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LOCAL PERCEPTIONS AND REGIONAL CLIMATE TRENDS ON THE CENTRAL PLATEAU OF BURKINA FASO

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ABSTRACT

Due to devastating droughts in the 1970s and 1980s, climatic and environmental change in the West African Sahel has attracted a great deal of scientific research. While many of these studies documented a long-term trend of declining rainfall, analyses conducted in the last few years suggest that a 'recovery' is underway. Drawing on ethnographic interviews, focus groups, and participant observation in two Provinces of the Central Plateau of Burkina Faso, we elicited local perspectives on these rainfall trends from the people who are most directly affected, namely local farmers. Fieldwork revealed that farmers in the research sites perceive that both overall seasonal rainfall and the number of 'big rains' during the rainy season have decreased over the last 30 years. We then tested these perceptions against rainfall records from nearby meteorological stations and found them to be corroborated. This paper illustrates how farmers of the Central Plateau now view drought as 'normal', having incorporated drought-mitigation adaptations into their agricultural systems. Our case study highlights the need for ground truthing scientific analyses and assessing livelihood implications at the local level. It also advocates for sustained institutional support for rural communities, to increase their ability to adapt to climate change. Copyright © 2008 John Wiley & Sons, Ltd.

KEY WORDS: climate change; drought; rainfed farming; livelihood vulnerability; adaptive strategies; local knowledge; Burkina Faso

INTRODUCTION

Experts often cite climate change, particularly as it affects precipitation, as one of the key obstacles facing rural producers in Africa. Its causes and effects on local communities are constantly debated and often fiercely contested. One such debate has focused on the Sahelian region of West Africa. The Sahel became the focus of international attention in the 1970s and 1980s, when droughts and famines struck the region. Thousands of people and even greater numbers of cattle perished due to famine and lack of forage. Tens of thousands of families were dislocated and left destitute. Due to the severity of these events and the attention they have received, volumes of reports, books, and articles have investigated the causal links between Sahelian droughts, climate change, desertification, agriculture, and natural resource-based livelihoods (Herrmann and Hutchinson, 2005). Debates on the direction, extent, and causes of environmental change swirl around issues of temporal and spatial scale (Chapman and Driver, 1996; Clifford and McClatchey, 1996; Wilbanks and Kates, 1999). So far, most studies on Sahelian desiccation focus on regional or global processes and interactions. These analyses have concentrated on the examination of scientific data such as satellite imagery, output from global circulation models, and regional rainfall indices. From these perspectives, local people—to the extent they are discussed at all—are often portrayed as irresponsible culprits or hapless victims of environmental crises. Very little research has attempted to understand the nature of the Sahelian drought from the viewpoint of the people most directly affected–its rural smallholder farmers and herders.

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In the last decade, a number of social scientists have begun to use local understandings of environmental change as a starting point for their investigations (Fairhead and Leach, 1996a,b, 2000). Drawing from long-term micro-level fieldwork in agricultural communities, they revealed substantial differences between the assessments made by scientific experts and those held by the local people who draw their livelihood from those environments. For example, Fairhead and Leach have shown how scientific interpretations of deforestation in Guinea contradict the accounts of local farmers, who believe that forests are actually expanding. Subsequent analyses of satellite imagery proved that forest expansion was indeed occurring and that the farmers were correct.

Comparing scientific and local narratives of environmental change has enabled social scientists to show how 'authoritative' knowledge shapes policy decisions that may not reflect the concerns and priorities of local stakeholders (Leach and Mearns, 1996; Moore, 2001; Bassett and Crummey, 2003). Colonial and post-colonial regimes in Africa have used alarmist predictions of environmental crisis to legitimize state policies aimed at wresting control of natural resources from local communities for the benefit of outside interests. In the name of 'environmental protection', international agencies and conservation groups have promoted regulations that come at the expense of local farmers, hunters, and forest-users whose livelihoods depend on natural resources. As an example, the threat of advancing deserts has been used as a rationale for governments to evict pastoralists from traditional grazing areas as in the case of Tanzania's Mkomazi Game Reserve in 1988 (Brockington and Homewood, 1996).

Most of these studies contrasting cultural understandings, scientific narratives, and policy discourses on the environment have largely focused on soils, vegetation, and forests. Few have concentrated on local perceptions of climate change (see Sollod, 1990). This paper discusses how local farmers understand and experience regional climatic trends and how they have adapted their livelihood strategies. In so doing, our goal is not to assert that one type of knowledge is more valid than another. Rather, we propose that the views of local rural producers, whose livelihood depends on the Sahelian climate and environment, be actively solicited and taken into account in scientific assessments. They offer important insights on the nature of environmental processes that the analysis of scientific data alone cannot capture. Our examination of regional climate trends, local perceptions, meteorological data, and farmer adaptations enriches our understanding of how long-term fluctuations in Sahelian rainfall are experienced by the people most affected.

REGIONAL CLIMATIC TRENDS IN THE SAHEL

The Sahel is a broad band of semi-arid territory that stretches across the continent from the Atlantic coast to the Horn of Africa. Technical definitions of the Sahel vary, but its name means 'shore' in Arabic, because it forms the geographic transition zone between the Sahara desert to the north and wetter Sudanian forests to the south. Since the Sahel droughts of the 1970s, scientists have examined a wide range of theories and hypotheses to explain their occurrence. Initially, Charney (1975) pointed to land clearing for agriculture and overgrazing as the main causal factors, proposing that increased surface albedo contributed to a negative feedback dynamic with regional rainfall. As another severe drought occurred between 1984 and 1985, some scholars proposed that the region was undergoing an externally-driven secular decline in rainfall since 1968 and that the severity of these periodic droughts would increase over time (see Herrmann and Hutchinson, 2005).

A study by Lamb (1985) presented the first empirical evidence of a drying trend over the Sahel. Using an index derived from 20 stations across West Africa, Lamb concluded that 'severe drought has extended with little respite since 1968' (1985). Fifteen years later, this trend appeared well entrenched and documented in regional rainfall records (Hulme, 1992; Nicholson *et al*., 2000; Nicholson, 2001). In fact, Hulme asserted that 'the prolonged and severe desiccation of the Sahel over three decades or more is the largest manifestation of multi-decadal rainfall variability observed anywhere in the world this century' (Hulme, 2001). For the purpose of our analysis, we define desiccation as a multi-decadal decline in annual rainfall. Such a decline appears prominently in regional rainfall indices (see Figure 1). Some scholars have argued that this apparent desiccation was due to changes in the network

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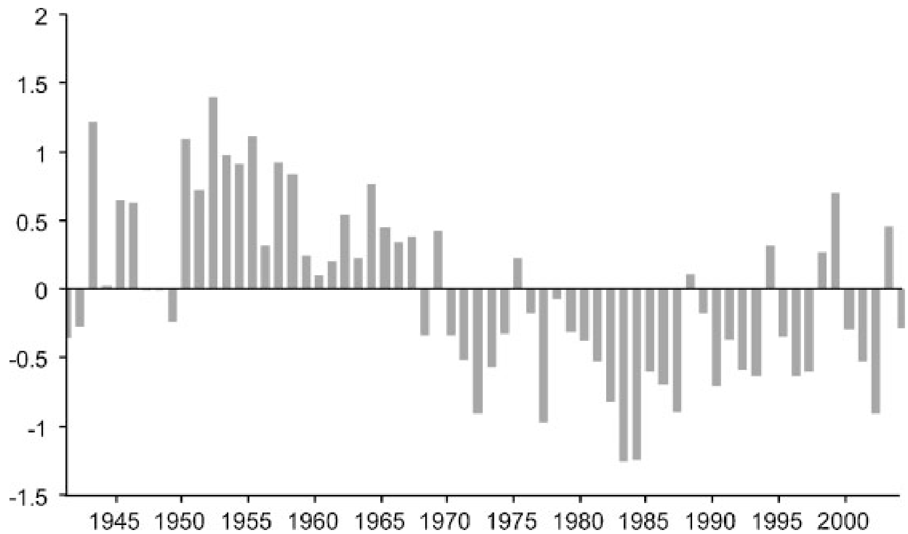

Figure 1. Annual precipitation index for the Sahel (from 11° to 18° N, west of 10° E) derived by Bell and Lamb (2006: p. 5344). Data provided by Dr. Michael Bell.

of stations used for analysis (Chappel and Agnew, 2004). However, Dai *et al*. refuted this claim and re-established Sahelian desiccation as undisputedly real (2004).

More recently, there has been some evidence of a modest recovery in seasonal rainfall over the region, beginning in the late-1990s (Nicholson, 2005). This new development has generated much optimism and the proposition that, combined with environmental management interventions, this wetter trend may have prompted a 'greening' of the Sahel (Olsson *et al*., 2005). Researchers on this topic emphasize that this rainfall improvement is not uniform across sub-regions of the Sahel. Considerable variation also exists in how this possible 'recovery' manifests itself in seasonal rainfall patterns. For example, Nicholson (2005) finds that August, which is the wettest month of the year (and whose rainfall is particularly important for the growth of most local crops) shows the least 'recovery'. In addition, Bell and Lamb (2006) point out that using a strictly climate approach underestimates the effects of weather systems that deliver rainfall locally. They suggest that researchers monitor the types and frequencies of rainfall events and their roles in driving Sahelian climate change. Others have suggested that the drying trend is not over and that, in fact, large deficits have been recorded up to 2003 (Dai *et al*., 2004).

Overall, there is a growing consensus among scientists that the moderate 'recovery' registered in some areas is not yet significant and adequately persistent to indicate a reversal of the long-term drying trend (Giannini, personal communication). The debate about the past and current climatic trends in the Sahel is mirrored by a divergence of opinion about the future. Based on different models and methods, some scientists suggest that global warming and greenhouse gases will bring about an increase in rainfall in the region, while others predict that drought conditions may persist and even worsen due to anthropogenic global climate change (Giannini *et al*., 2003; Paeth and Thamm, 2007).

We do not intend to enter into this debate among climate scientists, but we propose adding a new dimension by re-directing the focus from the regional to the local scale where the climatic trends in question are experienced directly by rural communities. In so doing, we place local environmental perceptions at the center of the study of climate change. Numerous studies have documented that Sahelian farmers and pastoralists perceive that rainfall conditions have been changing for the worse (Cross and Barker, 1991; Batterbury and Forsyth, 1999; Mazzucato and Niemeijer, 2000; Roncoli *et al*., 2002). None of them have systematically compared local understandings and

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scientific evidence in the context of regional climatic trends. Thus, our comparisons of farmer perceptions and rainfall data help establish this link between regional rainfall trends and local realities.

METHODOLOGY

This study draws on ethnographic research carried out in two provinces of the Central Plateau (Figure 2). In the Namentenga Province, research was conducted in Bonam (pop. 2800) located near the provincial capital of Boulsa. Fieldwork took place during three separate research sessions (4–6 weeks each) in January 1998, June 1998, and January 1999, followed up by brief visits between 2001 and 2004. Fieldwork in the Bam Province included one 3-month trip, from June to August of 2002, in the village of Rollo (pop. 4500), followed by a 12-month trip, from

Figure 2. Map of Burkina Faso and study sites. Geospatial data was provided by the Geographical Institute of Burkina (IGB).

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January to December, 2004. During this second period, research was conducted in three more villages surrounding the Bam provincial capital Kongoussi: Kouka (pop. 650), Sakou (pop. 1350), and Loulouka (pop. 1500).

Our research on local perceptions of rainfall variability partly overlapped with broader studies—the Climate Forecasting and Agricultural Resources (CFAR) project, which aimed to understand how climate information can help farmers adapt to climate variability (Namentenga), as well as a doctoral dissertation research on household adaptations to risk (Bam). We therefore also draw on a number of surveys on related topics that were conducted in the context of these studies. The research spanned 7 years, including those following severe droughts (such as the 1997 and 2000 rainy seasons in Bonam and the 2001 rainy season in Rollo). This provided opportunities to elicit farmers' understandings of drought and to observe household coping strategies at times of food shortage (Roncoli *et al*., 2001). The possibility that the recent experiences of drought might have somewhat biased farmers' responses about long-term rainfall trends was counterbalanced by the fact that fieldwork was carried out over several years, including relatively favorable rainy seasons, such as those of 1998 and 2003 in Bonam and 2003 in Kongoussi.

The nature of the rains is a common subject of conversation because rainfed farming is the principal economic activity. During fieldwork, discussion about the rains arose spontaneously in the course of daily encounters with research participants in the field and during interviews. These informal comments were systematically recorded as part of the authors' field notes. 'Participant observation' is a basic principle of ethnographic research and refers to the process of experiential learning that occurs during fieldwork, as a function of 'being there' (Spradley, 1980; Bernard, 1998). It is based on the recognition that engaging in daily social interactions provides insights into cultural realities that elude formal research methods. Although the extemporaneous, unsystematic nature of the findings means they cannot be translated into statistically significant results, this approach enables ethnographers to understand the research issues from the point of view of local people, thereby avoiding biases resulting from the imposition of Western scientific categories (see Nadasdy, 1999).

Given the cultural importance of rainfall, inquiries about the current and past rainy seasons were used as entry points during individual and group interviews with selected sectors of the population. Often building on spontaneous comments by respondents, we probed further by asking questions such as: 'How is this season going?', 'How was the previous season?', 'How do they compare to past seasons?', 'What kinds of climatic changes have you experienced in your lifetime?', 'How do these changes affect you as a farmer?'. Based on these responses, we asked more detailed questions regarding the seasonal variation in rainfall, to identify the most critical features whereby farmers evaluate rains. We also elicited farmer perspectives on climatic anomalies that occurred in the past, which led to the discussion regarding their livelihood impacts.

To identify key informants with expert knowledge of rainfall, we relied on local contacts, such as village chiefs, government representatives (**delegués**), development committees, and village associations. In most cases, these local experts were elders (ages ranging between 50 and 90) who, in traditional African societies, are generally recognized and respected as the repositories of collective wisdom and historical memory. They included customary chiefs, village elders, religious leaders, diviners, and prominent farmers. To ensure a broad representation of the different sectors of society, we also interviewed women, younger men, and other social groups such as agro-pastoralists. In total, approximately 43 persons were interviewed in Bonam, 37 persons in Rollo, and 41 persons in Kongoussi. These interviews include 20 women and 20 younger men, in addition to older men. We also conducted three focus groups in Bonam (one with men, one with women, and one with both male and female agro-pastoralists) and two focus groups in Rollo (one with young men and one with older men and women). In most cases, interviews were conducted in the local language (**Mooré**) with the help of local research assistants.

Key informant interviews enabled us to elicit a vast repertoire of local knowledge and perceptions about rainfall variability and climate change. These findings were then tested against the meteorological records from stations located near the sites where fieldwork took place. We consider only precipitation patterns that have persisted on the order of decades, based on precipitation records that stretch from the 1940s to 2003. In the case of Bonam, the nearest station is in Boulsa and for Rollo, the nearest station is in Bourzanga. The meteorological station for Kongoussi lies in Kongoussi itself. Precipitation data were obtained through the United States Geological Survey (USGS) Africa Data Dissemination Service (ADDS) web site (http://earlywarning.usgs.gov/adds/). The National

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Meteorological Service of Burkina Faso and the Projet Aménagement des Terroirs et de Conservation des Ressources dans le Plateau Central (PATECORE) provided post-1997 rainfall data.

THE RESEARCH SETTING

The Central Plateau of Burkina Faso is considered part of the Sudano–Sahelian zone of West Africa because it shares biological and climatological characteristics of both the semi-arid Sahel and the wetter and more densely wooded Sudanian zone. It encompasses approximately 94 000 km^2, or nearly one-third of the total area of Burkina Faso. The Central Plateau consists of an elevated plain with some scattered ranges of low mountains that reach 500 m. The laterite soils are poor and have low amounts of organic matter and nutrients. Vegetation is primarily a mosaic of thorny scrub interspersed with savanna grasslands. The plateau stretches from the wetter South, where mean annual rainfall measures 900 mm, to the drier North with a mean annual rainfall of 500 mm (Somé and Sivakumar, 1994). Based on 30-year records from 1971-2000, mean annual rainfall measures 635 mm in Boulsa, 610 mm in Kongoussi, and 507 mm in Rollo. Rain falls during a single growing season, which stretches from May–June to September–October. It is characterized by a high degree of temporal and spatial variability.

The total population of the Central Plateau is approximately 5 million, or about one-half Burkina's total population of roughly 11 million (Ouédraogo, 2005). The population density is high throughout the region and averages 50 inhabitants/km^2. The Northern Central Plateau is the most densely populated part of Burkina with densities exceeding 100 inhabitants/km^2 in many rural areas (Reij *et al.*, 2005). The Mossi make up the majority of the population of the Central Plateau although groups of settled and transient Peul pastoralists also inhabit the outskirts of villages. Bissa, Gourounsi, and Gourmantché ethnic groups live in the Southern part of the Plateau. The Central Plateau is made up of 18 provinces, with each province divided into a number of departments. As in most of the Central Plateau, rural producers in the Namentenga and Bam provinces draw most of their livelihood from rainfed agriculture. However, poor soils, erratic rainfall, and high population densities contribute to low agricultural productivity in any given year, especially during droughts. As a consequence, these provinces suffer from chronic food insecurity.

In addition to climate, other factors such as local topography, soil conditions, access to transportation, and market infrastructure shape different livelihood options in the research sites. Bonam lies in a wide plain with little topographic relief. A small dam built in the late 1990s created a reservoir used for livestock and for a small irrigated perimeter downstream. Kongoussi features several valleys that lie in between steep volcanic mountains that rise to 500 m. It is located next to Burkina Faso's largest natural lake, Lake Bam, which stretches approximately 2 km across and 30 km long at the height of the rainy season. Rollo lies at the base of a small mountain range and is surrounded by relatively flat plains. Soil quality varies among sites, and even within sites, ranging from heavier loamy-soils (**yakka** or **bãnzinga**) in lowland areas to the laterites (**kugri**) and gravels (**zîngdega)** that characterize upland fields, to denuded clay areas (**zippellé**), that have become unsuitable for cultivation. Diversification of land holdings over multiple field and soil types is a key strategy whereby farmers cope with rainfall variability, as it allows them to exploit areas with different water retention properties.

The droughts in the 1970s and 80s spurred international interventions to disseminate sustainable land management technologies and agricultural innovations on the Northern Central Plateau (Batterbury, 1998). Collectively referred to as soil and water conservation (SWC) techniques, these innovations include: (a) contour stone bunds, which are constructed by aligning low barriers of rocks along contour lines within fields in order to conserve moisture and soil; (b) level permeable rock dams constructed across gullies to halt their progression and slow erosion; and (c) **zaï**, an indigenous technique used to rehabilitate depleted soils by digging holes, filling them with manure, and planting seed in them (Reij *et al.*, 2005). Over the course of several years, villages progressively extend the rock barriers throughout their territory so that entire drainages become improved.

Due to substantial foreign assistance and accompanied by a strong sense of need, Bam communities have widely adopted these SWC technologies. Long lines of stones have become prominent features of the contemporary landscape. Since 1982, 12 000 hectares have been rehabilitated using these technologies, improving up to 50 per cent

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of all agricultural land (Reij and Thiombiano, 2003). Adoption of SWC techniques in the Namentenga province, however, has been more sporadic. They are limited to only those communities that have a strong non-governmental organization (NGO) presence.

Self-sufficiency in grain is the central focus of household labor allocation and defines food security in the Central Plateau, as in other parts of dryland Africa (Mortimore, 1998). The main staple grains are pearl millet (*Pennisetum glaucum* [L.] R. Br.) and sorghum (*Sorghum bicolor* [L.] Moench). Millet is generally planted in poorer upland-soils, while sorghum requires greater fertility and is planted in low lying and more fertile fields. Rural producers stagger planting dates and sow several varieties of each cereal that have different water requirements and different growth cycles as a way to spread climate risk and labor demands. Maize (*Zea mays* L.) is also cultivated in fields surrounding village compounds, which are fertilized with household waste and animal manure. This cereal serves as a 'hunger crop' because it can be harvested and consumed in September, while households await the harvest of sorghum and millet in October (Batterbury, 1997). In addition to cereals, peanut (*Arachis hypogea* L.), Bambara groundnuts (*Vigna subterrenea* [L.] Verdc.), and cowpea (*Vigna unguiculata* [L.] Walp) are grown alone or intercropped with cereals for domestic consumption. Small surpluses of these crops and sometimes grains can be sold on local markets. In Bonam, rainfed rice (*Oryza sativa* L.) is planted in valley bottoms as a cash crop and rice is produced in the irrigated perimeter during the dry season. The richer lowland-soils surrounding Kongoussi support some cotton cultivation, which is not possible in drier Rollo. Cotton was grown in Bonam until the droughts of the 1970s and 1980s made it too risky. Today, farmers grow cotton only in a few small lowland plots.

Greater water availability and better access to transport and regional markets in Kongoussi and in Bonam enable wealthy farmers and agro-pastoralists to keep larger herds of cattle than in Rollo. Households also raise small ruminants, poultry, and, more rarely, pigs. Donkeys are used for transport and for draught power. Plows allow households to get a head start on the planting season and to expand their holdings to compensate for declining land productivity. About a third of households in Bonam own plows. Those who do not own plows may rent them or borrow them, although they may be unable to do so at optimal times (Roncoli *et al*., 2001). Given the low level of productivity and profitability of local agriculture very few chemical inputs are used, but animal manure and household wastes may be used to fertilize fields.

Diversification of livelihood sources, particularly in sectors that are not rainfall-dependent, is an important strategy for reducing household vulnerability to climate risk. Most households rely on cash income from various economic activities to purchase grain when their own production falls short. Men may practice masonry, butchery, tailoring, or bicycle repairing, for example; while women may brew beer, sell cooked food or sauce ingredients, or make shea butter, baskets, and other items for the market. Kongoussi's lake and Bonam's reservoir also provide opportunities for fishing and dry-season production of vegetables, maize, and rice for additional income. The mountains surrounding Kongoussi have gold-bearing ore deposits, which enable local households to engage in artisanal gold mining during the dry season. Because of their greater access to roads and markets, households in Kongoussi and Bonam can engage in trade, while Rollo's relative isolation limits the opportunities for off-farm income. Nonetheless, drought and famine compromise the viability of off-farm income generation activities by reducing the supply of water and raw materials, the availability of money to invest, and the demand for products and services.

The need for cash prompts Central Plateau villagers to migrate elsewhere for work. Out-migration of local men started during colonial times, when local people were forcibly recruited for public works construction projects or for military service. They were also compelled to work in the coffee and cocoa plantations in neighboring Côte d'Ivoire to earn money to pay taxes (Cordell *et al*., 1996). As the population expanded and the need for money increased, Central Plateau migrants have also settled into wetter areas in Southern Burkina, particularly since the 1980s. This is due in large part to the agrarian reforms promulgated by populist leader Thomas Sankara, which enabled farmers to appropriate unclaimed land by putting it into production. Voluntary resettlement programs have also facilitated emigration from the densely populated Central Plateau to river valleys in Southern Burkina (McMillan, 1995). Migrant remittances are a crucial resource that helps rural households cope with droughts. In extreme cases, entire families may emigrate (Roncoli *et al*., 2001), but in most cases it is the young men who leave for periods ranging from one season to several years (West, 2006).

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Migrants' gifts and remittances help households to cope with food crises. At the same time, the absence of these members also diminishes the domestic labor force. Seasonal migration by household members is also a mechanism whereby households ration food at times of shortage and earn money to buy assets (Roncoli *et al*., 2001). This option is also practiced by wealthier households, which tend to be larger, although in this case migrants' earnings tend to be used to build their asset base and to invest in production (Roncoli *et al*., 2001). The recent political turmoil in Côte d'Ivoire and the violence that has been directed at Sahelian migrants has reduced access to migration destinations and important markets for Burkinabé products, such as livestock. This has further undermined the ability of Central Plateau farm households to deal with food insecurity, because of the risk of transporting goods and money across the border in such a volatile situation. Unrest in Côte d'Ivoire has also depressed prices for livestock, which are sold when households need cash.

COMPARISON OF LOCAL PERCEPTIONS AND METEOROLOGICAL DATA

Although the Central Plateau is part of the Southern Sahel, a zone which, according to recent analyses, is experiencing a modest rainfall 'recovery' (Nicholson, 2005), none of the farmers interviewed in the Namentenga and Bam Provinces expressed such views. Rather, most contend there has been a long-term decline in rainfall as well as an increase in its variability. These perceptions are grounded in local and regional history and culturally significant events. Several elderly respondents in the Bam sites dated the onset of the downward trend from around the time when Burkina (then Upper Volta) gained independence from France in 1960. Generally, powerful Mossi chiefs are often believed to have special powers and, when they die, to be able to cause extreme weather conditions. Bonam farmers believe that the death of the Mossi chief of Namentenga (the Bougoum Naba) set off the mid-1970s drought. Others in Bonam referred to the enthroning of the current Mossi paramount chief in 1982, or the death of the populist leader Thomas Sankara in 1987, as the beginning of desiccation.

Farmers detect this shift by its imprint on the landscape and its implications for land and crop management. For example, farmers talk about ponds and streams that have dried up and discuss having to dig much deeper wells than in the past. They mention the gradual disappearance of useful wild plants and woody species that provide food, fodder, medicine, and raw materials for crafts and building (see also Reij *et al*., 2005; Wezel and Lykke, 2006). Interviewees point to established settlements in areas that used to be uninhabitable because of periodic flooding and waterborne disease, such as the Tangpore neighborhood of Bonam. They recall traditional varieties of millet, sorghum, and other crops that are now rarely grown because of their longer growth cycle and higher water requirements. For example, Bonam farmers report that traditional varieties of sorghum, which took 4 or 5 months to mature, are now rarely planted (Roncoli *et al*., 2001). Likewise, referring to the disappearance of a long-cycle (150 days) variety of white millet, as an elderly man in Kongoussi stated:

> Now is not like before. It is the drought. Before Independence, we could count on rain until October and grow long-cycle millet that we would harvest and leave in granaries out in our fields. Since then, there is not enough rain and we can't grow that kind of millet anymore. It has vanished from here. There is less rain now and we grow different crops.[1]

Respondents claimed that dry years (**war yuumdé**) have become more common, and therefore tactical coping strategies, such as the shift to shorter cycle varieties and soil and water conservation techniques, have become incorporated into routine agricultural practice. Drought (**waré**) is largely conceptualized in terms of a shortened rainy season (**seog koega**), due to the frequent occurrence of a delayed onset (**sig yaoga**) or of a premature end of the rains **(saaga sen pa taase**). However, the distribution of rainfall during the rainy season is also an important feature, particularly the number of 'big rains' (**sa bedré** or **sa kênga**) and the frequency of dry spells (also referred to as **waré**). Several 'big rains' are expected to fall in July and August to help crops flower and form seed heads.

[1]This quote paraphrases his statement as translated from French.

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During these months, if no 'big rain' falls for 1 week or longer, farmers refer to the period as a 'dry spell', even if it has received some modest rainfall. By replenishing soil moisture and surface water, 'big rains' enable crops to withstand prolonged dry spells, even after a premature end of the rains. 'Big rains' are defined by the quantity of rain they deliver as well as the area they cover and the manner in which they fall. They deliver at least 20 mm (possibly much more), replenishing water sources and leaving the soil moist for several days. 'Big rains' tend to be widespread rather than localized. They fall without destructive flooding, and are unaccompanied by strong wind, thunder, or lightning. Violent thunderstorms (**sa raogo**), which damage crops and waste much of the rainwater through runoff, are not usually counted among these beneficial 'big rains'. People believe that rains 'invoked' by rainmakers (**sa tatta**) are of this latter kind. Therefore, they only resort to rainmakers in times of desperation.

The duration of rainfall events is also an important factor. Farmers welcome rain that falls for several hours (**sa nyanga**), mostly at night, enabling rainwater to infiltrate the soil rather than being lost as runoff (Roncoli *et al*., 2002). Such rains are particularly suited to the planting of maize; a crop that requires good soil moisture but is also sensitive to excessively wet conditions. Since 'big rains' are believed to occur during the dark phase of the moon, many Bonam farmers eagerly scrutinize the night sky in July, to decide when they should plant maize. An 8–10 days dry spell is generally expected during the visible phase of the July moon, so farmers prefer waiting till that phase is over to plant maize. Elderly farmers report that, in the past, two or three big rains generally followed the disappearance of the July moon, bringing enough moisture for planting and enabling maize to get established. But, in recent years, such rains have become less reliable. Given the key role maize plays in ending the 'hunger season', the failure of the July 'big rains' can have serious consequences for household food security.

The number of 'big rains' is among the key criteria used by farmers to evaluate the nature of the season. For example, after the 2000 rainy season, which registered a record low of 311 mm of seasonal precipitation in Boulsa, about half the farmers interviewed during a follow-up assessment expressed grave concern regarding the season's distribution. They defined the gravity of the situation by stressing that there were only three or four big rains during the entire season, compared with eight or ten in normal years (Roncoli *et al*., 2003). Indeed, the rainfall record for Boulsa shows that between May and October there were only three rains over 20 mm, all of which fell in the second half of July.

To assess the degree to which local perceptions correspond with meteorological records, we sought to verify whether annual rainfall in Kongoussi, Rollo, and Bonam had declined according to local perceptions of desiccation. We also tested the degree to which monthly rainfall in July and August in Boulsa had indeed declined. Using annual rainfall amounts, we plotted yearly rainfall for the entire observed record for the Boulsa, Bourzanga, and Kongoussi stations. We then fitted the 10-year running average to these annual amounts to produce Figure 3.[2]

The onset of desiccation in the late-1960s and its persistence until the early-1990s is clearly shown in the 10-year running mean for Kongoussi—especially when compared with the station's 1951 to 1980 mean (Panel A of Figure 3). Unfortunately, rainfall records for the other two stations do not extend back to 1951, so it is not possible to compare them with the Kongoussi records. But, using the 1961 to 1990 mean as a baseline for comparison, we note that all three stations exhibit long-term trends in which annual precipitation falls below average (Panels A, B, and C of Figure 3). The running means for Kongoussi and Rollo shows that these trends of below-average precipitation persist into the 1990s, supporting farmers' perceptions of a 30-year decline in rainfall. For Boulsa the decline is less severe, but there has been no substantial recovery in the 1990s. Consistent with Bonam farmers' recollection, Boulsa rainfall began its decline below the long-term average in the early-1980s. Some rainfall recovery in the mid-1990s is apparent in all three charts, but severe droughts in 2000 make such interpretations ambiguous. The meteorological records for each station show there were some wet years in the 1990s, but subsequent dry years explain why farmers believe desiccation persists.

Farmers in Bonam perceive that much of the decline in annual rainfall is due to a reduction in the number of 'big rains' in July and August (Roncoli *et al*., 2002). The state of the older meteorological records, which provide 10-day rather than daily rainfall, does not allow us to test whether there are fewer rainfall events, but the evidence suggests

[2]Mean rainfall from 1951 to 1980 cannot be calculated for Bourzanga and Boulsa because records do not extend back to the 1950s.

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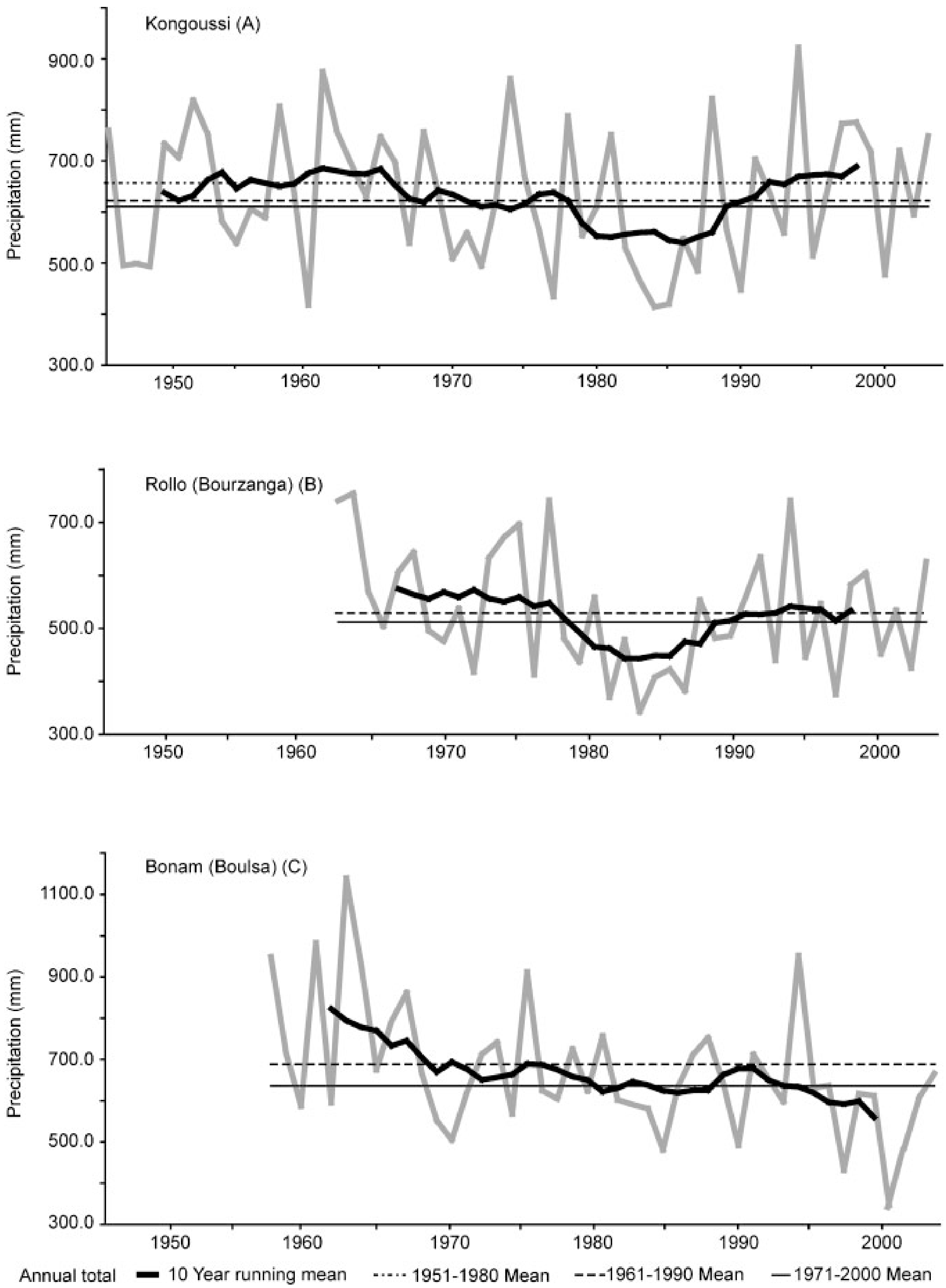

Figure 3. Annual precipitation for Kongoussi (1946–2003), Rollo (1964–2003), and Bonam (1959–2003)—note different y-axis scale ranges for each locality.

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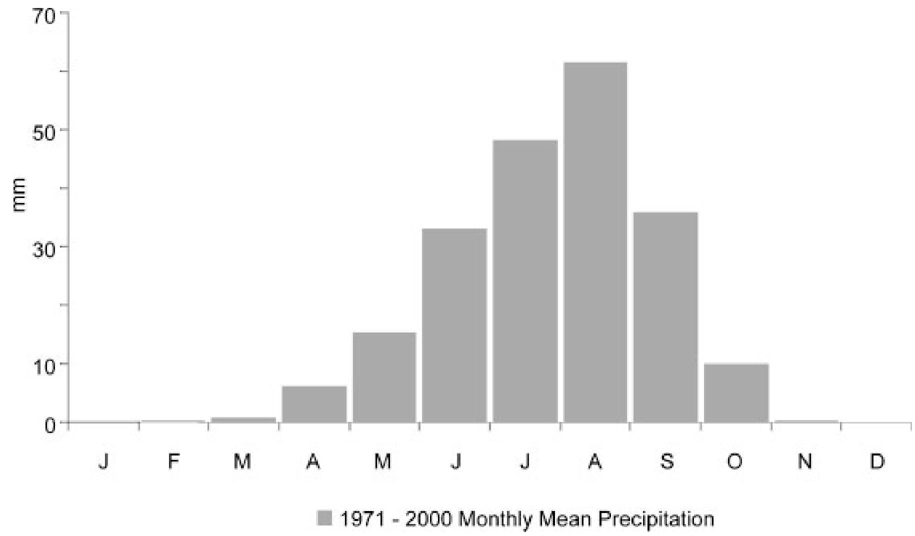

Figure 4. Mean monthly rainfall for Boulsa (from 1971–2000).

that rainfall in July and August is indeed declining. The Boulsa record from 1971–2000 shows that July and August receive the largest amount of rainfall (Figure 4) and that this pattern persists over time (Figure 5).

Panels A and B in Figure 5 indicate that there has been an appreciable decline in precipitation during early- and mid-July compared to the 1971–2000 mean. The peaks that appear in July and August in Panel C and Panel D clearly suggest a rainfall pattern that disappears in Panels A and B (Figure 5). Panel D of Figure 5 suggests that rainfall in this period has decreased markedly compared with the 1960s, which corresponds to the onset of regional desiccation. Thus, the meteorological record corroborates Bonam farmers' perception that big rains are less frequent for Boulsa. This decrease is particularly apparent in the 1990s and indicates that the reduction has persisted for at least a decade or two (Panel A and B of Figure 5). Other studies of Sahelian rainfall also support the observation that dry years are those with fewer ''big rains'' (Lebel *et al.*, 2003).

HOUSEHOLD ADAPTIONS TO DROUGHT

Cultural perceptions and regional rainfall trends structure household adaptive strategies on the Northern Central Plateau. During the prolonged and severe droughts of the early-1970s and mid-1980s, widespread famine prompted a mass exodus from the Central Plateau to other parts of Burkina and to Côte d'Ivoire (Reardon and Matlon, 1988; Reardon and Matlon, 1989; Reardon and Taylor, 1996). At the same time, farm households on the Central Plateau have also exhibited a remarkable capacity to adjust to changing and challenging circumstances (Reij *et al.*, 2005). Having come to expect drought as the normal state, farmers have incorporated what used to be tactical adjustments to occasional water deficits in into their routine farming practices. Yet these adaptations also expose farmers to additional risks and costs by limiting their ability to take advantage of favorable conditions and stressing household and community relations (Roncoli *et al.*, 2001). For example, farmers have responded to the decline in seasonal rainfall by expanding cultivation into lowland areas. These areas have been subject to increased pressure and competition, and their exploitation has intensified conflicts with pastoralists, who rely on these areas for grazing their herds.

Rainfed farming in the Sahel revolves around three major activities—planting, weeding, and harvesting—which are all linked directly to rainfall events (Mortimore and Adams, 1999). The planting period is the time of greatest uncertainty and risk because planting decisions largely structure the other activities and may not be easily reversed after a certain time. The high stakes of cropping decisions, combined with the fact that by May and June household

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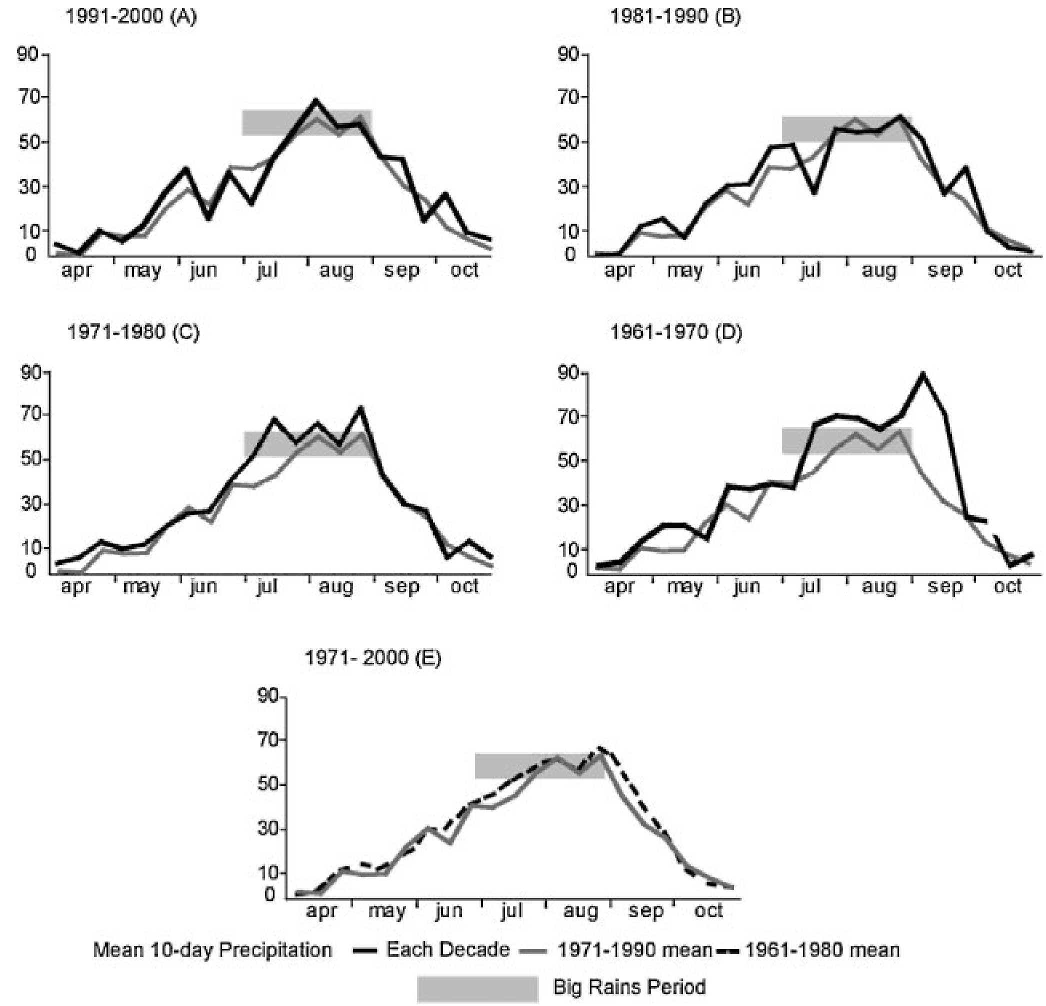

Figure 5. Mean 10-day rainfall distribution by decade for Boulsa (from 1961 to 1990).

food supplies are dwindling and grain prices increasing, make planting time a period of considerable anxiety for farmers. People we interviewed contend that the onset of the rainy season has become less predictable and now occurs later in the season. The experience of climate variability and desiccation has undermined farmers' confidence in their previous knowledge and practices. This hinders their ability to plan in ways that reduce their vulnerability to climate risk. As one young farmer in Rollo said, 'We don't know if tomorrow the word of our elders will still work'.

Bonam farmers perceive this increased variability in the rains' onset is related to the decline in the number of big rains and accounts for the decline in total seasonal rainfall. According to farmers we interviewed however, the rainy season now begins later and with rainfall events that are too far apart for crops to establish. Early rains may be followed by a dry spell of several weeks, which causes planted seeds to die. In this case, rains are referred to as 'false rains' and the rainy season is not considered to have started yet. Farmers have adjusted by planting as early as possible after the first viable rainfall event. This strategy is based on the fear that they may not get another rain for several weeks and therefore be forced to plant too late. Planting late runs the risk that crops will not mature before

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the end of the rainy season. However, if planting is followed by a prolonged dry spell, the newly planted crops may fail, wasting seed. In some cases, farmers have to replant part or all of their fields several times (Batterbury, 1997).

Based on rainfall patterns and crop performance during the planting period, farmers formulate expectations for the rest of the season and for the harvest (Roncoli *et al*., 2002). For example, farmers in the Bam Province sow white sorghum mixed with millet in some of their fields. After a few rains, both cereals germinate and begin to mature. At a certain point, farmers assess whether the rainy season may favor either white sorghum (**kenda**), which prefers wetter conditions, or white millet (**kasuya**), which is more drought-tolerant. They will then remove one crop, leaving the young plants of the cereal that seems to have a better chance of succeeding. Farmers refer to this practice as 'playing the lottery'. In a similar tone, writing about the neighboring Passoré province, Kohler (1971) noted that '. . .planting presents itself as a hazardous game of chance every year' (author's translation). If they misread the signs and make the wrong decisions, farmers may end up losing everything. Nonetheless, even in the best circumstance, they still waste part of their seed and much of their labor.

Farmers also adapt to the uncertainty of seasonal rainfall by staggering planting dates and diversifying their crop choices over a planting period that lasts from May to early August. Bonam farmers can chose from a rich variety of local sorghum and millet, including five millet and eight sorghum varieties (Roncoli *et al*., 1999; Roncoli *et al*., 2001). In Bam the choice is mostly between two millet varieties and white sorghum. Traditionally, farmers in Bonam begin by planting longer-cycle (120–150 days) sorghum varieties in low-lying fields, as the latter can be planted early, even with modest rainfall. However, if farmers do not have lowland fields, they must wait for two or three 'big rains' for the upland fields to be moist enough for planting. This often means delaying planting until July, and such delays engender intense anxiety. Under these circumstances, farmers select drought resistant crops, such as millet, or shorter cycle (50–70 days) sorghum varieties for planting. Among them, the **pisnu** (50 days) variety is increasingly common. Few farmers planted it in 1998, but 22 of 50 farmers interviewed in 2004 mentioned it. This new variety is also being introduced in the Bam province, as a 'hunger crop'–that is, a crop like maize, planted to provide food before the harvest of the longer-cycle cereals.

The shift to more drought-resistant crops and varieties entails trade-offs (Roncoli *et al*., 2001). The traditional long cycle sorghum varieties have a flexible growth cycle that can adjust to fluctuations in light and moisture, so they can better withstand dry spells. According to farmers in Bonam and in the Bam sites, shorter-cycle varieties of millet and sorghum tend to form smaller seed-heads and grains and be more vulnerable to weeds and pests. These cereals therefore require additional labor and are less able to provide a surplus to buffer households against food insecurity. They are also more perishable than the long-cycle varieties, which can be stored up to 3 years in the granary. Short-cycle varieties are considered less palatable and nourishing. This is especially true of **pisnu**, which is widely disliked as food and hardly marketable for cash.

In Bam, farmers have adapted to declining and variable rainfall by investing in soil and water conservation techniques. Older respondents told us these improvements would have been unnecessary during their youth, because rainfall conditions were more favorable. Nevertheless, the ongoing desiccation had made these new methods essential components of the contemporary farming system. Rehabilitating soils by preparing *zaï* holes, constructing contour stone bunds, and building permeable rock dams entail enormous amounts of labor, cooperation, and planning. Rocks have to be transported several kilometers by truck to local sites. After the rocks are delivered, village associations then work together to pile and align them into low walls or higher dams. These large-scale adaptations cannot be realized without substantial donor technical assistance and investment, along with substantial village-level coordination. In fact, at the time of our fieldwork in 2004, PATECORE, the principal NGO assisting with SWC projects in Bam, was preparing to withdraw from the Northern Central Plateau. Their pullout was due to the spectacular results they had achieved throughout the region. Villages worried that without PATECORE, they would not be able to expand their improvements. Households that had not yet been able to rehabilitate their fields would now never be able to do so unless external assistance continued. These concerns point out that the long-term benefits of SWC efforts depend heavily on donor support, and their benefits are not evenly distributed within villages (Atampugre, 1993; Batterbury, 1998).

Despite the numerous adaptive strategies households employ, food insecurity remains an intractable problem throughout the Central Plateau. Besides causing immense suffering, chronic seasonal famine often pushes younger

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men to migrate, thus draining the very labor force households and communities need to adapt. A survey among 96 households in the three villages around Kongoussi showed that 69 per cent of all households have at least one member absent due to migration (West, 2006). In Bonam, 18 per cent of men, 8 per cent of women, and 15 per cent of children, including four entire households, left the village between January and June 1998. They left because of the hunger and high prices resulting from the extremely poor 1997 rainy season (Roncoli *et al*., 2001). Loss of labor to migration was among the constraints farmers cited as a reason for reducing the size of their fields during the 1998 growing season, in addition to lack of money and seed. As a result, those households could not capitalize on the favorable rainfall they received that year. Overall, prompted by the prolonged and painful experience of drought and hunger, Central Plateau households are engaging in adaptive strategies that allow them to reduce their vulnerability significantly. Nonetheless, no one feels that the challenges imposed by life in a semi-arid drought-prone environment have been overcome. Even as farmers develop ways of adjusting their agricultural practices and livelihood strategies, new external shocks can intervene that undermine these adaptations.

CONCLUSIONS

This paper has sought to connect regional observations of Sahelian climate change with local perceptions of rainfall trends. Unlike those scholars who have detected a large disconnect between expert and local perspectives of environmental change, we find a close correlation between views on climate trends. The long-term decline in regional rainfall documented by numerous climatologists conforms closely to the belief held by numerous participants that their areas have undergone a period of desiccation for multiple decades. There is a similar correlation between views of meteorological experts and farmers about changes in rainfall events. However, scientific and local understandings of climate change diverge when we consider the most recent years. Whereas scientists detect a 'recovery' in regional rainfall patterns since the mid-1990s, rural producers with whom we interacted disagree.

Rural households on the Central Plateau have responded to drought and desiccation by changing their agricultural practices and diversifying their livelihoods. Farmers have incorporated different grain varieties into their cropping systems and adopted a host of soil and water conservation techniques. Opportunities to earn cash through migration, gold mining, vegetable gardening, and off-farm activities have helped make rural producers less dependent on rainfed agriculture. Nonetheless, the increased variability of rainfall patterns has compromised the ability of farmers to predict seasonal precipitation and make proactive decisions about managing household resources. Deciding when, where, and what to plant is hindered by how much labor is available, which depends heavily on the forces that compel household members to migrate. If crops fail due to miscalculations, households face hunger and risk losing members to the cities and the Côte d'Ivoire. This may be advantageous in the short term, because the farm now has fewer people to support and remittances may eventually flow back to the village. In the long run, however, it undermines their adaptive capacity.

Much of the recent literature on rainfall recovery, greening of the Sahel, and agricultural adaptations on the Central Plateau has generated guarded optimism for the future. Except for the noteworthy study by Reij *et al*. (2005), those conclusions are largely based on analyses of regional precipitation indexes and remote sensing data, which should be ground truthed in the realities of rural Sahelian life. Our experience, having lived and worked in rural communities on the Central Plateau over the course of several years, is that farmers still consider drought a perennial threat. Rural producers on Burkina's Central Plateau can continue to draw on their experience with rainfall variability during the last several decades to help them adapt to future climate change. Yet, such adaptations are only partially able to buffer them from the multiple vulnerabilities they face.

Integrating the views of the people most affected by droughts with scientific views on rainfall trends is crucial if we are to understand the effects of regional climate change on societies and their ability to adapt. Recognition that the Sahelian droughts were part of a larger long-term fluctuation in regional climate spurred development efforts to help communities adapt. Evidence of a modest recovery at a regional scale should not encourage a weakening or withdrawal of such support. On a regional scale, indeed, annual rainfall may be improving. On a local scale, based on meteorological records and long-term fieldwork among rural producers on the Central Plateau, it is the

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likelihood of drought rather than the chance of recovery that informs livelihood strategies. Policy decisions regarding the Sahel and its people must take into account regional trends as well as local realities. Despite some of the success communities have experienced in adapting to drought, they need increased and sustained institutional support to enhance local resilience.

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