops, followed by sorghum (*Sorgho bicolor*) and maize (*Zea mays*). Livestock is important, but is changing in composition, e.g., from horses to cattle and small ruminants. The main urban centre is Kaffrine. The population density is about 48 inhabitants per km^2, slightly higher than the national average. The study was carried out in three villages rather than in just one in order to represent the area better and to ensure that none of the study villages had very specific contexts that may influence results. All villages were found within 30 km of Kaffrine: Boulèle (90 households), Toun Mosqué (179 households) and Sania (68 households).

The study was based on interviews with key-informants, group interviews with farmers, and a household questionnaire:

- Informal interviews with four key informants (e.g. extension services) with the aim of identifying (a) main agricultural and natural resource management

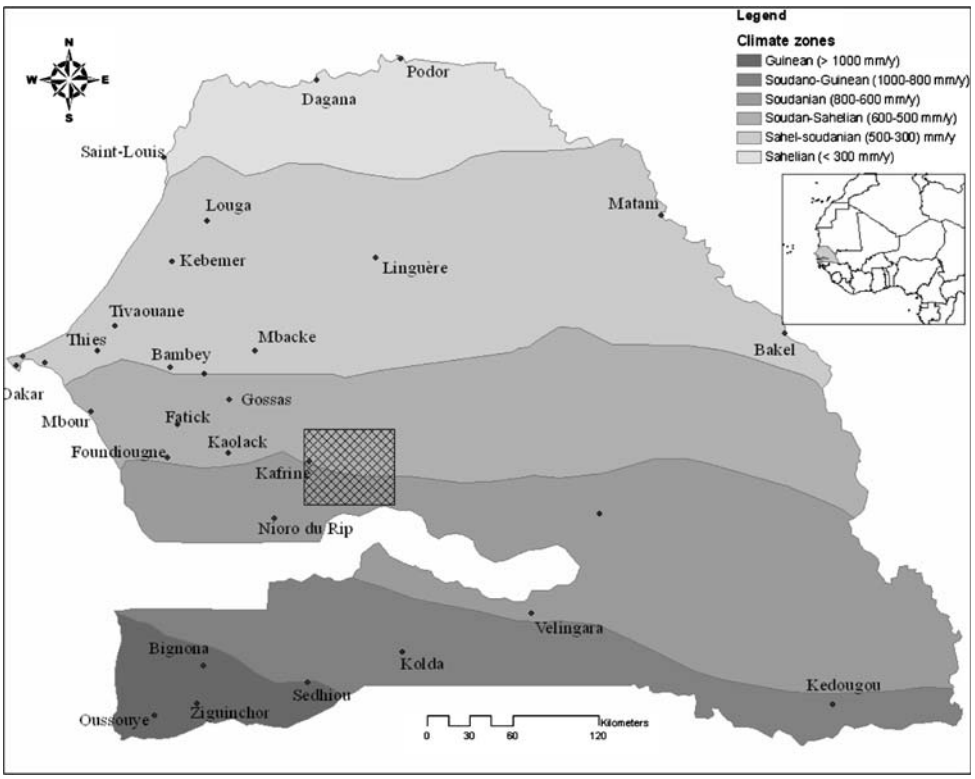

Fig. 1 Location of study sites in Senegal

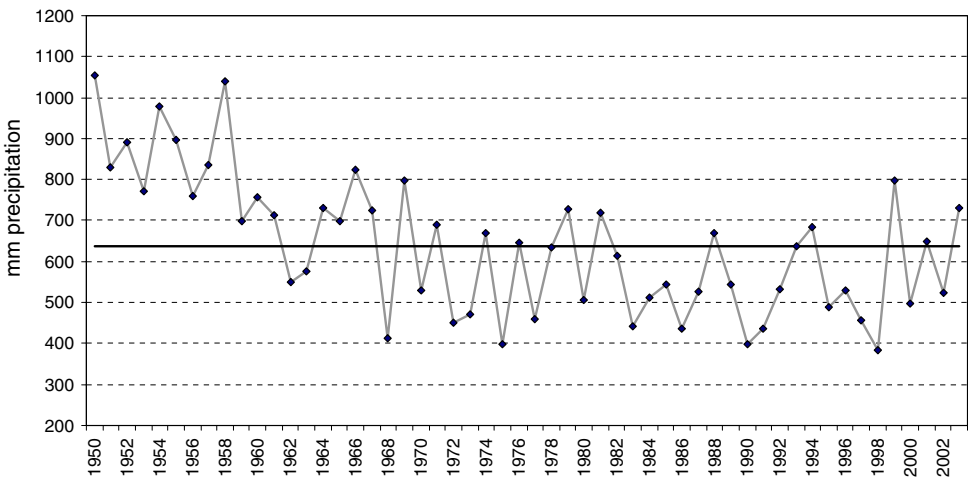

Fig. 2 Annual rainfall in Kaffrine 1950–2003. Horizontal line indicates annual average for this period

strategies, (b) significant change patterns in the last 50 years, (c) a list of major socio-economic and biophysical drivers of land use change, and (d) local reports, books etc., of relevance for this subject. The informants represented the regional agricultural extension service, the regional forest service, and two major internationally funded project coordination offices. Hence, both national strategies for agriculture and natural resource management and a more general overview of the contemporary perception of environmental changes were pinpointed.

- Group interviews with farmers from a set of representative villages with the aim of (a) triangulating the information obtained from household and key informant interviews, (b) testing (and further developing) the list of potential response options to climatic change, including listing of climate events that may have influenced local strategies, and (c) sketch out the main trends and changes in land use and labor supply to understand to which extent changes can be explained as adaptive strategies (responding to changes in climate, institutions, economy, demography). One interview

with a group of women and one with a group of men were made in each village in order to ensure that views were as representative as possible of the population.

- A household based questionnaire providing the basis for a quantitative characterization of household perceptions of CCV, adaptation to CCV and changes in household resource management and livelihood strategies over the past 20 years. A total of twenty-five households were selected for interview in the three villages. The selection procedure was complete randomization, but due to the absence of quite many households during the time of interviews, this schedule was not followed completely as priority had to be given to households that were present.

In the focus group and household interviews, questions directly referring to climate issues were only posed towards the end to avoid biases, an approach similar to that of Thomas and others (2007).

Results

Perceptions of Climate Change and Variability

The local communities have a very clear memory of the years dominated by extreme climatic conditions and other significant events leading to disturbances of the production (Table 1). In some cases, the same years are characterized by both drought and excessive rains.

The perception of climate parameters was also assessed at household level (Table 2). Households generally found that the overall trend was a decrease, but several households nuanced this view. Four mentioned that the "rains have returned" since the early 2000s, three that rains simply vary too much to determine the trend, and one that the quantity of rain is irrelevant as both drought and excessive rains may destroy the crops. Households generally agreed on increased temperatures throughout the year and that cold periods have become shorter and hot periods longer. Finally, wind was almost unanimously pointed to as having become stronger, especially in the dry season.

The statements in the group interviews generally corroborated the household questionnaires as the respondents were very concerned with the increasing dry and wet season wind speeds (Table 3). However, the nuanced views on rainfall seen in the household interviews were not repeated in the group interviews where there was agreement on a negative trend in rainfall. The perception of climate parameters of male and female groups was similar.

Perceptions of Climate Impacts and Adaptation

After evaluating climate change parameters, households were asked to identify impacts of climate change and variability and their adaptive responses (Table 4).

Most of the identified impacts are negative and related to effects of strong winds and excessive rain, which is interesting considering that most households and groups of

Table 1 Years of extreme climate conditions and other events of relevance to production in Kaffrine

Observations by local people	Official records of annual average rainfall in Kaffrine (see also Fig. 2)
1968: severe drought	1968 was a serious drought year in Kaffrine (412 mm), but not worse than several other years. The period was characterized by high variability
1983–1985: drought	1983 and 1986 are severe drought years. Some recovery in 1984–1985, but still below average
1984: important dry season rainfall	Small counter season rainfall in 1985 in Kaffrine (could have been stronger in villages). More serious counter season rains in 1976 and 1979
1990: sand storms	1990–1991 are severe drought years
1993: intensive rains	1993 an average year, but with very high rainfall in August, including two days with >70 mm
1998: intensive rain accompanied by very strong wind	1998 is a low rainfall year, where only September has average rainfall. Farmers may have confused this year with 1999, which had above average rainfall and in Kaolack, August had only 5 days without rainfall
2000: very cold dry season	2000 is a below average rainfall year, but without any apparent extremes
2002: intensive rain and inundations	2002 is also below average, but slightly higher than 2000. Rainfall in September is above average and may have caused the inundations
2003: short rainy season	Average year with slightly above average rainfall. June rainfall below average
2004: locust invasion	No data from Kaffrine. In Kaolack, 2004 is an average year, though no rainfall in October
2005: excessive rainfall and very strong winds	No data from Kaffrine. In Kaolack, 2005 is 100 mm above the average for the 1950–2006 period
2006: strong winds and dust, cold during dry season	No data from Kaffrine. In Kaolack, 2006 is also about 100 mm above average with very high rainfall in August (411 mm)

Comparison of local observations based on group interviews and official records

Table 2 Perceptions of climate change parameters by households in Kaffrine during the last 20 years

Percent of 25 households[a]		Increase	No change	Decrease	No answer
Precipitation	Annual	14	5	82	0
	Rainy season	14	0	64	23
	Dry season	18	0	68	14
	Length of dry spells, rainy season	45	0	23	32
	Intensity of rainfall events	23	5	55	18
	Inundation of fields and villages	32	0	23	45
Temperature	Dry season temperature	82	0	9	9
	Rainy season temperature	77	0	9	14
	Length of cold periods	9	5	68	18
	Length of hot periods	82	0	18	0
Wind	Intensity dry season	95	0	0	5
	Intensity rainy season	68	0	27	5

[a] Percentages are rounded to 0 decimals; hence, the sum is not always 100

Table 3 Statements on change in climate parameters by interviewed groups in three villages

	Women Sania	Women Toun	Men Sania	Men Toun	Men Boulèle
Rain	Less rain because there are fewer trees	Longer dry spells during rainy season Reduced number of rainy days during rainy season	Less rain Rainy season shorter Rain stops in September, before it rained in October	Rains are less intense	Less rain
Temperature	Heat is more intense Cold spells reduced in length and intensity	Cold spells reduced in length and intensity The heat is now torrid	Intensity of heat stronger Hot seasons longer Cold spells are shorter and less intense Previously the baobab fruits were spoiled because of cold Firewood for heating not needed anymore	Intensity of cold spells reduced Intensity of heat increased	
Wind	Winds are strong and stir up the dust	Clouds bring more wind than rain Strong winds destroy the millet Winds are stronger, more frequent and carry more dust		Wind is sometimes so strong that houses collapse	Winds associated with rain are so strong that they can remove roofs of houses

farmers perceived reduced rainfall as the main problem. Problems related to lack of rain are only mentioned eight times as the cause of negative impacts—compared to excessive rain, which is mentioned 14 times. Wind is mentioned 30 times as a cause of the problems. Positive impacts are mentioned by a few respondents and include better possibilities for business (if not hampered by bad weather) as well as recovering vegetation and fauna as a result of returning rains and a perceived decline in the area of cultivation leading to more fallow land and better soils. Migration by young people was identified as both an impact and adaptation measure: the absence of young people is by older people remaining in the household felt as an indirect impact of climate, which is considered to be partly responsible for declining yields and few opportunities within in agriculture thus causing people to leave; but it is, of course, also an adaptation measure by the family to secure income from remittances and thereby counter economic difficulties that may be directly or indirectly caused by climate factors. Migration was mainly perceived in a negative sense as more work was left for the older people—the most frequently mentioned adaptation measure to

Table 4 Perceived impacts of climate related parameters and adaptation measures

Category	Impact	No.[a]	(Climate) Cause	No.[a]	Adaptation	No.[a]
Cultivation	Reduced yield	13	Wind	14	New crops/varieties	3
	Damage to crops	10	Excessive rain	9	Other activities	3
			Lack of rain	2	Re-sowing	1
			Rain stops early	1		
Livestock	Poor animal health	16	Wind	8	Cattle replace horses	3
	Fodder shortage and costs	9	Cold	3	Animals in stables	6
	Theft	3	Excessive rain	2	Animals in kraals	2
			Drought	1	Collect, buy or cultivate fodder	3
Business	Less business	10	Wind	6	Market gardening (new business)	1
	People stay home	3	Rain/inundations	3		
	+More business	3	Heat	1		
Young people	Migration	18	Rainy season poor	2	Old people work more in all seasons	11
	Late marriages	3	Lack of seed or equipment	3		
Soils	Less fertile	19	Wind (erosion)	2	Use manure	5
			No fertilizer subsidies	1	Abandon fields	2
			Less trees	1	Use fertilizer	1
	+More fertile	1	More fallow land	1	Use more labor	1
Water resources	Less water in ponds	10	Clay mining	2	More wells and boreholes	2
			Less rain	1		
	+More water now	1	More rain	1		
Vegetation	Degraded	17	Abusive use and population growth	2	Reforestation	6
	+Recovering	3	Drought	1	Avoid and extinguish fires	1
	+Trees degraded, bush OK	2	Fires	1		
Fauna	Reduced	11	No vegetation			
	+Recovering	6	Recovering vegetation			
	+Stable	1	Less cultivation			

Responses are based on household interviews and the most frequent were selected and grouped by the authors. Some households had many responses in each category, others very few or none. A plus (+) indicates positive impact

[a] Indicates number of responses placed in the category

migration—though the positive aspect of income was acknowledged. Otherwise, the households generally mentioned few adaptation measures—new crops or crop varieties (mostly vegetables); keeping animals in stables; replacing draught horses with cattle, which are cheaper to feed; and using manure were the main measures mentioned to counter perceived climate impacts on agricultural production. While questions focused on climate induced responses, it is not completely clear whether all of these are in fact adaptation to climate change. The new crops are mainly introduced to diversify and secure better income (see also Table 7), both of which may be indirectly related to climate.

The six group interviews were initiated by asking respondents to agree on five positive aspects of living in the community and five major challenges (Table 5). Climate factors were not identified by any of the groups as a main positive or challenging aspect of village life, although it could be an underlying cause of several of the issues mentioned. Health, education, and road access could be considered the main concerns as they were usually mentioned first and are the most frequently mentioned. Only when asked directly about climate issues did the group interviews largely corroborate the impacts identified in the household interviews, and they reiterated that rainfall variability during the rainy season is of major importance. Identified impacts include declining crop yields as a result of strong winds, intensive rainfall events and extended periods of cloud cover (these statements relate to the past 1–5 years). Both heat and cold are mentioned as having detrimental impacts on livestock, which is partly contradictory to the household statements mentioning problems with cold weather to be on the decline. A decline in the population and yields of useful wild plant species was also mentioned as a consequence of more extreme weather and of increased damage from bush fires caused by strong winds in the dry season. Poor health was raised as a problem during periods with dust storms and prolonged

Table 5 Results of group interviews with 3 groups of women and 3 groups of men

	Positive aspects, men	Positive aspects, women	Challenges, men	Challenges, women
Agriculture		Good yields of millet and sorghum	Insufficient fertilizer and equipment	No mill
			Insufficient land, seed and equipment	No equipment for extracting ground nut and sesame oil
		Mill in the village (2)	Less livestock because of costly fodder	
			Soil erosion	Soil erosion
				Insufficient land, equipment and seeds
Health and nutrition	Clinic (3)	Clinic (3)	Clinic staff lives far away, urgencies are not treated (2)	Clinic staff lives far away, urgencies are not treated (2)
			Lack of medicine in the clinic	Food habits changed to more costly meals
			Insufficient clinic staff	
Education and child care	Primary school	Nursery	Lack of classroom	No nursery or kindergarten
	Choranic school	Literacy campaign for women	No literacy campaign for men	
	Literacy campaign for women	Primary school		
Markets and economy			Less access to credit	No activities apart from agriculture (3)
			Ground nut Board opens late	
				Few activities for women
				Sale of agricultural products difficult
Water and electricity	Street lights	Wells, borehole, faucets (2)	Borehole broken, water collected 8 km away	No electricity
	Wells, boreholes, faucets	Electricity	No electricity (2)	
		Street lights, solar panels		
Security			Aggressive behavior and theft increased due to weekly markets	
Access		Good road (2)	Ravines make access difficult	Road to Kaffrine impassable in bad weather
		Medical evacuations easy		
		Easy sale to market		
Social life	Peace, solidarity and understanding in village (2)		Migration of young people	
	Mosque			

The groups were asked to identify the main positive aspects of living in their village and the main challenges

Numbers in brackets indicate that two or more groups mentioned the same issue

rain, and "reduced solidarity" was identified as an indirect impact of adverse climate in the community as everybody is increasingly trying to keep their own households going without considering their neighbors. Finally, household work is directly and indirectly affected: cooking is hazardous during periods with strong winds because of the risk of fire, and migration of young people results in reduced labor availability.

Adaptive measures mentioned in the group interviews were also similar, though a few new activities emerged: credit schemes and support from NGOs were mentioned as important adaptive measures needed within agriculture, and a focus on revitalizing the traditional solidarity measures, especially for aiding each other with family events and during crises, was emphasized. The main barriers identified in the group interviews toward appropriate adaptation to CCV were lack of funds to initiate small businesses (credit access), lack of success in doing business (low income, low benefit), underpaid manual work, high price of basic supplies and food, and theft of livestock.

Observed Changes in Land Use and Livelihood Strategies

In order to assess whether the farmers' perceptions of climate change impacts and adaptation in agriculture are in

accordance with changes in household activities, selected parameters are analyzed.

The average cultivated area per household in the three villages in 2006 was 19.8 hectares with a range of 3–120 ha. If one large farm of 120 ha is excluded, the average is 14.8 ha. Sixty four percent of the farms are less than 20 ha. Farmers were asked an open question to assess the main determinants of how they decide on the area cultivated in any given year. Table 6 shows that climate factors play a very minor role in that decision, whether it is today or before the drought of the 1980s—rain was the only parameter mentioned and only by two households. Availability of farm equipment and seeds are by far the most important and fertilizer is by close to half of the respondents ranked second. Before the mid 1980s, this tendency was the same, although "food needs" are ranked first by 20% of the farmers indicating that there was a more urgent need to be self-sufficient in food at that point in time.

Another indicator of adaptation is the introduction of new crops. Only three farmers mentioned this as an adaptive measure, but as seen in Table 7, a wide range of new crops have been taken up by farmers. The most important new crop is water melon (*Citrullus lanatus*) and the number of households mentioning this crop as new exceeds the number of households farming it. This may be because they forgot it when mentioning crops in the fields or because they cultivated it in previous years but not in 2006. Cowpea (*Vigna unguiculata*), maize, and sesame (*Sesamum indicum*) are also new to several households. There is a wide range of reasons for adopting different crops, but none of these reasons are directly related to climate factors. A desire for increased income, especially in the "lean season"—the months before the annual grain harvest—is common. Although new to the households interviewed, none of these crops are new to Senegal and they are promoted by crop diversification programs—an objective also specified in the National Adaptation Program of Action (MEPN 2006).

Data were also collected for changes in livestock, but sample checks revealed that the household data are highly inaccurate, probably because farmers are unwilling to reveal their livestock holdings.

Discussion

Farmers in the Eastern Saloum are strongly aware of the climate and have clear opinions on changes, especially in wind patterns and the intensity of climate events. This is corroborated by studies in other parts of Africa, e.g., in the Limpopo Province of South Africa, where a large majority of respondents in three regions of Limpopo Province related changes in long-term climate patterns to increased variability and unpredictability and identified climate as a "livelihood-affecting risk" (Thomas and others 2007).

Linking household strategies for agricultural and livelihood change directly to climate parameters is, however, very complex inasmuch as cultural, socio-economic and environmental drivers of change are intimately linked. The data presented in this article do not show climate as a main driver of change, but the results may of course be limited by the sample size. The qualitative methods of semi-structured group interviews are the most valuable in getting information on the issue, but when comparing with the results of the household survey, relationships pointed to in qualitative group interviews are not easily rediscovered in the quantitative data. The changes are, for the most part, the same, but the perceived causal links are often different. This does not necessarily mean that climate factors are not the underlying cause, but the direct cause is seldom linked to excessive rainfall, heat or strong wind that are frequently mentioned as the most adverse climate conditions. The

Table 6 Farmer prioritization of determinants of cultivated area, now and before the drought of the 1980s

Determinant	Current situation			Situation before 1984		
	First ($n = 25$)	Second ($n = 25$)	Third ($n = 24$)	First ($n = 15$)	Second ($n = 14$)	Third ($n = 13$)
Labor	0	4	8	0	0	8
Food needs	0	0	13	20	0	0
Land	8	4	8	0	7	0
Seed	32	24	33	27	36	31
Manure	0	0	0	7	0	0
Fertilizer	8	40	21	7	36	31
Level of rain	4	4	0	0	0	8
Equipment	44	24	17	40	21	23
Traction animals	4	0	0	0	0	0

All figures are in percent of *n* households answering the question

Table 7 Crops cultivated by households in the three villages and newly adopted crops with reason for adoption

	Currently cultivated No. of hh (%)	Newly introduced No. of hh	Reason for adoption of new crop/variety, no. of households									
			Increase income	More food	Good yield	Good price/ easy to sell	Both sale and hh consumption	Early maturity, income in lean season	No choice of other crops	No ground nut seed	Well adapted	Free seed/ planting material
Millet	25 (100)											
Ground nut	24 (96)											
Maize	16 (64)	4		2	1		1					
Sorghum	13 (52)											
Water melon	8 (32)	11	1			1	1	4	2	1		
Cowpea	7 (28)	5	1	2					2			
Okra	6 (24)	3	1	1				1				
Pumpkin	5 (20)											
Roselle	5 (20)											
Gardening	3 (12)	3	3									
Sesame	3 (12)	4					2			1		1
Cassava	2 (8)	2	1									1
Sunflower	2 (8)	1	1									
Ground nut, new	0	1									1	
Total	–	–	8	5	1	1	4	5	4	2	1	2

lessons for these discrepancies in results from household and group interviews are twofold: group interviews appear to be influenced by narratives that may bias responses; on the other hand, household questionnaires may not capture underlying causes or drivers that are more easily explored in semi-structured interviews. Hence, both methods should have built-in checks for these biases and complement each other.

The household interviews showed some nuances in the opinions on changes in rainfall as some claimed that the rainfall had in fact increased. That the group interviews showed a unanimous negative trend could be related to well established local (and international) narratives of declining rainfall that are not easy to go against in a group and which have also been observed elsewhere in the peanut basin of Senegal (Tschakert 2007). On the other hand, climate was not an issue of concern when groups were asked to identify main positive and challenging aspects of village life. Several respondents stated that the main characteristic of the rainfall patterns is unpredictability and the official climate records more or less corroborate the statements related to extreme years.

It is clear that many concerns other than climate are equally or more important for decision-making in agriculture. Availability and affordability of farm equipment, seed, and fertilizers are the main constraints, and these are intricately linked to the political-economic situation, especially agricultural policies and market development, which also appear to overrule climate concerns elsewhere (Eakin 2000; Eakin and others 2005, 2006; Thomas and others 2007). The complexity of drivers of change and adaptation was shown by Mortimore and others (2005) in the Diourbel area of Senegal for the period between 1954–1989. They identified structural adjustment and "decapitalization" in 1984 as the main drivers of farming system change, including increased fallowing, disposal of equipment, decline in the use of fertilizer, migration, and investment in nonfarm activities. Adaptation to the situation included adoption of new crops, such as cowpea and roselle and more livestock, measures that are similar to what farmers are doing today.

In fact, current Senegalese policies to strengthen the productive capacity of agriculture through credit systems, new crops, and improving soil fertility are now labeled as climate change adaptation policies (Halsnæs and Verhagen 2007), although they, to a large extent, address general economic problems that have many different causes and are similar to earlier anti-desertification plans (Tschakert 2007). The implementation of the policies include distribution of agricultural equipment and food during 2004 and 2005, subsidies on new crop types and varieties, and establishing a processing facilities, but the impact of these schemes is not easily discerned in the responses of households in the present study, except for the adoption of new crops by few farmers. Moreover, it is not clear whether these schemes adequately respond to climate concerns. For example, several farmers stated that the current short season ground nut varieties are adapted to drought—an adaptive measure useful in the past during the drought crises—but the recent high rainfall years have caused yield losses as the ground nuts mature when the weather is still very humid.

Many farmer statements indicate concerns related to rainfall, but rarely without also including the economic situation, e.g., "The climate has become harsher. The drought and economic activities degrade the natural vegetation." Wind remains the strongest concern especially for the health of animals, although this may also be masking a generally poor animal health caused by insufficient veterinary services or funds to pay for them (Thomas and others 2007). Generally, farmers have a rather fatalistic approach to climate concerns and the typical statement, "weather is a divine phenomenon that we are not in charge of"' is also reported from other parts of Africa (Ajibade and Shokemi 2003). Degradation of the vegetation, mentioned by many respondents, was not only linked to climate but also to (mis)management. However, none of the respondents mentioned the recent "invasion" of powerful Marabouts (religious leaders) who moved to the area with hundreds of "talibé" (farm workers) and have proceeded with extensive land clearing to grow ground nuts and millet. This is probably due to the sensitivity of this issue as many people in the region are followers of the Marabouts, again underlining the complexity of arriving at clear understandings of local strategies in a "noisy" reality of social, cultural, economic, and environmental change.

The lessons for policy-making on adaptation to climate change are, despite the complexity of the issue, relatively simple. On the one hand, the uncertainty of future precipitation trends in the Sahel and—as the farmer observed above—good intentions with extension programs that may have adverse effects if weather patterns change call for great caution when policies are prepared. For example, many National Adaptation Programs of Action in the Sahel were developed before the results of the IPCC Fourth Assessment Report and base their recommendations and project proposals on the overall trends towards drying observed from 1950–2000 and on single model scenarios depicting future drying trends (Gouvernement du Burkina Faso 2007; MEPN 2006; République du Mali 2007). Obviously, this may lead to unfortunate results if the climate develops differently. On the other hand, if policies—like the recent Senegalese agricultural policies—promote general economic development that provide farmers with a range of options rather than a specific climate or drought driven focus on certain crops and water conservation

techniques, this will allow greater flexibility for local people to adjust to future changes no matter which direction they take. In short, strengthening general adaptive capacity to cope with CCV will, especially in the agricultural sector, be better than devising narrow climate adaptation solutions with uncertain outcomes.

Conclusion

Farmers in the Sahel are concerned with CCV and climate parameters play, according to statements in group interviews, an important role in decision making. However, it is difficult to rediscover the climate parameters when analyzing livelihood strategies in household interviews, unless the questions are directly focusing on climate issues. Reasons for changes are seldom directly attributed to climate, though these may be one of the underlying causes. Concerns with increasing speed and duration of wind and its destructive characteristics are by far the most noteworthy.

The present study has been too limited in scope to provide firm conclusions on the adaptive capacity of the communities. Although the problems in measuring adaptive capacity, finding the right indicators (Vincent 2007), and separating climate effects from other impacts have been dealt with by combining household surveys and group interviews and taking an open-ended approach when asking questions, the findings point in different directions as household responses do not always corroborate group responses. Hence, our findings support the view that strong narratives on climate exist in the local communities. Adaptive measures directly linked to climate parameters are found, but they appear less important in shaping the dynamic of rural livelihood strategies than adaptation to economic, political and social factors. The implications for policy-making is to exercise great caution before joining the quest for adaptation solutions until a better understanding of local and regional climate change scenarios, as well as local adaptive strategies and capacities, is obtained. Sensible focus on economic development that allows flexibility for adjusting to various CCV scenarios is likely to be most successful.

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