

# Floods in the Sahel: an analysis of anomalies, memory, and anticipatory learning

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**Abstract** This study explores the implications of recent extreme rainfall and flood events in the Sahel and the wider West African region for climate change adaptation. Are these events merely a temporal nuisance as suggested by the lingering desertification discourse or will more climatic extremes characterize the region over the next century? After reviewing incidences of severe rainfall and projected future climate variability, the paper examines local flood knowledge and decision-making, drawing upon a case study in Ghana. The data demonstrate that a variety of response strategies to flooding exist; yet, knowledge of and access to climate forecasts and other learning tools are essentially absent. So far, floods have not triggered mass displacement although cumulative environmental deterioration is likely to cause environmental refugees. The paper recommends to lay to rest the desertification narrative, consider the possibility of both floods and droughts, and mobilize local memory for anticipatory learning and practical adaptation.

## 1 Introduction

In a seminar at Penn State, one of the authors proposed the possibility of a flooded Sahel, essentially as a counter image to a tornado-stricken Los Angeles and Manhattan under ice as shown in the 2004 movie “The Day After Tomorrow.” The audience had considerable difficulty envisioning such a scenario. Typically, people associate the Sahel—a 2,400 mile long semi-arid tropical savanna belt south of the Sahara from the Atlantic Ocean to the Red Sea—with drought, food aid, starving

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children and cattle, and other hardship, but not floods. In effect, the region has a long history of climatic stress and extreme events. This includes the anomalously wet periods of the 1930s, 1950s, and 1960s as well as the droughts of the 1710s–1750s, 1770–1780s, 1910–1916, 1944–1948, 1968–1973, and 1983–1984 (Le Houerou 1977; Brooks 1998, 2004; Giannini et al. 2008). The Sahelian drying of the late 1960s through the 1980s and the associated devastating famines are among “the most undisputed and largest recent climate changes recognized by the climate research community” (Dai et al. 2004:1323) even if droughts are considered part of the ‘normal’ climatic pattern in arid and semi-arid regions (Glantz 1987). The particular climatology and anthropogenic drivers of these and potential future droughts, however, remain debated (Charney et al. 1975; Lamb 1982; Folland et al. 1986; Tucker et al. 1991; Hulme 1992, 2001; Olsson 1993; Nicholson et al. 2000; Giannini et al. 2003; Chappell and Agnew 2004; Dai et al. 2004).

### 1.1 Floods in drylands: an oxymoron?

In contrast to studies on droughts, only very scant information exists about floods and other damaging rainfall events in the Sahel and drylands elsewhere. Yet, semi-arid climates, such as in the Sahel, are intrinsically defined by alternating wet and dry periods on annual and decadal timescales. It is well understood that differences between wet and dry years in such regions are largely determined by sub-seasonal changes in the number of rainfall events, rather than intensity; in other words, rainfall deficits in dry years are primarily the result of fewer large convective systems, mainly in July and August (e.g. Le Barbé and Lebel 1997; Lebel et al. 2003). In fact, the Sahel has been described as the most dramatic example of climate variability (Hulme 2001). While long-term mean precipitation values are near meaningless, seasonal cycles and total rainfalls can still be predictable and, hence, may prove useful for proactive adaptation.

It has been argued that flood hazards in this part of the world have been largely ignored, despite the seriousness of the problem (Tarhule 2005a). For instance, in his newspaper assessment of 1970–2000 flood events in Niger, Tarhule describes 79 damaging rainfall and flood events, including one rainstorm to the north of Niamey that generated 186 mm (!) of rain in only 1 day, roughly equivalent to half of the location’s long-term mean. This intensive rain resulted in considerable infrastructural and crop damage; however, against the backdrop of the concurrent 1984 Sahelian drought, it received little attention.

Even the most recent (2007) heavy rainfalls in West Africa, ranked by the Dartmouth Flood Observatory (DFO) as one of the three most devastating flood events of the year, have only found limited access into scientific and policy debates. Yet, heavy rains are the most common cause of floods (Few 2003). The DFO data for 2007 support this, showing that 69% of a total of 244 floods worldwide were attributed to heavy rains. Table 1 illustrates impacts of heavy rains, monsoonal rains, and tropical cyclones per world region. These three types of floods together accounted for 91% of all the floods and 99% of all displaced people in 2007.<sup>1</sup> The numbers show that, in 2007, Africa counted 2.5 million people displaced by floods.

<sup>1</sup>Additional albeit relatively minor flood categories in the DFO database are brief torrential rains, dam/levy break or release, and snowmelt with or without rains.

**Table 1** Major flood categories and impacts per world region in 2007

	Heavy rains				Monsoonal rains				Tropical cyclone			
	Number of events 2007	Area affected (km <sup>2</sup> )	People killed	People displaced	Number of events 2007	Area affected (km <sup>2</sup> )	People killed	People displaced	Number of events 2007	Area affected (km <sup>2</sup> )	People killed	People displaced
Africa	45	8,868,223	869	2,439,180	0	0	0	0	2	570,500	87	63,000
Asia	63	4,424,510	2,507	5,453,880	28	3,723,700	3,493	20,491,203	16	1,356,450	4,325	4,897,000
Europe	16	598,800	58	38,950	0	0	0	0	0	0	0	0
North America	11	2,737,627	90	10,890	0	0	0	0	0	0	0	0
Central+South America	26	3,808,144	543	2,268,338	0	0	0	0	6	336,155	314	299,000
Australia	7	699,820	10	6,100	1	661,900	0	0	2	188,900	2	390
Total	168	21,137,124	4,077	10,217,338	29	4,385,600	3,493	20,491,203	26	2,452,005	4,728	5,259,390

Source: DFO (2007)

Moreover, the continent was the second hardest hit in terms of number of events, area affected, and number of people killed, after Asia. Most literature (and media attention) on floods stems from Asia as well as the industrialized world. It focuses to a great extent on low-lying floodplains (e.g. the Ganges–Brahmaputra–Meghna river system in Bangladesh) and low-lying shorelines vulnerable to storm surges from cyclones, hurricanes, or tsunamis (Few 2003). Sadly, the heavy rain floods in Africa have remained largely unnoticed and widely understudied.

Given the recent catastrophic rainfalls events and latest scientific projections of more to come, why is it that this notion of too much water in drylands appears so counterintuitive and, ultimately, far-fetched and unreal to many of us, just as the apocalyptic futures in “The Day after Tomorrow”? According to the Fourth Assessment Report of the IPCC (Christiansen et al. 2007), extremely wet seasons, high intensity rainfall events, and associated flooding in West Africa are expected to increase by 20% over the next decades. Yet, it is still predominantly droughts that occupy people’s mental models of this dryland hotspot. We argue that this bias is fundamentally related to the lingering desertification narrative or discourse of which droughts constitute the quintessential core. A discourse, as defined by Peet and Watts (1996:14), is an “area of language use expressing a particular standpoint and related to a certain set of institutions” and “emphasizes some concepts at the expense of others.” It is an institutionalized way of thinking that determines what is acceptable speech and what accepted truth. In this case, the accepted truth is that the Sahel is defined by droughts, not floods.

## 1.2 The lingering desertification discourse

The desertification discourse, instigated by the United Nations Conference on desertification (UNCOD) in 1977 in the aftermath of the 1972–1974 Sahelian droughts and famine, conveyed a highly alarmist claim that these droughts were largely caused by mismanagement of land resources. While the early explanations of the Sahelian droughts, implying internal forcings and feedback mechanisms between decreased plant cover, increased albedo, and dwindling of rainfalls (Charney et al. 1975) are now largely rejected in the climate science community, this environmental narrative has dominated the popular imagination ever since (Herrmann and Hutchinson 2005; Giannini et al. 2008). This is partially because it has funded decades of development interventions and legitimized repressive, state-controlled land policies in the name of development (Batterbury and Warren 2001; Vogel and Smith 2002). Through the United Nations Convention to Combat Desertification (UNCDD), ratified in 1996, the desertification discourse became institutionalized. Challenging such ‘received wisdom’ in the context of environmental change in Africa is exceedingly difficult. Moseley and Laris (2008) show how this accepted truth or ‘regional discursive formation’ (Peet and Watts 1996) on desertification evoked the notion of ignorant local resource users and reckless environmental stewards. It pervaded not only the media, popular debates, and policy decision-making but also the thinking and action of well-intentioned Peace Corps Volunteers working in West African Sudano-Sahel in the late 1980s and beyond. Such indoctrination left little room for counter-narratives.

Today still, the Sahelian drought/desertification discourse is deeply entrenched in people’s minds. Recent data on a possible recovery of rainfalls (Nicholson et al. 2000;

Nicholson 2005), debates on the ‘greening’ of the Sahel based on remotely sensed vegetation values (Rasmussen et al. 2001; Olsson et al. 2005; Herrmann et al. 2005), and speculations regarding a potential shift to substantially wetter periods (Ozer et al. 2002; Hubert et al. 2005) seem to thrive in academic circles only. Even scientific consensus on the role of tropical oceans and sea surface temperature anomalies as major driving forces in the 1970s and 1980s droughts (Lu and Delworth 2005; Giannini et al. 2008)—rather than local anthropogenic causes—has gone largely unnoticed in the West African policy area and, even more so, in public discourse. The response of semi-arid ecosystems to climatic variability and their ability to recover from desiccation are now widely acknowledged in the literature (e.g. Tucker and Nicholson 1999; Mortimore and Adams 2001; Eklundh and Olsson 2003; Olsson et al. 2005; Reij et al. 2005). Nonetheless, impoverished land managers often view droughts as ‘normal’ (West et al. 2008) or continue to blame themselves for increasingly irregular rainfall patterns. Yet, these irregularities may well be a consequence of anthropogenic emissions, primarily from the wealthy and industrialized North, rather than natural high variability or local resource mismanagement. The persistence of the desertification discourse in several African National Action Plans for Adaptation (NAPAs) is a perverse spin-off of this environmental injustice.

In this paper, we explore the implications of recent flood events in West Africa for climate change adaptation. Are they merely a ‘hiccup’ that can be easily brushed aside, based on the assumption of a long-term drying trend? Several climate change projections and simulation models and the lingering desertification discourse would support this argument. Or, is it safe to say that more climatic extremes, especially with respect to precipitation, are likely to characterize the Sahel and adjacent sub-humid regions over the next century? After an overview of recent flood events and a brief synthesis of projected future climate variability and extremes, we discuss three challenges that emerge from the recent regional flood history, drawing upon ongoing work in northern and central Ghana, representing the Sahel and the Sudano-Guinean transition zone. First, we examine what memory rural decision-makers have of past flood events and what strategies they have used to respond to these events. Decision-makers here are small-scale farmers, fishermen, and Fulani herders—the supposedly ‘most vulnerable’—as well as district policy makers and agricultural extension agents in three case study areas in Ghana. Second, we reflect on the emerging environmental refugee debate and its application for flood destruction, displacement, and migration. For this purpose, we use a conceptual model that views migration as part of a household’s adaptation repertoire. Third, we explore how climate forecasts and other learning tools may enhance adaptive capacity and action in the face of floods. The paper concludes with a pressing call to lay to rest the desertification narrative, acquaint our minds to the possibility of both floods and droughts, and mobilize local memory for anticipatory learning with respect to future extremes and practical adaptation.

## **2 ‘Red, green, and blue Sahel’: making sense of recent flooding events**

In the 1990s, Kim Stanley Robinson published a science fiction trilogy on the settlement of Mars that describes colonization, terraforming, and the emergence of rivers and seas on the planet (Red Mars, Green Mars, and Blue Mars). Robinson’s trilogy

is fascinating and, in the following section, we propose a rather bold analogy. We certainly realize that any comparison between Mars and the Sahel lacks acceptable empirical basis and is instinctively disputable. Nevertheless, the idea of possible parallels is intriguing. Are semi-arid and sub-humid areas undergoing cycles that could be roughly equated with drying/desiccation, greening, and deluges? And, more importantly, what is likely to come next?

## 2.1 Recent flood history in the Sahel and the wider West African region

Following the drought period of the 'Red Sahel' in the 1970s and 1980s and the 'Greening of the Sahel' in the 1990s and early 2000, the conception of a 'Blue Sahel' can only be seen as a euphemism for the devastating floods that have battered the region since the 1990s. These floods have essentially occurred on an annual basis, albeit in varying magnitude. According to the Emergency Events Database (EM-DAT 2008), the years of 1995, 1998, and 1999 each counted more than one million people affected by heavy rainfall events, in five, eight, and 11 West African countries, respectively, including Sudan. At the beginning of the new millennium, more and more extreme wet events and associated damage have been recorded, with the most notable occurrences in 2002, 2003, 2005, 2006, and 2007.

The 2005 season witnessed substantial localized flooding, primarily in Senegal and Sudan (GIEWS 2005). August 2005 precipitation in Dakar amounted to 455 mm, the closest to the century high of 495 mm, recorded in 1959 (CSE 2005). Continuous heavy rains within short time periods into early September as well as urban sprawl into flood-prone areas caused inundations in most of the city and a sharp increase in cholera cases with 46 deaths, which led the government to declare an emergency and evacuate 60,000 people (IRI 2005a; Mbow et al. 2008). The 2005 rainy season ended with 36% and 150% above average October rains in Bambey and Ngoye, respectively, the center of the Old Peanut Basin (pers. communication ISRA/CNRA 2005) where the one of the authors happened to do her field work, confirming the IRI September-October-November prediction of 65% above normal rainfall probability (IRI 2005b). Despite the fact that the year's precipitation values for west-central Senegal were evenly distributed throughout the rainy season and total values approached the high levels from the 1960s, most crops (millet and groundnuts) rotted in the fields. They were adapted to a short (90-day) growing cycle, not late heavy rains. Farmers who contributed to the author's research complained bitterly about their poor harvest. They seemed utterly unprepared with no strategies to moderate damage or take advantage of the opportunity (Tschakert 2007).

The 2006 rainy season in the Western Sahel produced satisfactory rainfall in most parts, despite irregular rainfall in June and July over Senegal and Mauritania. However, torrential rainfalls in August caused flooding in Niger, Burkina Faso, and Sudan. In Niger, over 15,000 people were affected, with most harm occurring in the region of Agadez, including over 1,000 houses destroyed and roughly 2,000 ha of fields damaged and more than 1,800 gardens and 480 wells ruined (ReliefWeb 2006). In Sudan, over 160,000 people were under distress and 167 killed in addition to the roughly 10,000 houses that were reported damaged or destroyed (EM-DAT 2008; Reuters 2006). By then, the Sahel floods received large-scale international attention. In Penn State classrooms, however, students were rather bewildered about the launching of food aid for flood victims in Africa's archetypical dry belt.

Predictions for the 2007 rainy season (July–September) showed slightly to substantially enhanced probabilities for above normal rainfall for the Western Sahel (IRI 2007; ACMAD 2007). Yet, few people were prepared for what resulted in the worst floods in Sahelian history. On October 17, 2007, Agence France Presse reported the “worst flooding in 30 years that battered West Africa from July” [to September] (see Fig. 1). The UN Office of the Coordination of Humanitarian Affairs reported that more than 800,000 people were homeless in 14 countries, by October 30.

Among the hardest hit countries were Ghana (over 330,000 affected and 56 killed), Burkina Faso (93,000 affected, 28,000 displaced, and 46 killed), and Togo (more than 125,000 affected, 13,700 displaced, and 23 killed). Andrews Frimpong, secretary general of the Ghana Red Cross Society, referred to the floods as “one of the most severe catastrophies our country [Ghana] ever had to face” (IFRC 2007). The final official number of total people affected by these floods was 1,649,230. While there have been three previous flood events in this part of Africa since 1960 that caused more victims (three million in 1988, mainly in Sudan; two million in 1991 in Ghana, and 1.9 million in 1998, primarily in Sudan, Senegal, and Benin), the number of countries affected by each of these events was fairly small (EM-DAT 2008).

What was distinctive about the 2007 floods was that they hit both rural and urban areas in essentially every single country in West Africa, from Mauritania to Nigeria, as well as Sudan and Chad. Out of the 244 floods that the Dartmouth Flood Observatory identified for 2007 (DFO 2007) three events were ranked highest in magnitude with a score of 8.3, calculated as duration × severity × affected area: the

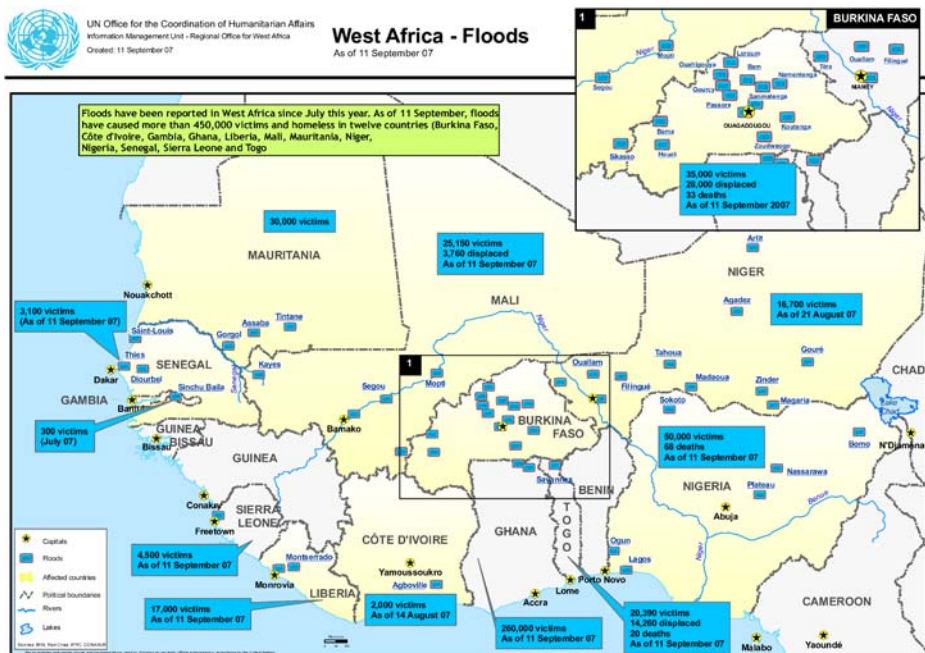


Fig. 1 Floods and their impacts across West Africa, July to September 2007 (Source: ReliefWeb)



floods in China (June 6–August 17), those in West Africa (July 26–Oct 10), and the ones in Bolivia (December 15–April 30 2008). All three were caused by heavy rains rather than cyclones or tidal surges. Slowly, some of the earlier numbers related to displaced and homeless people were adjusted upwards and additional information on this humanitarian tragedy and the intensity of the event emerged.<sup>2</sup>

In the aftermath of the 2007 floods, most West African countries faced food shortages. Hartill (2008), for instance, reported declining food stocks, climbing prices, and hoarding by traders all across the region. While a 110-lb bag of rice cost \$28 in January 2008 in Burkina Faso, the price in April was at \$35, leading to food riots in several major cities (IRIN 2008a). Families in Niger and Ghana are reported to have replaced meals with wild plants. The Senegalese Parliament was assaulted by a man with an empty rice bag shouting that people were hungry. Hartill also cites a regional advisor for agriculture referring to the situation as a ‘time bomb waiting to explode.’

Early 2008 forecasts warned that the entire West African region would once again receive above average rainfalls. These rains would undermine any relief from the precarious situation triggered by the early drought and the August–September floods the previous year. The IRI forecasts for July–August–September 2008, issued in May of the same year, indicated above normal rainfall for all countries in the Western Sahel, with substantially enhanced probability (>48%) for above normal for Burkina Faso, Gambia, Guinea Bissau, Mali, and Senegal. The ACMAD (2008) precipitation predictions reveal similar information. The forecast for July–August–September, issued in May, indicated a 45% probability for above normal rainfall in Zone I (arid region, 15–22° N), 50% probability for above normal rainfall in Zone II (semi-arid region, 10–15° N), and about normal rainfall in the sub-humid zone (5–10° N).

By mid July, the first news reports on renewed flooding appeared. Monrovia, the capital of Liberia, confirmed the worst floods ever seen in the city with 1,000 people displaced (IRIN 2008b). Torrential rains were reported for Zinder in Niger, the plateau and coastal area of Togo, the southern part of Benin, the southwest of Chad, and other floods in parts of Senegal, Burkina Faso, and Cote d’Ivoire (IFRC 2008; OCHA 2008a, b; IRIN 2008b). High flood risks were announced for Sudan and Ethiopia (HAC 2008). By August, 13 countries were affected (OCHA 2008c), and disaster relief teams started pouring into the region to assist people camping in schools, reduce health risks related to malaria, cholera, diarrhea, and meningitis, and provide food and shelter (WHO 2008; IRIN 2008c; UN News Service 2008).

The predictions for the end of the 2008 rainy season (September–November) also show high precipitation for the majority of the region, with substantially enhanced probabilities (>48%) for above normal rainfall for Benin, Burkina Faso, Gambia, Guinea, Guinea Bissau, Mali, Senegal, and Sierra Leone. It is worth noting that in no single IRI forecast was below normal rainfall the most likely category for any countries in all of West and East Africa.

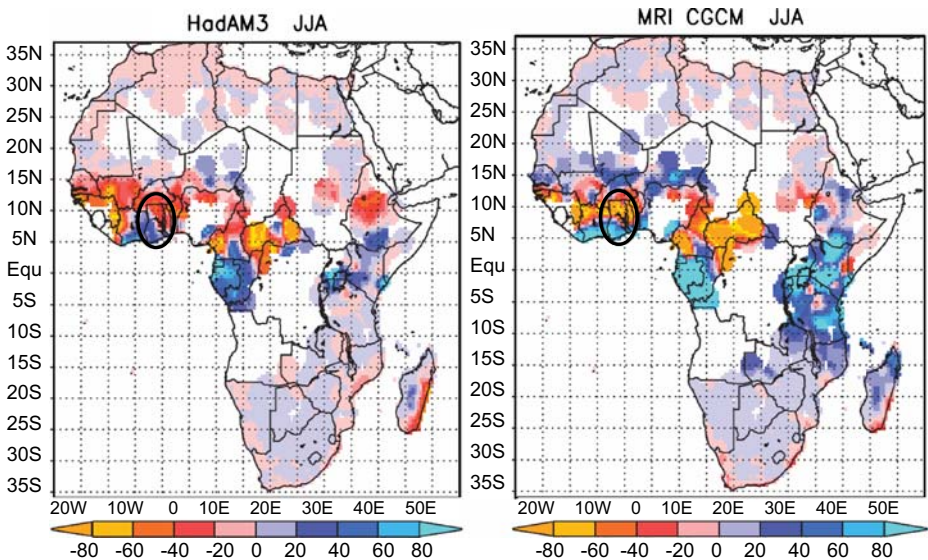
<sup>2</sup>In northern Ghana, for instance, 250 mm of rain fell within three consecutive days, which is equivalent to one third of the average total annual precipitation (CARE 2007). In Togo, 101 bridges and seven dams destroyed. In Burkina Faso, 786 granaries were washed away and Ougadougou, the capital, declared the event as worst flooding in 54 years. In Ghana, a total of 6,000 farms were destroyed while 4,000 ha of farmland were inundated in Guinea. Also in Guinea, 6,000 people in the Dinguiraye area were rescued in canoes (DFO 2007).



## 2.2 Projections: floods as temporary nuisance or long-term reality?

The question that emerges from this account is how to make sense of these recent heavy rainfall and flooding events. Should we treat them as a short-term deviation from a long-term drier mean? A mere hiccup or temporary nuisance that, as severe as it may currently be for millions of people, could potentially be weathered out and disregarded in the grand scheme of climatic changes in the region? At the present time, it remains highly contested whether or not these recent observations of wetter conditions in the region signify a climatic shift that will continue throughout the coming decades. Model predictions for the Western Sahel, some based on reconstruction of the twentieth century drought, include both significantly drier conditions and clearly wetter monsoons with 20–50% more precipitation (Mitchell et al. 2000; Held et al. 2005; Haarsma et al. 2005; Hurrell and Hoerling 2005; Zhang and Delworth 2006; Knight et al. 2005; Kerr 2005; Tippett and Giannini 2006; Lu and Delworth 2005; Hoerling et al. 2006).

The Fourth Assessment Report of the IPCC notes that research on extreme events for Africa is limited (Christiansen et al. 2007). While there is general agreement that the entire continent will be warmer by the end of the twenty-first century, projections for precipitation extremes remain both difficult and disappointing. Latest IPCC model predictions for Africa, drawing upon empirical downscaling of GCM simulations by Hewitson and Crane (Christiansen et al. 2007), suggest strong drying over the center of the Sahel but wetter trends along the coast, especially the Gulf of Guinea. Figure 2 shows two examples of downscaled precipitation anomalies (drier or wetter) for the months of June/July/August in the late twenty-first century. It is worth stressing that the simulations also indicate marked local scale variations and



**Fig. 2** Anomalies (percent deviation) of mean monthly precipitation (mm) for June/July/August using daily data down-scaled from two GCMs for the period 2080–2099 (from Hewitson and Crane 2006 in Christiansen et al. 2007)

spatial and temporal uncertainties in these predicted changes. Extremely wet seasons are expected to increase by 20% by 2080–2099, also implying a general increase in intensity of high rainfall events. In areas with anticipated drying, this is projected to be coupled with a decline in the number of rain days. Climate change, as argued by Trenberth et al. (2003), has increased potential evapotranspiration and moisture availability in the atmosphere and, as a result, is likely to trigger more intense local rain events as well as longer dry spells in case of non-precipitable conditions. Although these changes in the character of rainfall have not yet been quantified for Africa, a stronger emphasis on intensity, frequency, and duration of events would complement and improve the current understanding and future projections of climatic and anthropogenic drivers for the Sahel and West Africa at large (e.g. Held et al. 2005; Cook and Vizy 2006; Lau et al. 2006; Biasutti and Giannini 2006; Giannini et al. 2008). Neither scientists nor policy makers know whether to expect positive or negative rainfall anomalies for the decades to come and even less so in which locations.

The spatial and temporal challenges for decision-making that emerge from currently available data and predictions are enormous. First, there is uncertainty with respect to the spatial extent of the projected wetter and drier zones. For instance, Ghana is predicted to experience increased precipitation in the South and drying in the North (blue and orange to red, respectively, in Fig. 2). For people who live at the transition between the two zones the implications of these dual trends of wet and dry are crucial. Their future is highly unknown and variable, one that could be either wetter or drier (uncertain direction of change), or not change at all. Moreover, there are likely to be significant uncertainties in interannual variability, despite the general wet or dry trend in a given region. Communities will experience climatic variability in the short-term that may deviate considerably from the predicted long-term condition. For example, the heavy rains and devastating floods that occurred in the northern part of Ghana in September 2007 seem at odds with the predicted long-term drying trend implied by the downscaled GCM models. Yet, acknowledging the possibility and anticipating these deviations along the predicted trend line are fundamental to a community's short-term decision making and adaptation processes.

### **3 Learning from the past in anticipation of the future: flood lessons from Ghana**

We need to learn from our experiences. These are recurring situations, and it seems that no one is listening

(Jerry Niati, Regional Disaster Manager for West Africa International Federation of the Red Cross, after the heavy rainfall events in Togo in August 2008; IRIN 2008d)

Not knowing the future climatic conditions to which to adapt makes planning and adaptive management an exceedingly difficult undertaking. While more scientific certainty with respect to extreme events and changing climate patterns for the Sahel is undoubtedly desirable, adaptation to the visibly expanding tails in rainfall distributions has become paramount. Giannini et al. (2008) warn that most existing models for the Sahel do not suggest a simple extrapolation of the twentieth century drying trends into the next decades. Hence, flexible response mechanisms to both

floods and droughts appear more opportune than attempted adaptation to changing long-term means.

In August 2008, immediately after the heavy rains in Togo that forced 6,000 Lome residents into government-run shelters, the regional disaster manager for West Africa with the International Federation of the Red Cross, Jerry Niati, lamented the lack of preparation among citizens. “Most people are quick to respond, but slow to prepare. Mindset change is what needs to be done. [...] So we need to be creative. But we need to engage the community to raise its awareness about the alternatives if they do not prepare” (IRIN 2008a, b, c, d). This echoes Few’s (2003, 2007) call for a better understanding and strengthening of local capacity to cope with flooding, especially among poor people in developing countries. In contrast or addition to typical structural measures or engineering interventions such as river channel modifications, reservoirs, and embankments, Few promotes non-structural vulnerability reduction at the household and community scale. He views the poor as “strategic managers of complex asset portfolios” (Moser 1998:5) who can cope with adverse situations and take advantage of opportunities.

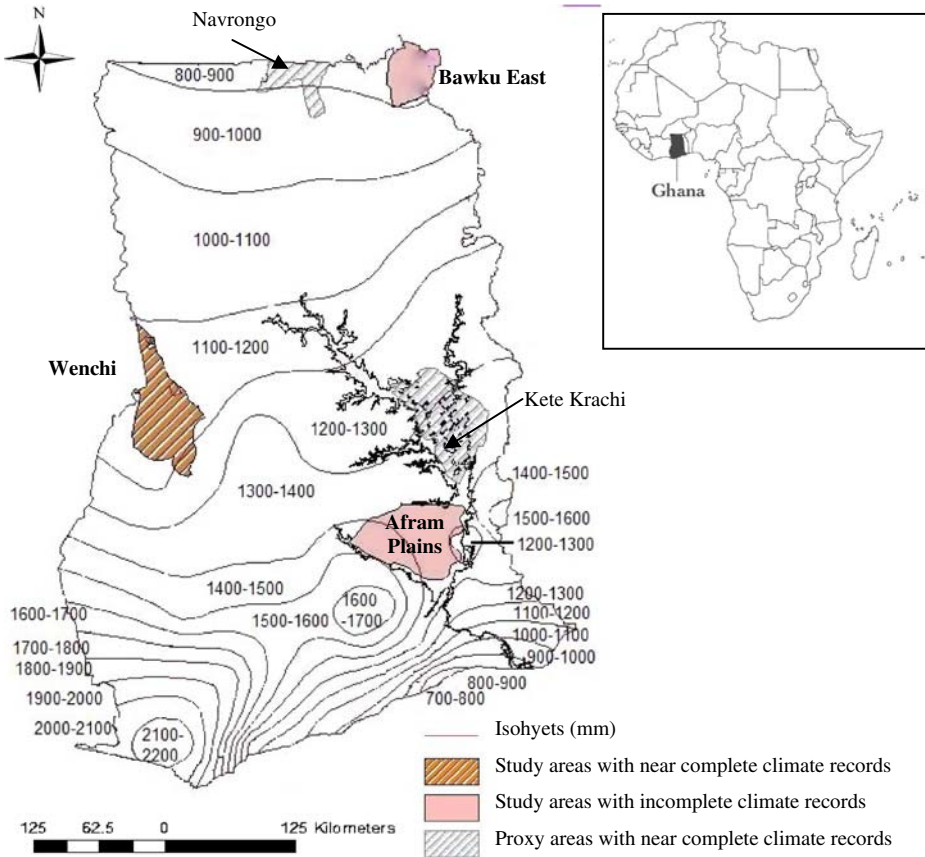
### 3.1 Case study description

The following section explores the knowledge base of Ghanaian subsistence resource users, agricultural extension agents, and district-level policy makers with respect to extreme flood events and the coping and adaptive strategies available to them. It evaluates what people have learned from extreme events in the past and how they use their memory to prepare for future events. Data have been collected under an ongoing project funded by USAID, titled ‘Climate Change Collective Learning and Observatory Network Ghana’ (CCLONG).<sup>3</sup> The project is carried out in collaboration with researchers and students from the University of Ghana in Legon, governmental agents at the national and district level, and communities in three rural areas: Kwahu North District (also referred to as Afram Plains) in Eastern Region (Akyemfour, Xedzodzoekepe, Mem Chemfre, and Ekye Amanfrom), Wenchi and Tain Districts in Brong Ahafo Region (Buoku, Bofie, and Asuano), and Bawku East District in Upper East Region (Kadi, Denugu, and Pusiga).

Figure 3 shows the precipitation zones for Ghana and the location of the three study areas. Near complete daily precipitation records were used for Kete Krachi (7.82° N, -0.03° E), Wenchi (7.75° N, -2.10° E), and Navrongo (10.90° N, -1.10° E). In the data set for Mem Chemfre (6.93° N, -0.03° E), located directly within the Afram Plains area, the years 1983–1988 are missing. Nevertheless, the

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<sup>3</sup>The methods for this data collection included historical matrices of memorable climatic events and structured interviews. The matrices were constructed in ten communities (four in the Afram Plains, three in Wenchi, and three in Bawku East) through a community-level mapping activity followed by a group discussion, involving older men and women who were able to recall past events. Structured interviews were carried out with 72 households in six communities (Afram Plains and Wenchi) on individual responses to past and potential future extreme events. Efficiency of strategies was evaluated through scoring (1–5) with the help of beans or pebbles. Households were selected through stratified random sampling based on participatory wealth ranking (Adams et al. 1997) carried out with community elders and opinion leaders. Additional information (although no scoring) was obtained through group discussions in Bawku East and with Fulani herdsmen in Ekye Amanfrom (Afram Plains).



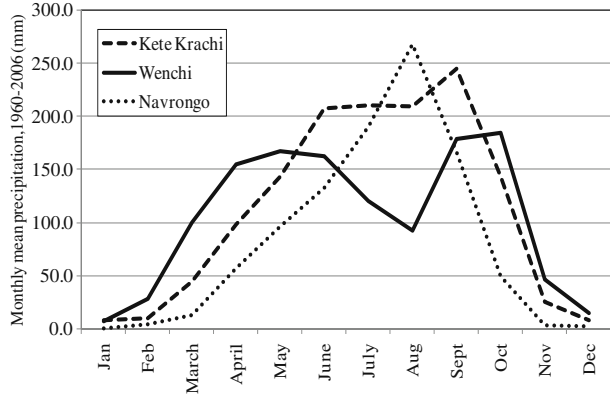
**Fig. 3** Ghana map with isohyets (mm), study areas, and areas with climate stations

available data reveal most important heavy rainfall events. Annual rainfall distributions for the three study areas, based on daily precipitation records from 1960 to 2006 from the most reliable weather stations, are depicted in Fig. 4. Wenchi has a strong bi-modal distribution representing the Sudano-Guinean transition zone whereas Navrongo, the furthest north and illustrative of the Sahelian zone, has a clear uni-modal curve. The Afram Plains, influenced by Lake Volta, display a weak bi-modal distribution.

### 3.2 Historic and recent flood events: memory and data

Through the design of historical matrices on climatic events (Fig. 5), men and women discussed 'normal' peaks in their rainy seasons and extreme rain events, as experienced since their arrival in the location. In the Afram Plains, people who remembered the 1960s stated that the highest rainfalls used to be in June or July, whereas now, they occurred in September. Fulani herdsmen claimed that more pronounced changes with respect to rainfalls and pastures for cattle had started 5 to 8 years ago. They argued that the dry season was now more pronounced, that early

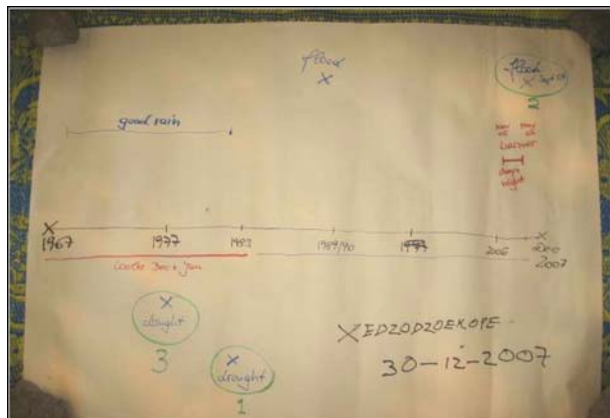
**Fig. 4** Monthly precipitation (mm) for three climate stations, 1960–2006 (Data source: Ghana Meteorological Services)



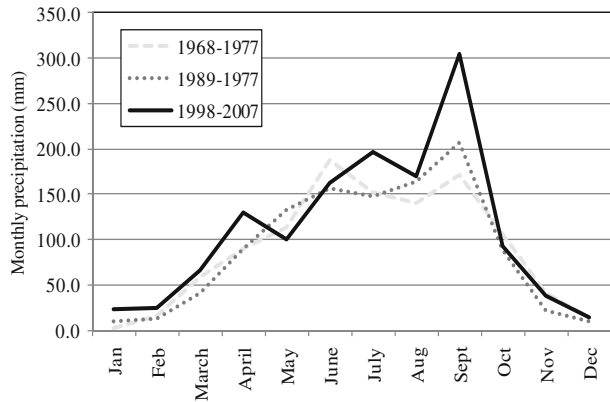
rains were more erratic and no longer guaranteed in April or May, and that rains in September and October were noticeably heavier. These local observations are substantiated by available climate records. Figure 6 indicates the shift in precipitation peaks for Mem Chemfre. In Wenchi, some people claimed that, instead of one major season (April to July) and one minor season (August to November), they now only had “1.5 seasons”. In their view, the minor season was no longer reliable and rains tended to concentrate more towards the end of the season. This is reflected in a later start of the rainy season and more variability in May, June, and July. In the Bawku area, the furthest north, the overall consensus was that rains used to peak clearly in August, and now there was more uncertainty, described as erratic rainfall behavior.

While all historical matrices generated at the community level identified the 1983–1984 drought as the most memorable and devastating extreme event, heavy rainfall and flooding events also featured prominently in the discussions. The events of September 2007, 1991, and 1972/73, and 1969 were ranked among the four most severe incidents. Clearly, the September 2007 rains received most attention. Particularly in the Bawku communities, the combination of the very recent occurrence and the severity of the impacts compelled participants to refer to them as the most extreme

**Fig. 5** Historical matrix on climatic extremes as identified by community members in Xedzodzokope, Afram Plains (Source: Field work CCLONG 2007)



**Fig. 6** Monthly precipitation (mm) for three decades, recorded in Mem Chemfre, Afram Plains (Data source: Ghana Meteorological Services)



incident. Statements included “no place to sleep”, “all rooms and crops destroyed”, “people were killed”, “guinea fowls washed away and died”, “farm animals died”, “bridges and building destroyed”, and “cars could no longer move.”

Most references were with respect to flooded fields, destroyed crops (yam, maize, cassava, pepper, cowpeas), and destroyed structures (houses, roofs, bridges, etc.). Several people cited muddy paths, fields, and roads as major impediment because walking was tiring and it made them lose time. The second most cited negative impacts were diseases among people and animals. People recalled numerous cases of foot rot, bad malaria, rheumatism, serious cold and flu, arthritis, yellow fever, and measles. Animals that did not get washed away or drowned suffered from foot rot and other diseases. One Fulani herdsman mentioned the possibility of a recent outbreak of foot and mouth disease as linked to the 2007 rains. Participants also discussed loss of income due to the destruction of crops and loss of productive time, insufficient food and hunger during the months after the heavy rains, and in some cases death. The few positive impacts that were associated with heavy rainfalls and flooding were the abundance of fish (mainly tilapia and mud fish) in rivers and Lake Volta, good pasture for roaming cattle for several months after the rains, and good opportunities for women to collect water in nearby rivers or through roof gutters and rainwater storage tanks. Table 2 depicts all extreme wet events that participants in the three study areas mentioned, although the list is likely to be incomplete.<sup>4</sup>

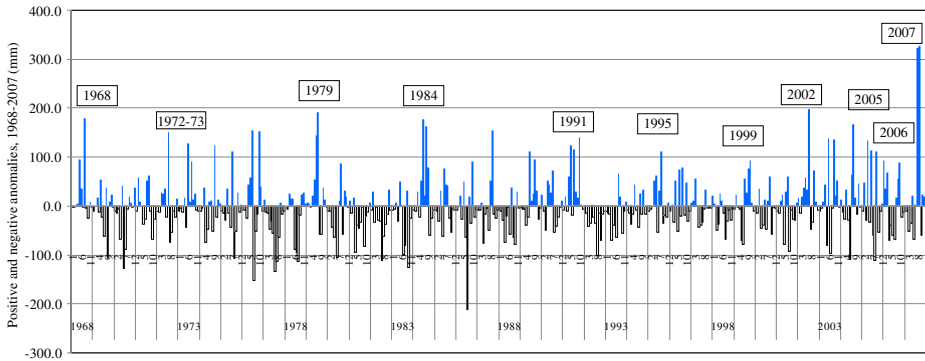
Figure 7 illustrates the remarkable overlap between people’s memory of extreme wet events and available climatic records. These results rebut the common belief that people’s memory is unreliable. The 2007 flood anomaly is the most pronounced. However, there is another element that made this particular event so dramatic: the low rainfalls between April and July coupled with the extreme intensity in August and September. Figure 8 depicts cumulative precipitation for Mem Chemfre between 1968–1982 and 1989–2007. It shows a substantial delay at the beginning of the rainy season and then the steepest curve in a 40-year history! It is also worth noting that the data indicate the highest total accumulated amounts as well as the highest

<sup>4</sup>The higher frequency of extreme rainfall events in the Afram Plains compared to the other two study areas is a reflection of inconsistency in depth of data collection rather than people’s memory or actual events.

**Table 2** Extreme rainfall events and impacts, based on people's memory in three study areas

Years(s)	Period(s)	Districts		Negative impacts				Positive impacts							
		Afram Plains	Wenchi	Bawku	Structures destroyed	Fields and crops destroyed	Human diseases	Animal diseases	Loss of income	Deaths	Other	Abundant fish	Easy water collection	Good pasture	Other
1963–1964	–	x			x		x								
1968	–	x			x										
1969	3 months		x		x		x						x		
1972–1973	–	x			x		x		x						
1979	–	x			x								x		
1984–1985	–	x			x					x					
1986	Sept–October		x		x		x								
1989–1990	–	x			x		x								
1991	All year	x			x		x								
1995	July–October	x			x		x		x						x
1997	–			x	x		x								
1999	June–October	x			x										
2002	July	x			x										
2005	1 week	July			x										
2006	July–September	x			x										
2007	Aug–October	x			x		x								

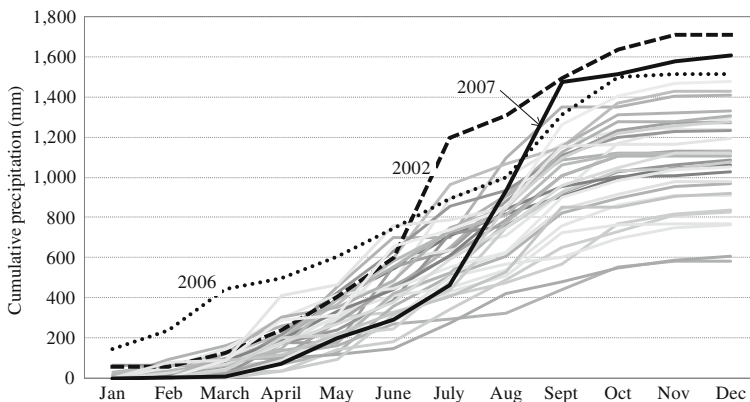




**Fig. 7** Monthly precipitation anomalies (mm) based on records for Mem Chemfre and Kete Krachi, Afram Plains, 1968–2007. *Boxed dates* indicate periods of extreme events as discussed in the historical matrices (Data source: Ghana Meteorological Services)

unpredictability and irregular distribution throughout the rainy season all within the last 5 years.

The gravity of the 2007 event is also clearly reflected in one local precipitation record. Chief Ransford of Akyemfour in the Afram Plains has recorded what he calls ‘significant’ rainfall events since 1973. In the absence of a rain gage, he uses his machete to measure the depth of moist soil after a rainfall event. If the moist soil on the blade reaches at least the length of his middle finger, he records the date of the event. Ransford’s data for the 2007 rainy season reveal the following count of significant events per month: April (3), May (6), June (8), July (5), August (4), September (15), and October (4). More importantly, it shows 21 significant rainfall events in only 43 days, between August 21 and October 2. In other words, the flooding that occurred during that period was the result of heavy rains essentially every other day.



**Fig. 8** Cumulative precipitation (mm) for 1968–1982 and 1989–2007 as recorded for Mem Chemfre, Afram Plains (1983–1988 are missing) (Data source: Ghana Meteorological Services)

### 3.3 Household and community response strategies

Following Few's (2003, 2007) call for a more specific focus on strategic responses to flood events at the micro-scale, the next section explores structural and non-structural actions and adjustments at the household and community level, as discussed by participants in the three rural study areas. First, strategies that were used during and after past events are described. Next, people's perceptions of the likelihood of extreme rainfall events occurring in the future are explored. Finally, we present best strategies for immediate action.

Table 3 lists the various strategies households had used during heavy rainfall events in the past, as discussed during structured interviews. Clearly, people are not passive victims of such events. They draw upon a variety of structural strategies and/or community-based actions (gutters, ditches, and raised storage structures), individual adjustment in farming practices (selection of field location and crops, timing of planting and harvesting), alternative economic activities (labor, petty trade, services, and animals for food), social capital (sharing homes, accepting loans and gifts), and external assistance (drugs, food, evacuation, and shelter). Nonetheless, some few participants took a fatalistic approach by responding that "there was nothing we could do" or "only God can help us in the future."

While participants judged all strategies from the past to be possible in the future, most of them were not seen as very efficient (efficiency score  $< 3$ ). In contrast, relocating fields to upland locations—successfully employed by some farmers in the past—is widely perceived as the most beneficial strategy for future extreme rain events. The difference in elevation in the three study areas is not very pronounced (average elevation of 122–340 m). Yet, farmers argue that this difference would be sufficient to prevent fields from flooding, although not everybody would be able to obtain upland plots. In terms of costs, two acres of upland with yam and cassava or maize were estimated to amount to 200–500GHC (\$200–500), depending on the use of equipment for land preparation. Other potential strategies to cope with future floods included structural modifications for new houses and more alterations in crop selection and timing.

All interviewed households expressed the belief that extreme rainfall events could occur again in the future. The fact that the 1991 flooding also happened in 2006 and even worse so in 2007 is evidence for the recurring nature of such events. Some people argued that the erratic rains at the beginning of the rainy season (May, June) are a good indicator for heavy rains in September. All households also saw their livelihoods and wellbeing affected by potential future extreme wet events. They cited loss of income, debts, insufficient money for school fees, food, and clothing, and sickness and diseases as major impacts.

There are four striking details that emerge from this account. First, essentially all strategies that people have used in the past were reactive rather than proactive. In other words, these strategies were employed during and after flooding to minimize the extent of already occurring damage and foreseeable repercussions in the aftermath of an event. Upland farming appears to have been the only strategic, proactive choice in order to avoid inundation of crops. Yet, farmers did not choose to plant on a higher-elevation plot in anticipation of a specific extreme rain event; they farm on these plots every year, with crops that do well under drier conditions, such as yam and maize. Second, to successfully minimize crop and food losses, most participants

**Table 3** Past and future strategies to cope with floods and their estimated efficiency

Strategies	Strategies used in the past	Efficiency score for the future (1–5)	Additional strategies for the future	Efficiency score for the future (1–5)
Several responses				
Cultivate crops on uplands (slightly higher elevation)	X	3.60	X	3.8
Raise foundations/floor levels of low-lying properties before building	–	–	X	3.7
Plant cassava as soon as rains stop to take advantage of early bulking	X	3.50	–	–
Construct raised sheds to store yam	X	3.50	–	–
Repair roofing, with own money or through loans	X	3.30	–	–
Consume food stored from previous harvest	X	3.00	–	–
Share rooms with those whose houses got destroyed	X	3.00	–	–
Construct draining ditches and gutters around the house	X	2.80	–	–
Second planting of cassava, maize, groundnuts, or cowpeas	X	2.70	–	–
Petty trading (firewood, processed food) to obtain money for food	X	2.60	–	–
Create gutters and trenches in the community	X	2.50	–	–
Provide labor for food (work on other people's farms)	X	2.40	–	–
Create draining system on farms	X	2.20	–	–
Purchase food with saved money	X	2.00	–	–
Evacuation of people living close to the lake	X	n/a	–	–
Evacuation of animals from muddy areas near the lake to avoid death	X	n/a	–	–
Obtain drugs from medical personnel to treat diseases	X	n/a	–	–
Weave straw mats to build temporary shelter for animals	X	n/a	–	–
Obtain food and shelter from NADMO (Nat. Disaster Agency)	X	n/a	–	–
One response only				
Obtain loans from neighbors	X	5.00	–	–
Purchase rice seeds and plant in wet soil	X	4.00	–	–
Sell building plots to obtain money for food	X	4.00	–	–
Build block houses with concrete foundations	–	–	X	4.00
Cultivate maize during the minor season	–	–	X	4.00
Cultivate water yam	X	3.00	–	–
Start planting earlier in the season to harvest before heavy rains come	–	–	X	3.00
Cultivate tomatoes and okra right after the floods	–	–	X	3.00
Sell livestock for money to buy food	X	2.00	–	–
Receive food gifts (esp. yam)	X	2.00	–	–
Provide tractor services transporting yam to obtain money for food	X	1.00	–	–

**Table 3** (continued)

Strategies	Strategies used in the past	Efficiency score for the future (1–5)	Additional strategies for the future	Efficiency score for the future (1–5)
Purchase food and store for emergencies	–	–	X	1.00
Cultivate off-season vegetables along rivers	–	–	X	1.00
Temporary migration (herdsman)	–	–	X	n/a

Efficiency scores were assigned with pebbles and ranged from 1 to 5, with 5 being highly efficient in solving the problem

conceived of two basic strategies, both tied to external assistance: (a) more farm inputs (improved seeds, fertilizer, and herbicides) and equipment to increase their acreage; and (b) enhanced knowledge, education, and financial support to build and maintain storage facilities for food preservation. Currently, neither option is pursued. Third, except for one farmer—and only after some deeper probing—nobody mentioned *ex ante* information on the likely occurrence of such extreme rainfall events. This lack of familiarity with climate forecasts and other learning tools is discussed in Section 5. Fourth and finally, while some people reported that they had to temporarily seek accommodation in other people's homes or in government-provided shelters or relocate to higher grounds in the community, displacement and migration appeared rather insignificant compared to other impacts. The next section explores the linkages between floods, displacement, and migration in more depth.

## 4 From destruction to displacement and migration

### 4.1 Floods and environmental refugees

Globally, the 2007 floods displaced over 35 million people, including 800,000 in West Africa. For comparison, 26 million people were estimated to have been displaced by conflicts the same year, the highest number in this decade (IDMC 2007). According to Adeel (2006), increasing numbers of people will move as climate extremes become more frequent and severe and livelihoods deteriorate. The term 'environmental refugees', although heavily contested, is often used to depict people who are driven from their homes in masses as a result of ecological destruction. Based on an estimate by Richter (1998), the total number of African environmental refugees resulting from floods between 1973 and 1997 amounted to seven million or more. The Red Cross and Red Crescent estimated 25 million migrants from environmental stress in 2000 (Taipei Times 2007). According to the World Resources Institute, this number could be as high as 200 million by 2050. Most of these people are anticipated to come from rural areas and developing countries (Kliot 2004). In Africa, many of these environmental refugees are anticipated to come from drylands, driven by droughts and floods, reinforcing a trend of migration from the dry Sahel southwards and towards the coast (Hammer 2004). Yet, comparatively little regional and international attention has been given to this seemingly looming time bomb.

In a recent article on the links between climate change and migration, using the example of floods caused by heavy rainfall events, Perch-Nielsen et al. (2008)

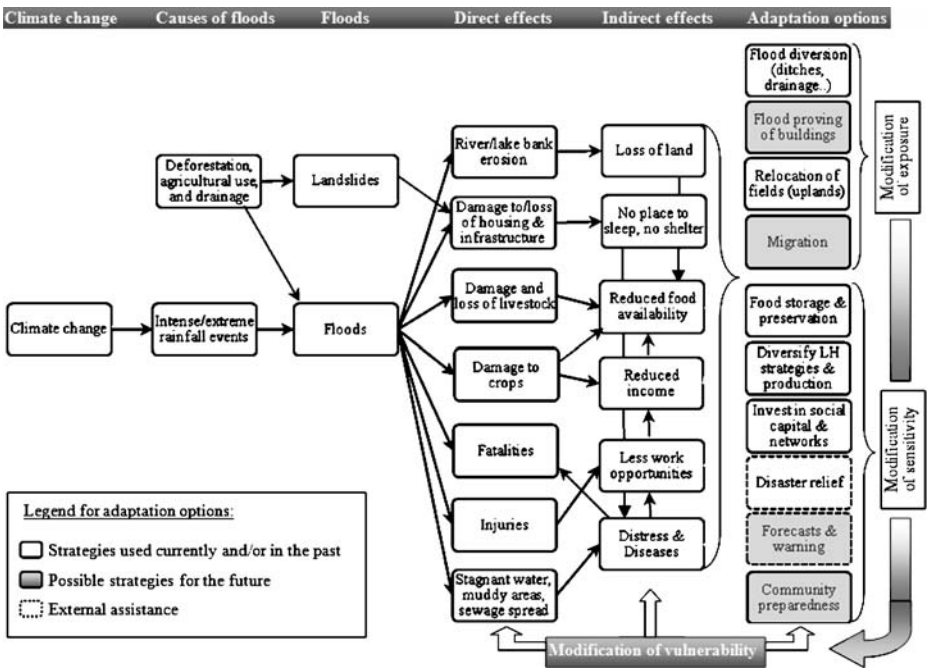
critically review the simplistic ‘common sense’ line of reasoning between floods, destruction of land, houses, and other assets, and displacement/migration. They argue that the large amounts of people that are usually displaced due to a fast-onset natural disaster (hurricanes, floods, earthquakes, etc.) are displaced only temporarily. In most cases, these people return home to rebuild their homes and lives. Drawing upon case studies in the US, Central America, and Southeast Asia (McLeman and Smit 2006; Smith and McCarty 2006; Belcher and Bates 1983; Delaney and Shrader 2000; Haque and Zaman 1989), Perch-Nielsen and colleagues conclude that mass displacement (temporary homelessness) triggered by extreme events does not lead to large-scale, permanent mass migration. Those who do migrate commonly move only short distances, and rarely across borders. In urban areas, especially in neighborhoods where uncontrolled sprawl and illegal construction in flood-prone areas have resulted in destruction and death after heavy rainfall events, emergency shelters, relocation, and eviction constitute typical post-flooding responses, as in the case of Dakar in 2005 (Mbow et al. 2008). However, displaced poor people in overcrowded cities are unlikely to migrate; many have moved to urban centers in the hope to escape more dire realities at home. Hence, estimates of ‘environmental refugees’, as those by Richter (1998), based on newspaper and disaster relief accounts, need to be treated with great caution.

#### 4.2 Migration as an adaptive response to floods?

In the climate change debate, migration is often seen as ‘maladaptation’ or failed adaptation. An analysis by Brown (2007) revealed that none of the 14 NAPAs he had evaluated considered migration or population relocation as a desirable strategic option. Yet, migration is often part of a household’s adaptive response repertoire. The challenge in exploring the connections between floods and migration is twofold: (a) data are exceedingly scarce; and (b), mobility and migration in West-Africa, especially in drylands, tend to be uncritically subsumed under seasonal movements. The primary purpose of such seasonal migration is to mitigate negative impacts of droughts, both economically and with respect to food security. This circular migration between rural and urban centers usually occurs after harvest time and is known as ‘eating the dry season’ (Rain 1999; Hampshire and Randall 1999). Migration due to floods is different.

In this section, we draw about a conceptual framework developed by Perch-Nielsen et al. (2008) to investigate the linkages between climate change, floods, adaptation, displacement, and migration, using data from the Ghana project. The model (Fig. 9) allows depicting the major factors and connections with respect to floods and household responses; emphasis is put on adaptation options. These shape the links within the framework and, ultimately, vulnerability and adaptive capacity to extreme wet events and flooding. Also, the model allows pinpointing gaps in existing data and key research and policy priorities.

Ghanaian subsistence resource users (farmers, fishermen, and herders) employ a range of adaptation options to reduce the negative impacts of extreme rainfall events. Some benefit from a limited number of advantages. These adaptation strategies can be divided into those that reduce exposure and others that reduce sensitivity. Exposure and sensitivity are two key elements of vulnerability, the third being adaptive capacity. Smit and Wandel (2006) describe exposure and sensitivity as



**Fig. 9** Impacts of intense/extreme rainfall events on rural household vulnerability, modified by the use of adaptation options. Based on 2007–2008 field work in Ghana (adapted after Perch-Nielsen et al. 2008)

a pair that implies the likelihood of a system experiencing a certain event and the occupance and livelihood characteristics that influence the sensitivity to such exposure, such as settlement location, land use, housing structures, and livelihoods. In the Ghana case study, exposure to extreme rainfall events is high, given the record of several severe incidents in the past and people’s conviction that such events will most likely return in the future. As for sensitivity, all except for one household interviewed are dependent on agriculture (farming, fishing, cattle raising) for their main livelihood and, therefore, highly sensitive to climatic variability.

While the key strategies to reduce sensitivity—livelihood diversification and food storage—were quite common among participants in this study, clearly fewer people had attempted to reduce exposure, either through relocation of farm plots or structural modifications. Migration was not mentioned as a conceivable option, independent of the relative difference in resource endowments between households. The only exception was a Fulani herdsman who stated that he would leave the community if all pastures were flooded but would come back as soon as the water had receded. By contrast, 45% of all 72 participating households declared that one or several members had migrated during periods of drought, at least temporarily, in search for labor, and would do so again in the future.

The unattractiveness of migration as a response strategy mirrors findings from Burton et al. (1993) and Belcher and Bates (1983). Yet, it is surprising that not even temporary relocation was mentioned in interviews, for neither the participants themselves nor other people they know, especially given the frequency and severity

of heavy rainfall events recently witnessed in the areas. There are three main possible explanations: (a) the adaptation options that people employ are effective; (b) people have nowhere else to go to start their lives over; (c) there is a deep-seated conviction that these experienced floods are simply anomalies that need to be endured in the grand scheme of the otherwise ubiquitous drought reality.

The scoring of adaptation strategies for future extreme events shows that few strategies were judged highly effective. This largely essentially rules out the first explanation. As for the second possibility, approximately half of all project participants had themselves moved to their current location at a previous point in time, either in search of work, good farmland, or because of dam-related resettlement schemes. Land scarcity does not appear to be a valid obstacle. Therefore, people *could* relocate if they wanted or needed to do so. By contrast, participants repeatedly cited local resource mismanagement as main cause for climatic changes, all above deforestation, bushfires, charcoal burning, poor farming practices, and Fulani cattle grazing. Unknowingly, they alluded to the old Charney hypothesis of locally-produced droughts, attributing most blame to themselves. We consider this yet another example of the lingering desertification narrative in which heavy rainfall events and flooding have no place.

## 5 Climate forecasts and community preparedness

The conceptual model used for the Ghana case study reveals two major stumbling blocks: (a) a huge lack of climate information, seasonal forecasts, and early warning systems that could facilitate preparation and adaptation; and (b) grave deficiencies in community preparedness (indicated in gray boxes in the conceptual model, Fig. 9). Access to financial, technological, and information resources together with policy influence are considered key elements of adaptability or adaptive capacity (Smit and Wandel 2006). Yet, the large majority of rural decision-makers, including agricultural extension agents and district- and regional-level policy makers, have no access to information and learning tools that would allow them to judge whether the recent extreme wet events and associated flooding are simply a hiccup to be ignored or indicative of a longer lasting change that would require adaptive responses.

It seems that much more emphasis has been put on disaster relief after the occurrence of an extreme event, such as the 2007 floods, than adaptation behavior, learning needs, community capacity, and limits to adaptation. The news reports are packed with humanitarian statistics on the number of mosquito nets, tents, high-protein biscuits, and other emergency items distributed. Other reports cover efforts to fight cholera, diarrhea, malaria, and meningitis (UNCT 2007; WHO 2008). While all these are undoubtedly crucial in post-hazard emergencies, they hardly ever enhance adaptive capacity for future events.

### 5.1 Seasonal climate forecasts and channels of distribution

It is both surprising and discouraging that in a country with 60% of its population in rain-fed agriculture (Government of Ghana 2007) climate forecasts or other climate learning tools are essentially non-existent or inaccessible for farmers' decision-making processes. Washington et al. (2006) argue that the best way for



African climate science to engage with climate variability and enhance adaptation, including adaptation to increased extreme events, is on an interannual time scale, both institutionally and information-wise. In the case of the recent floods in Togo, the disaster preparedness manager for West Africa explained that partnering with meteorological institutions that provide data was key, not necessarily high-tech early warning systems, in addition to changing people's behavior so they wouldn't be unprepared (IRIN 2008d).

There has been a tremendous progress in the production of seasonal climate forecasts for West Africa and other regions on the continent (Roncoli et al. 2002; Tarhule and Lamb 2003; Tarhule 2005b; Patt and Gwata 2002). Also, much effort has been made to find innovative, interactive approaches for disseminating these forecasts (Roncoli et al. 2008; Patt et al. 2005; Boulahya et al. 2005). The West African Climate Outlook Forums have been using data on sea surface temperature anomalies and ENSO to issue seasonal rainfall predictions since 1998. An excellent overview of lessons learned from this and other forums can be found in Patt et al. (2007). Also, there are initiatives like AMMA (African Monsoon Multidisciplinary Analysis), pilot studies and seasonal forecasting projects including those in Burkina Faso (e.g., Kirshen and Flitcroft 2000; Roncoli et al. 2002; Ingram et al. 2002) and initiatives in Mali (Tarhule 2005b). While forecasts from ACMAD (African Centre of Meteorological Applications for Development), for instance, are freely available on the internet and new communication technologies like local radio stations, satellite reception, and wind-up radio listening are promoted (Tarhule 2005b), widespread dissemination of seasonal forecasts has not happened.

Over 25 years ago, Van Apeldoorn (1981) determined the ability of stakeholders to deal with climatic extremes as dependent on (a) their understanding of the problem, (b) the accessibility of knowledge to potential victims and policy makers; and (c) the ability of society and vulnerable groups to put that understanding into practice. Appropriate channels of distribution, the presentation of the information, and the recipients' modes of understanding and processing of the information are equally important (Stern and Easterling 1999). Tarhule and Lamb (2003) evaluated awareness and utilization of seasonal climate forecasts in Burkina Faso, Mali, Niger, and Nigeria. They found that the large majority of vulnerable groups was acutely unaware of where to obtain helpful information and, oblivious to scientific progress in forecasts, continued to "cope blindly with climate variability" (p. 1752). Interestingly, their study focused exclusively on droughts, drought awareness, and the utility of forecasts for drought mitigation—another upshot of the all pervading desertification discourse.

Among community members and agricultural extension agents who have been participating in the CCLONG project in Ghana not a single one has ever seen a seasonal climate forecast. What is available over the radio and television are weather forecasts and broad-scale, general forecasts of the rainy season for the entire country. Given the country's distinct agro-climatic zones, these broad forecasts are inadequate. According to one employee of the National Disaster Management Organization (NADMO) in the Afram Plains, not even his agency has access to seasonal climate forecasts produced by the Ghana Meteorological Services. It may be true that low literacy levels and limited access to information combined with scattered climate studies have inhibited more widespread use of seasonal climate forecasts (Tarhule 2005b). Inappropriate translation in terms of language and terminology as well as

continued deficiencies in communication channels have been identified as additional hurdles for successful application (Archer et al. 2007).

## 5.2 Tools for anticipatory learning and adaptation

In addition to inadequate or inexistent forecasts, we argue that there are two other obstacles that prevent poor land users from dealing with changing climatic conditions and extreme events. First, there is a spirit of non-collaboration, a deplorable reluctance to share available data that continues to pervade many countries in West Africa. For instance, in Ghana, all official climate records now need to be purchased at the headquarters of the Ghana Meteorological Services in Accra. District officers are prohibited from making existing data available. While strategies to ensure the economic survival of poorly funded meteo services are crucial, this new policy undermines equally important data exchange. In one community, a meteo employee conveyed his frustration about such controlled data sharing, in addition to the fact that he hadn't been paid for 7 years. On the home page of the Ghana Meteorological Services (<http://www.meteo.gov.gh/index.html>), as of September 2008, the links to meteorological data and historical events were dysfunctional, the most recent seasonal forecast was for the rainy season in 2005, and the update on weather for farmers portrayed the onsets of the 2004 growing season.<sup>5</sup> This is particularly sad as Ghana hosted the Accra Climate Change Talks in August 2008, one of the latest rounds of United Nations climate change negotiations.

Second, there is a complete absence of learning tools for adaptation. Except with one NGO in the Afram Plains<sup>6</sup> that just recently started a weekly climate program on the local radio, we found no educational material that allows people to grapple with the intricacies of climate variability and change. No utensils, gizmos, or even simple posters exist that encourage anticipatory learning—learning about concrete possibilities in preparation for floods, droughts, and other extreme events. By contrast, visual learning tools on environmental degradation and management, clean water, personal hygiene, and communicable diseases were widely available with district assemblies, agricultural extension agencies, elementary and secondary schools, and NGOs. These materials could be used as inspiration for designing climate learning tools for vulnerable, low-literacy populations.

Not surprisingly, the Africa chapter in the latest IPCC report stresses the need for climate-based decision support systems (Boko et al. 2007). More specifically, the Nairobi Work Programme, adopted at the 12th Conference of the Parties to the UN Framework Convention on Climate Change (UNFCCC) in 2006, deals with improving the understanding and assessment of climate change impacts, vulnerability, and adaptation, particularly in developing countries. Three out of the nine focus areas of the program focus specifically on information, tools, know-how, and communication regarding adaptation planning and practices while one covers climate related risks and extremes and another one climate modeling, scenarios,

<sup>5</sup>As of July 2009, the “website is under review” and no information is available.

<sup>6</sup>The Afram Plains Development Organization (APDO), originally focused on water and sanitation, now has an educational program on climate change.

and downscaling (SBSTA 2006). Canada, arguably the most advanced with respect to methods for vulnerability assessments and adaptation decision making, contends that ‘one of the most significant gaps at present relates to decision-support tools for adaptation planning and the assessment of specific adaptation options (SBSTA 2007).

There is increasing recognition that top-down approaches to climate change adaptation, including extreme events, are inadequate if not counterproductive. For instance, Van Aalst et al. (2008) promote participatory, simple, and flexible community risk assessments for climate disasters. Participatory climate impact studies have been applied before (Cohen 1997; Cohen et al. 2004), but it is only now that comparable assessments of extreme events and changes are emerging. Toth and Hizsnyik (2008) describe ‘Atlantis’ (Atlantic sea-level rise: Adaptation to imaginable worst-case climate change), the arguably first participatory assessment and learning tool in Europe for envisioning adaptation strategies to an extreme event. For those usually labeled ‘most vulnerable’—poor subsistence farmers dependent on climate-sensitive natural resources—no comparable learning tools exist. This is not to suggest that rural communities in Ghana or anywhere else in Africa should engage in computer-based simulation gaming techniques. Our argument is rather that there is a desperate need for materials and tools (posters, brochures, board games, theatre skits, etc.) that facilitate learning, experimentation, and creative decision making in the face of complex risks and uncertainties. The purpose is to awaken what Tschakert (2007) calls ‘latent’ adaptive capacity, often buried under the self-accusing and victimizing desertification narrative, and to foster people’s capacity to influence their future through iterative and anticipatory planning rather than learning by shock. This, in fact, is the main objective of the CCLONG project.

## 6 Discussion and conclusion

In their overview of the African Sahel 25 years after the great drought, Batterbury and Warren (2001) describe the persistent desertification discourse as a dangerous, homegrown Sahelian myth that has been flourishing and, at the same time, obstructing development for decades, partially due to incomplete scientific understanding of the complex environmental and social processes in the region. Today, droughts and degradation continue to provide compelling arguments in the debate on climate change impacts and vulnerability where the ‘most vulnerable’ countries anxiously compete for a share of the adaptation funds. Despite an increasing recognition among researchers and also policy-makers of the Sahel as a dynamic landscape, the extreme rain fall events, flooding, and damage to assets and livelihoods of recent years don’t seem to fit the overarching narrative.

In this paper, we argue that the current scientific uncertainty with respect to future climatic trends in the Sahel and other parts of West Africa further undermines much needed immediate responses. While it is true that half of the 21 models in the MMD-A1B simulations project an increase in precipitation over the next century and the other half does not, as illustrated in the chapter on regional climate projections in the most recent IPCC report (Christiansen et al. 2007), such disagreement over long-term trends easily overlooks extremes that occur in the short-term. In other words, it seems futile to wax and wane about the white pixels of uncertainty for 2080–2099

(see Fig. 3b) when the real action is happening in the tails of the distribution, at this very moment in time. The number of extremely wet seasons over the next 80 years will increase by 20% in West Africa, i.e. one in five seasons are predicted to be extremely wet compared to one in 20 in the control period in the late twentieth century, independent of the long-term trend.

Even in research circles, debates on drought still dominate. Floods were neither discussed at the 2006 Danish Sahel Workshop titled ‘Natural Resource Management in the Sahel—Lessons Learnt’ (November 6–7) nor the 2007 African Migrations Workshop in Ghana (September 18–21). Also, floods play only a minor role in the NAPAs produced by Sahelian countries such as Mali, Niger, Senegal, and Mauritania. On the ground, the vast majority of subsistence land users, agricultural extension agents, and regional policy makers are also still entrenched in the lingering drought and desertification discourse. Most participants in our project see a direct link between land degradation, deforestation, agricultural overexploitation, and drought. Repeatedly, farmers insisted that cutting down trees brought droughts, whereas shady canopies attracted rains. This discourse is dangerous as it underestimates the real threat of externally-driven wet extremes and flooding, suggesting that they are a temporary albeit troublesome anomaly. It appears the time is right to lay the desertification paradigm to its much overdue rest.

This study has shown that floods in West Africa are recurrent events and by no means a trivial issue that should be neglected any further. It has also shown that local stakeholders are well aware of heavy rainfall events, have a memory of past events that closely matches climatic records, and try to cope with flooding and associated losses and health impacts as best as they can. What is missing is institutional and informational support to facilitate knowledge sharing, collective learning, and preventive and adaptive responses. This does not mean that a ‘flood narrative’ should replace the drought narrative. What this article shows is that both droughts and floods are likely to characterize the region over the next decades. Local people describe this turn as “rainfalls have become erratic and more unpredictable.” It is this unpredictability and inconsistency in the tails of the rainfall distribution that affects rural livelihoods, the choice and timing of crops, the quality of pasture, the availability of puddles of waters for grazing animals, the abundance of fish, as well as human and animal diseases. While the September 2007 rains were extreme, it was the combination with the wide-spread drought spells during the preceding months of May to July that further distressed household coping mechanisms. Crop insurance for poor people against floods and other extreme events, as proposed by various organizations at the COP13 in Bali (IRIN 2007), does not (yet) exist in Ghana.

Have floods triggered mass displacement and environmental refugees? The findings of this study indicate that migration is not perceived as a desirable option—mainly because floods are seen as a temporary nuisance, even if they are more likely to destroy livelihood assets than droughts. Also, most people who are displaced as a result of heavy rainfalls are likely to return to their homes as soon as possible. This means that reported statistics on the number of displaced people have to be read with caution. However, when people have to face a chain of environmental deteriorations such as land degradation, slowly evolving climatic changes, and sudden-onset hazards (including floods), distress accumulates beyond a manageable threshold, resulting in environmentally-induced migration (Renaud et al. 2007). This threshold is likely to be reached in northern Ghana.

What is most needed, from a researcher's perspective, is a better understanding of practical adaptation options, decision-making processes, needs, and limitations in the context of extreme events, both at the community and the policy level. Of particular importance is the conceptualization of adaptation as a dynamic process. Too little is known about how vulnerable groups respond to consecutive rounds of disturbing events, such as the back-to-back drought and floods in 2007. At the local level, the single largest gap in the adaptation repertoire is access to climate information. In the Ghana case study, knowledge of seasonal climate forecasts and other decision-support tools is essentially absent. Even on a more basic level, there exists only very scant practical or visual material that would allow rural communities to better comprehend the multiple-scale drivers of climatic changes and extreme events. Posters, drawings, board games, songs, theatrical skits, open days, and special radio programs are just some examples of tools that could be used to facilitate anticipatory learning, envisioning possible scenarios and alternative options, and facilitating effective and timely adaptation. Shared knowledge and lessons learned from previous climatic stresses and responses can mobilize local memory and provide vital entry points for collective learning and enhanced adaptive capacity to both wetter and drier periods, now and in the future. Most importantly, such learning tools sustain agency building rather than victimization and learning by shock. In the Ghana project areas, there is a tremendous eagerness among various stakeholder groups—farmers, herders, fishermen, agricultural extension agents, health personnel, governmental employees, students, and researchers—to participate in such forums for collective learning. As one Fulani herdsman put it: “The scientists were able to predict the [solar] eclipse in 2006. They surely can predict the climate too”. It is not likely to be all that simple, but we should give it our best effort.

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