

# International Journal of Sustainable Development & World Ecology

ISSN: 1350-4509 (Print) 1745-2627 (Online) Journal homepage: <http://www.tandfonline.com/loi/tsdw20>

## Coping with the impacts of weather changes in rural Sierra Leone

Kabba Santigie Bangura , Kenneth Lynch & James Anthony(Tony) Binns


To cite this article: Kabba Santigie Bangura , Kenneth Lynch & James Anthony(Tony) Binns (2013) Coping with the impacts of weather changes in rural Sierra Leone, International Journal of Sustainable Development & World Ecology, 20:1, 20-31, DOI: [10.1080/13504509.2012.740511](https://doi.org/10.1080/13504509.2012.740511)

To link to this article: <http://dx.doi.org/10.1080/13504509.2012.740511>



Published online: 13 Nov 2012.




[Submit your article to this journal](#) 



Article views: 250



[View related articles](#) 



Citing articles: 5 [View citing articles](#) 

## Coping with the impacts of weather changes in rural Sierra Leone

Kabba Santigie Bangura<sup>a\*</sup>, Kenneth Lynch<sup>b</sup> and James Anthony (Tony) Binns<sup>c</sup>

<sup>a</sup>*Department of Geography, Fourah Bay College, University of Sierra Leone, Freetown, Sierra Leone;* <sup>b</sup>*Department of Geography, University of Gloucestershire, Cheltenham, UK;* <sup>c</sup>*Department of Geography, University of Otago, Dunedin, New Zealand*

(Received 16 July 2012; final version received 11 October 2012)

Global changes in climate today present hostile weather conditions which pose considerable threats to the rich and poor alike. The capacity for developing countries to cope with these impacts is weak and a development concern. The post-conflict West African nation of Sierra Leone is no exception. In fact, rural areas are exposed to high degrees of vulnerability, livelihood insecurity and hostile environments. This paper explores the experiences of rural people and identifies impacts and coping mechanisms used in response to these changes. The research on which this paper is based adopted a facilitated group discussion approach involving 250 participants drawn from five rural settlements in Kambia and Kono Districts of Sierra Leone. In safeguarding rural livelihoods and ensuring environmental protection, this paper concludes with a number of policy recommendations, including the provision of external support, enforcing land tenure arrangements, strengthening rural people's resilience and encouraging collective and adaptive environmental management practices.

**Keywords:** settlement; perception; livelihoods; vulnerability; impacts; adaptation

### Introduction

Changes in weather conditions in recent years have required rural Africans to adapt locally to these new patterns and their associated problems. Past experience is crucial in building greater resilience to erratic weather changes which can have a significant impact on household livelihoods, sustainability and survival. Although many settlements in developing countries lack the required capacity to deal effectively with the impacts of weather changes (de Haen 2007), their inhabitants nevertheless often demonstrate some useful coping strategies (Intergovernmental Panel on Climate Change 2007). According to Boko et al. (2007), precipitation trends in Africa since the close of the 1960s have shown a significant decrease. For example, in West Africa, the annual rainfall regimes have changed such that in some places communities have lost their established cycle of roughly 6 months of rainfall followed by a similar period of dry weather (see Chappell and Agnew 2004).

Settlements in rural Sierra Leone are no exception to such weather changes, and this research has strong links with Gurung and Bhandari's (2009) study which examined weather abnormalities and the impacts experienced by rural people in Nepal. Changes in rainfall patterns have direct effects on farming which represents the main source of livelihoods for some 70% of Sierra Leone's population. As a major contributor to the present-day economies of most African countries, the agricultural sector's average contribution of 21% (ranges from 10% to 70%) is predicted to decline to 4% by 2100 due to climate change (Mendelsohn et al. 2000). This situation underscores

research findings on the relationships between rainfall patterns and agriculture which have shown the impact of rainfall changes on reductions in cereal production (Food and Agriculture Organisation 2007; Intergovernmental Panel on Climate Change 2007; Jianchu et al. 2007).

The aim of this paper is to report on field-based research designed to provide a clearer understanding of rural people's experiences of the major impacts of erratic changes in local weather patterns and the responses adopted to cope with the effects of these changes. This paper begins by exploring the background to the study settlements selected on the basis of two contrasting geographical regions (coast and interior plateau) in Sierra Leone. The settlements are examined in the context of the most frequent weather changes and the related impacts perceived by participants in their settlements. This paper then focuses on local coping mechanisms which have developed in response to changing weather conditions in rural Sierra Leone and the external interventions which are needed to complement local coping strategies for effective rural adaptation. The discussions demonstrate that the climate is changing in Sierra Leone and these changes have had serious effects on rural poverty and livelihood security, leading to socio-economic difficulties and environmental degradation.

### *The selected settlements*

Five rural settlements in Sierra Leone were selected for study, drawn from two contrasting geographical regions – three from two coastal chiefdoms in Kambia District in the

---

\*Corresponding author. Email: [ksbangura@yahoo.com](mailto:ksbangura@yahoo.com)

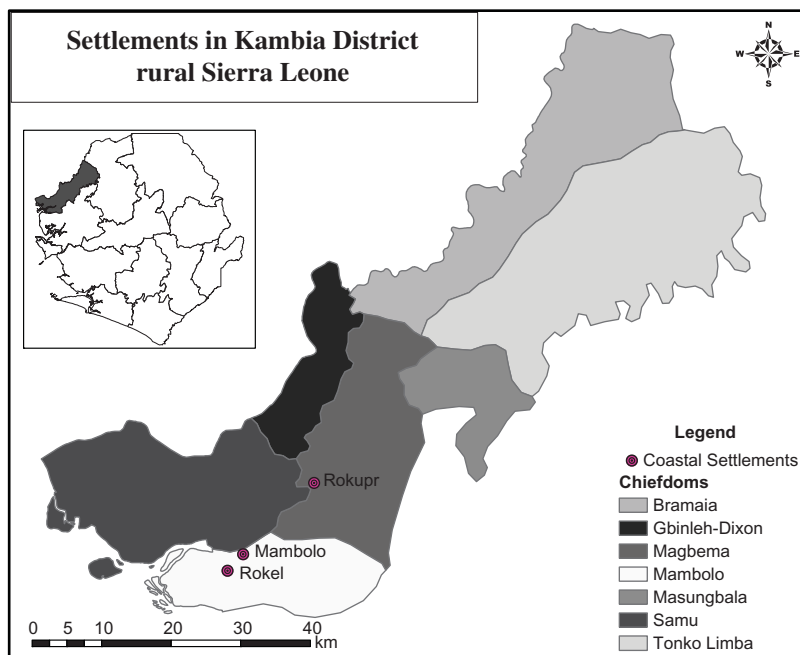


Figure 1. Case study sites for discussions with residents in Kambia District. Source: Our fieldwork.

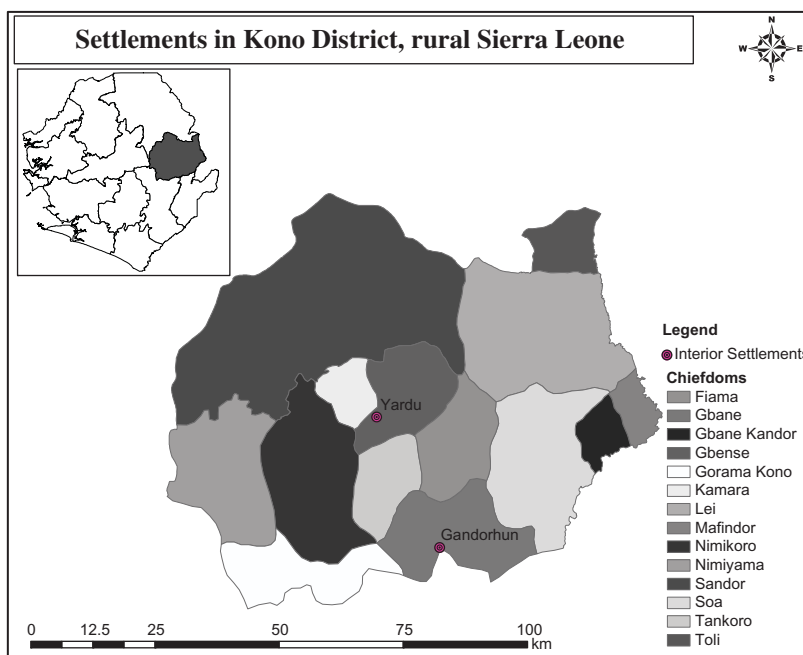


Figure 2. Case study sites for discussions with residents in Kono District. Source: Our fieldwork.

north-west of the country, and two from two chiefdoms in Kono District in the interior plateau region of the north-eastern part of the country (see Figures 1 and 2). Rice farming is the dominant occupation in all five settlements.

*Mambolo town* is the headquarters of Mambolo Chiefdom in Kambia District. It is located along the estuary of the Great Scarcies River, has an estimated population of 3000 people and consists of vast areas of mangrove swamps. Mangrove rice farming is undertaken by about 80% of the population, while the remaining

20% comprised of petty traders, fishermen, government employees and skilled workers (carpenters, blacksmiths, etc). Erratic changes in weather conditions have been experienced over recent years and have led to serious crop losses for farmers. High levels of poverty and income insecurity are major socio-economic problems faced by people in Mambolo.

*Rokel village* in Mambolo Chiefdom has an estimated population of 1400 and is situated close to the coastal swamps and tributaries of the Great Scarcies and Little

Scarcies Rivers. It is located some 2 km from Mambolo town. Mangrove rice farming is the main occupation, but farming has been seriously affected by changes in weather patterns, such that rice yields have declined steadily with serious negative consequences for household livelihoods.

*Rokupr town* is a settlement of 3500 people located in Magbema Chiefdom in Kambia District. It is situated along the Great Scarcies River just a few miles inland from the Atlantic Ocean. Subsistence farming; small-scale cash crop production such as oil palm and cashew nut plantations; and livestock rearing are some of the main economic activities. Agriculture is faced with serious challenges from weather changes, with local people contending with declining farm yields, food and income insecurity.

*Gandorhun* is the headquarters of Gbane Chiefdom, one of the 14 chiefdoms in Kono District (Figure 2). The population of Gandorhun is roughly 2500, and was established by Kono tribal warriors during the tribal wars of the seventeenth century. Hence, for defensive reasons, it was strategically located on a hilltop above a valley. The settlement is located about 12 km south of Koidu City in a formerly forested area, where farming practices such as rice farming, cattle rearing, cash crop production (cocoa, coffee and kola nuts) and artisanal gold mining are the major economic activities. Serious weather-related problems which have affected the town include water shortages, waterborne diseases, low crop yields, food shortages, income insecurity, deforestation and a deteriorating road network.

*Yardu* is a small Kono town of about 1200 people established by descendants of the Sofa warriors during the eighteenth century. It is an important settlement with a strong farming tradition and Yardu residents discovered that the land around the Monkey Hills was ideal for rice production. Aside from farming, since the 1930s, Yardu has gained prominence as a diamond mining town which has attracted the attention of companies and artisanal miners. Changes in weather patterns have caused adverse effects on both farming and artisanal mining which are the major occupations of residents in Yardu.

## Methods

The study examined the perceptions of rural dwellers to the impacts of weather changes and the local strategies used in response to these weather changes in rural settlements in Sierra Leone. Prior to data collection, several stages of research design were used. These include: determination of study sites; site visits prior to data collection; determination of the most appropriate language to use for the research; the use of facilitated group discussions during data collection; and recording of relevant responses from respondents on flip charts during the group discussions. The development of the research design involved three key issues which are now addressed.

First, the determination of study sites was done by initially allocating the 12 districts of Sierra Leone into two contrasting physical classifications, coastal and interior plateau regions. Within these two domains, Kambia and

Kono Districts were selected, each representing coastal and interior plateau regions, respectively. In these districts, a total of five study sites were selected; those in Kambia District were Mambolo Town, Rokel and Rokupr; and those in Kono District were Gandorhun and Yardu (see Figures 1 and 2). The sites selected in Kambia District are predominant for subsistence farming, that is, they are located within the country's main indigenous farming areas and those in Kono Districts are reknown for subsistence farming and artisanal mining. These dominant means of livelihoods for rural dwellers in the sites selected are directly influenced by weather changes which expose them to varying degrees of vulnerability and poverty.

Second, the site visits prior to data collection were conducted in all the selected study sites between December 2010 and January 2011. The purpose of these visits was to sensitise residents, that is, make rural dwellers aware of the study and its purpose in order to recruit participants for the data collection exercise, which was undertaken between March and September 2011. The two phases of the site visits further were intended to achieve the recruitment on as wide a representation of walks of life in each group discussion. The recruitment was based on an attempt to include all stakeholders over the age of 18 and draws from a broad range of respondents' backgrounds. That is, men and women such as local authority workers, civil servants, youths, school teachers, students, farmers, miners, traders and housewives. A total of 250 respondents were involved in the group discussions from a combined population of 11,600 in the five settlements. In addition, the Sierra Leonean society like any African country is characterised by multilingual and diversified ethnicity. This was a cause for concern during the data collection. To address this issue, a medium of communication, that is, the most appropriate local language, for use during data collection was determined and operationalised during the site visits and data collection. In the case of study sites in Kambia District, Temne is the common spoken language while Kono is the common spoken language in Kono District. However, Krio is widely spoken and understood nationwide in Sierra Leone. Hence, it is the nationwide lingua franca. On that basis, Krio was then chosen as the main means of communication during data collection. However, translation was done in each group discussion from Krio to the local language and vice versa. This dual use of common spoken languages was adopted to ensure that participants fully understood the issues being considered.

Third, the data collection instrument consisted of facilitated group discussions, an adaptation of focus groups as proposed by researchers such as Conradson (2005). According to Conradson, the ideal size for a focus group discussion is between 3 and 10 participants, but he further argues that researchers should be flexible as the size and choices of participants depend on what the study seeks to achieve. For the purpose of this study, a more loosely defined approach was used which increased the group size to 25 participants. This is best described as a facilitated group discussion. In addition, two respondents among the 25 participants were unanimously appointed by members

of each group to serve as assistants to the field researcher. This was done to manage time effectively and thoroughly deal with translation in order for issues considered to be dealt with effectively.

The data collected for this study using the outlined instruments were analysed using a simple qualitative technique to reveal an understanding of rural dwellers' perceptions of the impacts of weather changes. These discussions focused on the perceived causes, including too little or too much precipitation, frequent storms, declining crop yields and the participants' respective coping strategies adopted in response to these impacts. The study has adopted an exploratory approach, making use of the perceptions of rural dwellers in order to interpret the changes of the weather patterns in the study sites. The reason for using several sites is in order to verify and triangulate the results of each group's discussion. This has also prompted the discussions to move on to the participants' responses to the changes in weather patterns. This has been described as qualitative because given the limited scope of the study and context, there is no baseline to compare or contextualise. Therefore, the study has aimed at exploring the way rural people (especially farmers) view any weather changes and what their responses have been. However, Hageback et al. (2005) adopted this approach to determine farmers' perceptions of climate change in the Danagou watershed in China using both local perceptions and temperature data. Unlike the China study, this study in rural Sierra Leone lacks reliable weather statistics; therefore, it focuses only on exploring local people's responses to the impacts and the coping strategies that they have adopted. Where many participants reported similar views, an indication of a proportion was calculated and will be reported below. This is not intended to represent the entire population of the five selected settlements (i.e. 11,600). Rather, this shows the number of participants involved in the facilitated group discussions.

Furthermore, the study has captured and documented local knowledge, innovations and practices that promote community-based adaptation and outlined some external interventions which could strengthen local coping strategies and provide a more effective adaptation to future weather changes in rural settlements.

## Results and discussion

### *Local meaning of weather changes*

Informal discussions with people during field-based survey indicate that the residents of these rural areas do not have scientific understanding of the causes of weather changes affecting their communities. However, they are well aware of the consequences which these changes have on their lives and their attempts at adapting to these changes (Magrath 2010). Other writers have commented on such changes in semi-arid areas of West Africa (see, e.g. Desanker and Justice 2001; Nicholson 2001; Barrios et al. 2006).

In this study, about 190 people (76% of participants) noted that there have been serious changes in weather

conditions in their respective localities and respondents indicated that such changes had been noticeable even before 2000. The decline in rainfall observed by participants, for example, concurs with studies of declining rainfall trends in West Africa between 1931 and 1990 (see Chappell and Agnew 2004; Dai et al. 2004; Malhi and Wright 2004; Boko et al. 2007). Respondents reported that sometimes, it starts to rain as early as February and then breaks off in April, followed by 2 months with no rain and then it resumes late June and continues until the end of October. The study revealed that rural people experienced marked variations in the start, intensity and duration of the rainy season and also the increased frequency of severe storms with thunder and lightning. The experience of changing rainfall patterns was explained by a representative of the Mothers Club in Rokupr. For example, this 45 year-old female farmer and Mothers Club Representative explained:

A change in the pattern of rainfall is realized over the years which suddenly start in March or April instead of the normal time in May. In our farm work, we could not burn our rice farms as usual. Sometimes we are forced to abandon our brushed upland rice farms because of earlier and heavy rains. Also, most of our inland valley swamps (IVS) are usually flooded and cannot be cultivated due to early rains and this adversely affects our food production and our well-being. Even the crops that we manage to grow are often prone to insect pest attacks whose population we see to be flourishing under high temperature conditions. (Mothers Club Representative, Rokupr)

Sometimes, lives and properties are lost during storms. Respondents indicated that the intensity of rainfall does not follow any regular pattern. Changing rainfall patterns can impact upon activities such as farming, petty trading, small-scale enterprises and artisanal mining (gold and diamonds), and on both the physical infrastructure and the natural resources within and around rural settlements.

### *Social and environmental impacts of weather changes*

Weather changes are realities that rural people have to live with, and these call for the use of local measures to cope with both the changing weather hazards and their associated effects. In the midst of these hazards, the increasing size of rural populations was also perceived by participants as a factor compounding the problems of changing weather (Hope 2009).

Rain-fed farming has been severely affected by weather pattern changes resulting in declining crop yields and the combined effects of crop losses and food scarcity (see Fischer et al. 2005; Dinar et al. 2008; Thornton et al. 2009). Poor rural farmers live close to the environment and their livelihoods are intimately dependent on the weather. Farmers commented that they are no longer able to predict the beginning of the rainy season and this has cost them serious farm losses, leading to income insecurity, forced migration to urban centres and prostitution.

Declines in crop yields were reported to correlate closely with rural peoples' earnings. Farmers in the study



maintained that the higher their annual crop yields, then the higher their incomes and purchasing power. Good crop yields also lead to greater income security which assures them of being able to afford their basic needs, and they can also hire labour or engage in any economic activity that will benefit their households. With higher yields farmers are more able to increase their productive power. The study revealed that since 2000 farmers experienced a decline in rice yields in years characterised by erratic weather. For example, field data revealed that about 70% (70 out of the 100) of participants in Kono District were affected by low crop yields. These findings accord with a study in the Shire Valley of Malawi which showed how erratic environmental conditions can seriously exacerbate poverty levels and lead to farmers becoming trapped in a cycle of poverty and vulnerability (Phiri et al. 2005). Farmers in Mambolo and Magbema Chiefdoms in Kambia District lamented, saying, 'day by day we mature into abject poverty because our farms are less productive', and this concurs with the predicted threat on global food security due to weather or climate change (see Schmidhuber and Tubiello 2007). According to a 48-year-old farmer in Gandorhun:

Sometimes we experience early rains and sometimes they are late. We are never able to forecast the rainfall pattern for the season. Can the rains be early or late? We do not know. For example, in the last five years, we have experienced early and too much rain which left us with no option but to abandon our brushed (cleared) farms. This situation affects the frequency and quality of our domestic food consumption, and exposes our households to hunger, malnutrition, sickness and economic hardship. (Farmer, Gandorhun)

Evidence in the coastal area of Mambolo Town on this situation further reported in July 2011 by a 38-year-old farmer who has experienced several severe weather events was:

The changes in environmental conditions have created serious effects on us and these have caused our local livelihoods to be seriously threatened. The rainfall patterns are now very erratic, sometimes the rains may start as early as March, or as late as May. In this period, we experience increased temperatures during the day and excess heat and discomfort during the night. We also live with several sicknesses and diseases, which we believe all have direct or indirect connections with the changes in the weather patterns we experience in this town. (Farmer, Mambolo)

Respondents also reported that irregular rainfall puts more stress on the limited finances of farming households. Most participants revealed that even though investment in farming is done with the aim of producing enough food, the yields are low making food and income insecurity significant realities for households during several months of the year (see Nyong 2009). This could lead to prolonged lean periods, violence, disrespectful behaviour, frustration, the breakdown of order and power struggles in households.

The hardship experienced by rural livelihoods with a combination of factors such as poor crop yields and limited or no profits from artisanal mining often serves as a push factor that induces migration to urban centres such as the

capital city, Freetown and provincial cities such as Makeni and Bo. The study participants indicated that the most active social group engaged in rural–urban migration as a result of changing weather conditions are youths. In rural areas, the outmigration of youths has seriously depleted the rural labour stock, leading to lower crop yields and hunger. Meanwhile in the urban centres of Sierra Leone, there is immigration of youths which adds to urban social problems such as unemployment, increases in crime and a range of youth-related problems such as theft, ghetto living and idleness. These social problems are directly linked with weather changes.

Although it may seem incredible, respondents reported on observing an increase in immorality during times of insecure rural livelihoods. For example, the field study revealed a close relationship between prostitution or unfaithful marriage relationships and rural livelihood insecurity. About 48% of participants, especially household heads and females, made claims that were similar to the following: 'Young girls and wives apparently engage in secret love relationships for money with relatively wealthy community people.' Most times such clandestine relationships are a recipe for domestic violence, broken relationships and suffering for women and children. More cases of crime and prostitution were reported, especially during years when the store of food for domestic use was either insufficient or threatened because of less rain and prolonged dry periods.

Husbands are generally expected to take responsibility for providing household needs such as food, clothing, shelter and finance, but participants reported that failure to carry out this function provokes tension and violence and has led to child labour and even unfaithfulness. Tension can develop when cases of unfaithfulness become evident to the husband and this can often lead to divorce and household breakdown. Children often work very hard in the fields, especially when they have a single parent, or are left in the care of a stepmother.

Participants said that when the rice yields are very low they are often left with little option but to borrow money from moneylenders in their settlements on exploitative terms to the borrower. Such loans can lead to the borrower getting more into the cycle of poverty. This situation was reported by many participants who were affected by either too little or too much rainfall leading to lower yields and income insecurity. The study revealed a widespread inability among poor rural people to easily invest in their children's education. Most rural parents send their children to school, but sometimes they cannot keep them in school because of inadequate income from their livelihoods. This finding indicates one reason for the high rate of illiteracy in rural Sierra Leone. In the words of a 54-year-old resident in Rokel:

My father used to produce 100 bushels of rice from our two acre family swamp. I took over from him in the last twenty years, but have been experiencing decreases in crop yields. I can hardly produce over 40 bushels on the same swamp. This phenomenon is affecting negatively on my assets, now

I can neither invest easily in my children's education nor keep them in school right through the three terms. (Farmer, Rokel)

Most participants reported that the perceived warming effects caused by longer periods of dry weather and shorter rainfall periods put severe pressure on the limited freshwater resources. The study revealed an absence of functional pipe-borne water systems in all the settlements; therefore, residents reported that they relied on running streams, boreholes and water wells for their freshwater supply. On the one hand, the need for pure and freshwater supply for domestic uses (e.g. bathing, drinking, laundry, agriculture) puts more pressure on women and children, demanding more of their time and energy in accessing freshwater. This observation concurs with findings from the Strengthened Actions for Governance in Utilization of Natural Resources Program of CARE Nepal (Pathak and Bouare 2009). For example, this study revealed that it was common for women and girls to access clean water from places which were often 2 or 3 times further from their homes during periods of water shortage. Water scarcity may also encourage the spread of waterborne diseases like cholera, typhoid, dysentery and stomach upsets. Over 60% of respondents reported that these diseases are more common in the case study settlements during periods of water shortages. Participants also showed that the burden to care for the sick rests on women. Meanwhile, the role of rehabilitating households damaged, or sometimes completely destroyed, by storms is generally undertaken by men, but the effect of such disasters is considerably greater among women or in female-headed households where it adds significantly to their daily responsibilities as breadwinners and domestic workers. This study shows that men take the lead and sometimes the economic cost but in their absence, a damaged household further adds to the vulnerability of women (Pathak and Bouare 2009).

The facilitated group discussions revealed that the inability to meet household consumption requirements and a lack of money have provoked theft and social crimes in rural settlements. Cases of theft of food (local produce such as palm oil, seed rice, etc.), money, domesticated animals (e.g. goats, sheep, chickens) and other household properties were identified in the study. The desperate need to earn money exposes rural people to attacks by robbers and other social crimes such as fraud, frequent conflicts, defaulting repayment, debtors arraigned before local authorities or the police and absconding due to an inability to repay loans or debts.

The environmental impacts perceived by participants were mainly related to changes in temperature and precipitation. Participants identified features such as high temperatures, frequent storms, wild bush fires, increasing deforestation, stress on the use of natural resources leading to water scarcity and conflicts, insect pest infestation and seasonal flooding.

The study's findings showed that people now experience more months of dry season accompanied by hot days

of sunshine. These hitherto unusual conditions cause rapid evaporation of limited domestic water resources, water shortages and sicknesses associated with various air and waterborne diseases. According to a 40-year-old teacher in Mambolo Town:

Too much heat has caused our streams and water wells to dry out resulting in water scarcity especially between March and May, and at this same period cholera often hits the township. Children and women suffer most as they are responsible for fetching water for domestic uses. The warming makes us perspire a lot and causes us serious discomfort during the day time and in the night between 7 pm and 12 midnight. The common diseases that we suffer from at this time are malaria, diarrhoea, measles, tuberculosis, cough, itchy eyes and sore throat. (Teacher, Mambolo)

Participants reported serious scarcities of safe drinking water, especially during the months of January, February, March and April. During such dry periods, participants reported the drying up of running streams, rivers and water wells. Hence, the quality and quantity of water available for community uses become problematic. Scarcities of clean water are associated with outbreaks of diseases like cholera, typhoid, dysentery and stomach ache. In addition, conflict over the use of limited water sources was a common problem during periods of acute water shortages (see Ecosystems and Human Wellbeing 2005).

Storm disasters impact upon communities in many ways and have financial, social and other costs. Respondents gave a brief account of what used to be the normal time for storm incidents in their settlements. A unanimous response was that storms in the past typically occurred at the end of the rainy season, between mid-September and the end of October. In coastal settlements, participants revealed that around this period they used to experience a storm locally called '*Koliaboko*', which in the Temne language means, 'a destructive storm that clears and takes away'. But nowadays storms occur much more frequently, with serious damage at any time during the rainy season.

Some of the costs of storm disasters identified by respondents were explained. First, financial cost is incurred by households when a storm strikes houses which then have to be repaired, which in turn puts pressure on often very limited resources. Second, there is social cost through the loss of lives. For example, a 60-year-old resident of Kapesseh Section in Mambolo, reflected on the year 2000, when four of his family members, including his 20-year-old son, drowned during a sudden storm that engulfed them while trying to return to Kapesseh in the late evening from their rice swamps across the Great Scarcies River.

Storm disasters lead victims to use their meagre financial resources, which can have social implications such as a reduction in the quantity and quality of domestic food consumption. Reducing the frequency and quantity of family meals can lead to serious health problems, especially among children, breastfeeding and pregnant women and the elderly. In some cases after storm destruction it was

reported that families have to live in just one or two rooms until they can afford to repair the whole house.

Severe storms can also inflict considerable damage on valuable economic trees such as mango, orange, coconut, banana and others like kola nuts and oil palm. Such trees provide valuable food and income for many households, and the trees often take several years to recover from the damage and become productive once again. A further impact of severe storms is that people who are affected often become traumatised, fear not having enough food to eat, as well as being concerned about the loss of important possessions such as their homes, clothing, other household items and economic trees.

This study revealed that rural people's practices lead to a loss of natural vegetation as a result of the indiscriminate felling of trees for farming, logging, mining, settlement expansion, extensive burning of charcoal and cutting of trees for firewood. This loss of forest cover from around settlements has exposed dwellings to a greater impact from storms.

Most wildfires are reported to be caused by either passers-by or by the burning of household farms for crop production with no fire belts or other control measures. To address this problem, laws and penalties were instituted in Gbane Chiefdom. For example, in Gandorhun, participants revealed that food preparation in the community takes place before 8 am or after 2 pm, when no heavy wind is blowing. Domestic cooking usually is between 3:30 pm and 4:00 pm. In addition, people are not allowed to smoke fish or meat in close proximity to dwelling houses, and children are not allowed to play with fire, particularly during the dry season. All these precautionary measures or laws are observed to reduce the risk of causing wildfires, since houses are mainly thatched. Local penalties for causing wildfires are enforced by the chiefdom authorities. Respondents reported that with the irregular rainfall patterns and higher temperatures there were now more insects in the villages, notably biting insects like mosquitoes and grasshoppers.

Flood events were experienced in coastal settlements in Kambia District, Rokel, Mambolo and Rokupr, particularly in locations close to the Great Scarcies River. Outside these settlements, flooding was reported by farmers cultivating mangrove swamps around the settlements. This led to the rotting of transplanted rice seedlings leading to reduced rice yields (see Action Aid International 2006). It was revealed that when rains start early and become severe between June and August, flooding takes place along the shore areas and in the tidal mangrove swamps around these coastal settlements. At such time the volume of river water flowing into the sea is high, leading to the flooding of houses close to the shore. Farmers commonly transplant their rice seedlings from upland nurseries to their mangrove swamps in mid-July, and newly transplanted rice seedlings are increasingly rotting because of floods and silt deposited in the cultivated swamps.

Flooding is now more common during the months of August and September, and in addition to the destruction

of infrastructure, the floods perpetuate poverty since no form of profitable economic activity can be undertaken at this time. Artisanal diamond and gold mining, farming and petty trading either come to a complete standstill or become seriously constrained. At the same time, clean water for domestic uses often becomes contaminated leading to water shortages, waterborne diseases and mosquito infestation.

Adaptation is 'the adjustment of natural and human systems in response to the actual or expected climate stimuli or effects in order to moderate harm or exploit beneficial opportunities'. In addition, Zakieldein in his vulnerability assessment to climate change for Sudan maintains that 'adaptation involves individuals or households changing processes or practices either automatically or in a planned way' (Zakieldein 2009, p. 4). This section seeks to answer the research question: What are the local adaptation mechanisms in response to changing weather conditions in rural Sierra Leone? Traditional knowledge is particularly important in adapting livelihood strategies to changing weather patterns (United Nations Framework Convention on Climate Change Secretariat 2006a, 2006b, 2007a, 2007b). The study identified two categories of local adaptation mechanisms that residents use to build their resilience and these were social and environmental coping strategies. It, however, conforms with the findings of Oriandi and Zakieldein (2006) and that of Zakieldein (2009) which showed that adaptation depends on access to assets such as human, social and natural resources (Oriandi and Zakieldein 2006; Zakieldein 2009, p. 4).

### *Socio-economic impacts and coping strategies*

The study revealed that in the face of increasing livelihood insecurity rural people use a number of different coping strategies which will be discussed in the following section.

Some respondents reported their belief in God and on an expectation of God's intervention. For example, one 50-year-old farmer in Mambolo explained:

I am doing all in my ability to cultivate my farm, rear my goats and sheep and encourage my family to work hard, grow crops in our gardens and raise a few chickens. If from all these activities my household does not receive enough income and food to meet our daily consumption and other financial needs for a decent living, then I leave that for God to intervene. (Farmer, Mambolo)

In some households, husbands migrated for paid work when crop failure hits them, as a member of the Mother's Club in Rokupr commented:

Each year that my husband is unable to produce enough yields from his farm for daily consumption and other needs of the family, he is forced to travel to Yeliboya Island in Samu Chiefdom, Kambia District for a paid job in the artisanal fishing sector. He sends money from his wage to support the family. Sadly, even the option to migrate for work has not been favourable over the past five years because of declining fish catches. (Participant, Mother's Club, Rokupr)



One of the most significant findings from the study is the dependence that rural people have on social networks to cope with the impact of erratic weather patterns. When livelihoods are insecure people often take loans to meet household consumption needs. Another common, but unfortunate, strategy is that families may withdraw their children from school in times of food and money shortages (Eriksen et al. 2011). Another common coping mechanism is that affected households can depend heavily on remittances in cash or in kind from extended family members.

Even without such impacts, children and relatives living elsewhere are traditionally expected to reciprocate the assistance made to them by their parents and other family members in rural areas. The study showed that this option is often used to source support from relatives who are better off, and in some cases these relatives may adopt their children or link them to foster parents. Another strategy used in difficult times is that some respondents raise livestock such as goats, sheep, chicken and pigs for food or alternatively to sell and earn money. Lastly, food shortages are addressed by rationing household food intake and eating just one square meal a day, usually at or before 8:00 pm.

In the case of low-income households with limited skills, some participants mentioned that cutting wood for sale can provide valuable income. However, participants in Gandorhun and Yardu acknowledged that this was not a solution to reversing the changes in weather patterns.

About 45% of the participants are males and Muslims, and they reported that despite religious conventions, their wives are using birth control methods to space and reduce the chances of giving birth to too many children. These participants are aware that large family size adds to the pressure on household resources. Hence, they acknowledged the use of family planning measures provided by Marie Stopes, a local non-governmental health organisation which they say is targeting 35% of the population in Rokupr town. The users of birth control measures expressed a wish that the family planning programme would be expanded to cover the entire town, as well as targeting youths both in and out of local schools.

In the coastal swamps of Mambolo Town, Rokel and Rokupr, residents have in recent years reverted to growing improved high yielding and local short rice varieties maturing in 90 days in mangroves and inland valley swamps. The improved crops which were reported to be grown on swamps are the 'New Rice for Africa' and 'Research on Knowledge Systems' breeds and also resistant rice varieties known locally as 'Buttercup' and 'Pa Thédéh'. On upland farms, drought-resistant varieties of crops such as millet, cassava and sorghum are grown. Both crops grown in swamps and on uplands are cultivated alongside the usual long maturing varieties of rice in mangrove swamps. The strategy of growing multiple crops provides households with food security and some income to cope with the problem of low yields. Additionally, cassava tubers are locally processed into gari and fofoo,

which are used for consumption during periods of food scarcity.

Participants also reported selling their assets during times of household food scarcity. Assets owned by both men and women are often sold at low prices during times of stress. According to a 54-year-old female resident of Mambolo, she believed that women feel the greatest impact of such asset sales because they have often worked hard to acquire them. She added that 'most of these assets are useful for daily household chores, and *the worst thing is that not even her gold bracelets, earrings, necklaces, dresses, pots and bowls, are left, since all have been sold and/or exchanged for food*' (54-year-old female resident, Mambolo).

In dealing with prostitution, local coping measures have involved creating skills training centres for youths, especially young girls on a cost recovery basis. In the words of a 38-year-old woman who is the proprietor of the Mamaro Tailoring Centre in Mambolo:

Most young girls and women engage in prostitution because of not having skills or an educational background for self reliance. The Mamaro Tailoring Centre is here to empower youths, especially young girls, to be expert seamstresses for self reliance. (Tailoring Centre Proprietor, Mambolo)

Most parents use counselling measures to advise their daughters from age 12 and above and threaten to impose sanctions on those who engage in prostitution. Most parents subscribed to taking the man to the Family Support Unit, a department of the National Police Force with the authority to deal with family issues, and start court action for alleged sexual offences on their daughters.

### ***Environmental impacts and coping strategies***

The field-based survey revealed that people believed that changes in temperature and precipitation have altered the natural environment, causing it to unleash severe weather events in rural environments. In the face of these events, people have adopted a range of measures to ensure household survival.

Participants realised the need to responsibly manage the natural environment. Forests are mainly destroyed by farmers and miners, as well as illicit loggers using power saws, resulting in deforestation and loss of biodiversity. Local measures introduced to control deforestation include community tree planting and community forest management sensitisation. There is a new desire by locals to be empowered by central authority to criminalise the indiscriminate use of power saws and to restrain the issuance of licenses to power saw users. Local participants indicated the significance of community forest management taskforce groups whose aim is to conserve the forests and spread best practices.

The study revealed the use of several coping measures adopted by rural households. First, doors and windows of dwelling houses are often left open in the late evenings for

the breeze to blow away the heat trapped inside. In addition, people said that they used manual fans locally made from hardcovers, cards or plastic to improvise in the absence of electricity and electric fans. These simple manually operated devices help to cool the body by removing heat and sweat, especially when the house gets so hot. Other measures include growing trees around houses, sitting under shade during the day and in the evening sitting outside for several hours before going to bed.

Measures to cope with water shortages include increasing the depth of wells, sourcing water from new areas for domestic use and walking long distances to access freshwater sources. Water accessed through these sources often contains sediment particles and must be allowed to settle before being filtered and boiled to make it suitable for cooking and drinking.

In addition to local coping strategies, this study indicated that rural people's resilience could be strengthened by proactive interventions of government and development organisations. First, rural settlements like Mambolo, Rokupr, Yardu and many others with relics of pipe-borne water supply facilities need to be urgently rehabilitated. There is also a need for more hand pump facilities with regular chlorine treatment and more community sensitisation about the importance of having safe drinking water. Water and sanitation projects with funding from the carbon credit scheme should be introduced sustainably as a way forward.

Water shortages and increases in temperatures have direct links with deforestation caused by the pressure of people on the forest environment. In order to ensure sustainable community water supplies and possibly reverse temperatures, the study identified that local people need to be supported through reforestation programmes. The dependence on firewood and the traditional three-stone fire for domestic food preparation should be discouraged; direct subsidies should be made available to provide alternative energy sources for domestic use. In this regard, the study identified the need to establish local projects to support biogas use and to encourage farmers' groups to grow crops for biofuel production – but not to the detriment of food crop production. In addition, help is needed to provide incentives to encourage biogas manufacturers to produce effective and affordable domestic biogas plants.

Local strategies used by rural people to prevent or cope with wildfires include sensitising their communities about wildfire disaster prevention; discouraging farming close to settlements; building fire belts around brushed farms; putting sandbags around houses to prevent fire from burning houses; and encouraging residents to keep reserve water supplies in their homes in case of a fire emergency. However, findings show that the last two measures were only common in two of the settlements, Yardu and Gandorhun in Kono District. Government, Non-Governmental Organizations (NGOs) and development agencies need to build upon local adaptation measures by conducting regular radio and community sensitisation programmes in local languages; supporting the establishment

of local wildfire disaster prevention and management committees; and local level enforcement of laws, with stiff penalties for defaulters.

### *External support needed to cope with the impact of weather changes*

On discussing the external interventions that rural people need in order to better cope with weather changes, a number of concerns were raised. There is a need for sustainable adaptation intervention, as argued by Eriksen and O'Brien (2007) in their analysis of poverty and vulnerability to climate change. Sustainable adaptation hinges on reducing risks and vulnerability and strengthening adaptive capacity among poor households (see Eriksen and O'Brien 2007, p. 342; United Nations Framework Convention on Climate Change Secretariat 2007b). Some possible interventions are discussed below.

### *Socio-economic impacts*

The negative socio-economic impacts of weather changes on rural people need attention beyond the scope of local capacity (Organisation for Economic Cooperation and Development 2003). In this respect, proactive and committed support should be provided to build rural people's capacity and strengthen local coping measures so that they are better placed to adapt to weather changes and their related problems (Salick and Byg 2007). In the first place, there should be the provision of social safety nets; social protection; and educational, agricultural and health programmes. Second, official mechanisms should be established by government and development partners to encourage and compensate rural people for mitigation activities, and this should incorporate comprehensive adaptation strategies such as impact assessment, monitoring, early warning systems and effective land-use planning. Finally, there is a need to provide adequate public and private investment in infrastructure and natural resource development and small and medium-sized enterprises (SMEs) development in rural areas (World Bank 2007).

### *Environmental impacts*

External intervention identified by local communities should be integrated with the outlined local measures to cope or adapt with the tripartite effects of temperature warming, water shortages and deforestation and to establish conservation programmes in forests and protected areas (see Eriksen et al. 2011, p. 13). External assistance should be directed towards building the capacity of local communities in rural Sierra Leone to better manage community forests; to organise sustainable tree planting exercises in deforested areas; and to maintain a green environment within settlements (see de Haen 2007).

The conservation of natural resources should form part of the rural development activities for the common good of

especially vulnerable households. Respondents identified possible measures such as carbon credit payment benefits, capacity building, effective land use, rural smallholder agriculture, social protection and service investments, pro-poor policies and other best practices.

In the case of flood events in their settlements, participants emphasised the need for the central and local governments to collaborate with development agencies to accelerate the ongoing construction of roads, drainage infrastructure and bridges. This support can go a long way in reducing the loss of property like household goods, livestock and crops and will address the constraints faced by many rural people in moving about during the rainy season.

### Conclusion and recommendations

The testimonies from rural people in the five selected settlements indicate that perceived weather changes have direct and sometimes serious effects on their households, livelihoods and environments. These are summarised in Table 1. There are a number of impacts, but they can be broadly categorised as 'socio-economic' and 'environmental'. This indicates that although the scientific understanding of the causes of weather changes in rural Sierra Leone is limited, however, there is a considerable knowledge about the impacts.

The need for stakeholder involvement and collective natural resource management is important in charting a way forward. The facilitated group discussions indicate that in addition to the collective knowledge of the impacts of weather pattern changes, there are also local practices that could be effective in responding to possible weather changes. These are summarised in Table 2 under the categories of socio-economic and environmental impacts, as in Table 1.

This study of five rural settlements in Sierra Leone has revealed a widespread awareness of changes in weather

patterns among community members, and an impressive range of adaptive coping strategies which are already in place. Working through community structures there is a need for future strategies to eradicate practices which are harmful to the natural forest environment, for example, the indiscriminate cutting of trees for timber and fuelwood in search of much needed income. This practice should be discouraged and replaced by environmentally friendly measures. Examples include: access to sustainable small and middle-income enterprises (SMEs); skills for self-reliance; creation of opportunities for environmentally friendly and efficient rural livelihoods; and accessible and affordable use of gas for domestic cooking in rural areas. From an organisational point of view, coping measures should concentrate on strengthening social networks. For example, rural people are able to cope by lending their collective support to victims of weather disasters through cash and in-kind assistance such as remittances, food and material donations from community members and extended family relatives and friends. Respondents have shown that collective actions towards addressing disasters caused by environmental changes can have both immediate and lasting relevance for victims.

There is a need for pro-poor policy reforms backed with affirmative action to enforce and regulate the natural environment in rural areas. Central government should work with rural communities to design and strengthen collaborative mechanisms to be implemented under the recently introduced local government decentralisation process enacted by an Act of Parliament in March 2004 (The Local Government Act 2004). Such an initiative must be made to address the rural land tenure systems through securing access and ownership rights, especially for the rural poor. There is a need to consider reforming local landowning policies by possibly shifting custodian rights from local chiefs towards community and family ownership rights. There is a need to criminalise

Table 1. Perceptions of weather changes: identified local impacts in rural Sierra Leone.

#### *Identified impacts of weather changes*

##### *(a) Socio-economic*

- Greater insecurity of rural livelihoods compounded by the effects of low yields, food scarcity, income insecurity, borrowing or taking exploitative loans, withdrawal of children from school, migration to urban centres and prostitution
- Gender and household burdens such as putting more pressure on the time of women and children, especially girls, in accessing freshwater for domestic uses; spread of waterborne diseases puts an additional burden on women to care for the sick, and a house damaged by a storm is the responsibility of the husband to rehabilitate but in the absence of the man or in female-headed households, it increases the vulnerability of women (the house owner)

- Increase in theft and crime

##### *(b) Environmental*

- Too much heat or warming, delay in the onset of the rains
- Water shortages and conflict over use of limited natural resources
- Severe storms
- Increased deforestation
- Wild bush fires
- More frequent insect pest attacks
- Seasonal flooding leading to the rotting of rice seedlings on tidal mangrove swamps and corresponding low yield; flood events on areas close to the Great Scarcies in the coastal settlements resulting in the destruction of infrastructure; contamination of domestic sources of water; spread of waterborne diseases; and mosquito infestation. These impacts can exacerbate poverty because of their direct negative effect on the livelihoods (farming, mining) of rural people

Table 2. Perceptions of weather changes: identified coping strategies in rural Sierra Leone.

*Identified coping mechanisms**(a) On socio-economic impacts*

- Believing in God for intervention
- Husbands migrate from the village to the city in search of wage labour
- Social network options such as taking loans, receiving cash or in-kind remittances (reciprocal assistance) from extended family members and adoption of their children
- Increasing production of wood and charcoal for sale and domestic uses
- Accepting and practising family planning which was regarded as a strategy that reduces the effects of weather changes which were locally believed to be compounded by a large family size
- The use of improved and drought-resistant varieties of crops
- Selling acquired household assets such as farm equipments (hoes, cutlasses), dresses, gold bracelets, earrings, necklaces, pots and bowls; sold to buy food or exchanged for food
- Skills training for youths, counselling and legal actions assist affected youths with expertise in skills for self-reliance, equipping them to use those skills as a fallback position rather than engaging in petty crimes and prostitution. Parents use counselling and threaten to impose sanctions to control prostitution, while serious alleged sexual offences on girls are reported to the Sierra Leone Police Force (Family Support Unit) for legal actions

*(b) On environmental impacts*

- Community reforestation and community-based natural environment management
- The use of a range of options to cope with increased temperatures and water shortages such as leaving doors and windows of dwelling houses open in the late evening to blow away the heat, the use of locally made manual fans and sitting outside under shade. For water shortages, measures include increasing the depth of water wells; sourcing water from new areas and boiling it before drinking; and the need for external proactive interventions through rehabilitation of existing or provision of new, pipe-borne water supply facilities
- Disaster preparedness responses to cope with wildfires such as community wildfire disaster prevention; sensitisation and management; encouraging residents to keep reserve water supplies in their homes in case of fire emergency; and enforcement of fire prevention laws with stiff penalties for defaulters

Source: Our fieldwork.

indiscriminate economic logging and provide alternatives for collective benefits, such that community forest reserves within and around settlements are protected. It may be possible to create an opportunity for carbon credit conservation projects with collective community benefits and to strengthen effective local coping mechanisms which can deal with the realities of changing weather patterns in rural settlements.

### Acknowledgements

This article is the result of stakeholder consultation under the Climate Change Project for Sierra Leone. We are grateful to both the United Nations Development Programme (UNDP) and Government of Sierra Leone for funding this exercise under the Second National Communications, after successful completion of the National Adaptation Programme of Action and the First National Communications. We thank the project director and coordinator for their support in undertaking this study. We are grateful for the contributions made by all participants, especially those who gave us their time to discuss the nature and impact of weather changes in their communities. Our appreciation also goes to the Royal Tropical Institute (KIT) for training given to the resident author on 'article writing for publication'.

### References

- Action Aid International. 2006. Climate change and smallholder farmers in Malawi – understanding poor people's experiences in climate change adaptation [Internet]. A report by Action Aid International, October 2006. Books for Change. London (UK): Action Aid International. [cited 2011 Oct 11]. p. 1–7. Available from: <http://www.reliefweb.int/node/23267>
- Barrios S, Bertinelli L, Strobl E. 2006. Climatic change and rural–urban migration: the case of Sub-Saharan Africa. *J Urban Econ.* 60(3):357–371.
- Boko M, Niang I, Nyong A, Vogel C, Githeko A, Medany M, Osman-Elasha B, Tabo R, Yanda P. 2007. Africa. In: Parry M, Canziani O, Palutikof J, van der Linden P, Hanson C, editors. *Climate change 2007: impacts, adaptation and vulnerability: Working Group II contribution to the fourth assessment report of the intergovernmental panel on climate change.* Cambridge (UK): Cambridge University Press. p. 433–467.
- Chappell A, Agnew CT. 2004. Modelling climate change in West African Sahel rainfall (1931–90) as an artifact of changing station locations. *Int J Climat.* 24(5):547–554.
- Conradson D. 2005. Focus groups. In: Flowerdew R, Martin D, editors. *Methods in human geography: a guide for students doing a research project.* London (UK): Pearson. p. 128–143.
- Dai A, Lamb PJ, Trenberth KE, Hulme M, Jones PD, Xie P. 2004. The recent Sahel drought is real. *Int J Climat.* 24(11):1323–1331.
- de Haen H. 2007. Climate change and rural development. A modified version of a key note address at the Second European Forum on Sustainable Rural Development; Berlin. p. 1–8.
- Desanker PV, Justice CO. 2001. Africa and global climate change: critical issues and suggestions for further research and integrated assessment modelling. *Climate Res.* 17(2):93–103.
- Dinar A, Hassan R, Mendelsohn R, Benhin J, Some' L, Ouedraogo M, Demele Y, Some B, Kambire F, Sangare S, et al. 2008. *Climate change and agriculture in Africa: impact assessment and adaptation strategies.* London (UK): Earthscan.
- Ecosystems and Human Wellbeing. 2005. *Millennium Ecosystem Assessment. Desertification synthesis.* Washington (DC): World Resources Institute.
- Eriksen S, Aldunce P, Bahinipati CS, Martins RD, Molefe JJ, Nhemachena C, O'Brien K, Olorunfemi F, Park J, Sygna L, et al. 2011. When not every response to climate change is a good one: identifying principles for sustainable adaptation. *Clim Dev* [Internet]. [cited 2011 Dec 11]; 3(1):7–20. Available from: <http://dx.doi.org/10.3763/cdev.2010.0060>



- Eriksen S, O'Brien K. 2007. Vulnerability, poverty and the need for sustainable adaptation measures. *Clim Pol.* 7(4): 337–352.
- Fischer G, Shah M, Tubiello F. 2005. Socio-economic and climate change impacts on agriculture: an integrated assessment, 1990–2080. Vienna (Austria): International Institute for Applied Systems Analysis (IIASA).
- [FAO] Food and Agriculture Organisation. 2007. Adaptation to climate change in agriculture, forestry and fisheries: perspective, framework and priorities. Rome (Italy): Food and Agriculture Organisation of United Nations.
- Gurung GB, Bhandari D. 2009. Integrated approach to climate change adaptation. *J Fores Livelihood* [Internet]. [cited 2012 Jul 9]; 8(1):90–99. Available from: [http://www.forestation.org/app/webroot/js/tinyMCE/editor/plugins/filemanager/files/images/stories/pdfs/journal\\_of\\_forest\\_and\\_livelihood/vol\\_8\\_1/13\\_Gurung\\_and\\_Bhandari.pdf](http://www.forestation.org/app/webroot/js/tinyMCE/editor/plugins/filemanager/files/images/stories/pdfs/journal_of_forest_and_livelihood/vol_8_1/13_Gurung_and_Bhandari.pdf).
- Hageback J, Sundberg J, Ostwald M, Chen D, Yun X, Knutsson P. 2005. Climate variability and land-use change in Danangou watershed, China – examples of small-scale farmers' adaptation. *Clim Change.* 72(1–2):189–212.
- Hope Sr, KR. 2009. Climate change and poverty in Africa. *Int J Sust Dev World Ecol.* 16(6):451–461.
- [IPCC] Intergovernmental Panel on Climate Change. 2007. Climate Change 2007: Synthesis Report. Contribution of Working Groups I, II and III to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change [Core Writing Team, Pachauri, R.K and Reisinger, A. (eds.)]. Geneva (Switzerland): Intergovernmental Panel on Climate Change. 104 p.
- Jianchu X, Shrestha A, Rameshananda Vaidya R, Eriksson M, Hewitt K. 2007. The melting Himalayas: regional challenges and local impacts of climate change on mountain ecosystems and livelihoods. Laxenberg (Austria): International Centre for Integrated Mountain Development. Technical Paper.
- The Local Government Act. 2004. Supplement to the Sierra Leone Gazette extraordinary. CXXXV(14):1–38.
- MaGrath J. 2010. The injustice of climate change: voices from Africa. *Local Environ.* 15(9–10):891–901.
- Malhi Y, Wright J. 2004. Spatial patterns and recent trends in the climate of tropical rainforest regions. *Philos Trans Royal Soc B. Bioll Sci.* 359(1443):311–329.
- Mendelsohn R, Dinar A, Dalfelt A. 2000. Climate change impact on African agriculture [Internet]. Available from: [http://www.cepa.co.za/climate\\_change/pdf/\(5-22-01\)afbrckgrnd-impact.pdf](http://www.cepa.co.za/climate_change/pdf/(5-22-01)afbrckgrnd-impact.pdf)
- Nicholson SE. 2001. Climatic and environmental change in Africa during the last two centuries. *Clim Res* [Internet]. [cited 2011 Oct 11];17(2):123–144. Available from: <http://www.int-res.com/abstracts/cr/v17/n2/p123-144/>
- Nyong A. 2009. Climate change impacts in the developing world: implications for sustainable development. In: Brainard L, Jones A, Purvis N, editors. Climate change and global poverty: a billion lives in the balance? Washington (DC): Brookings Institution Press. p. 43–64.
- [OECD] Organisation for Economic Cooperation and Development. 2003. Poverty and climate change: reducing the vulnerability of the poor through adaptation. 2003 Paris: organisation for economic cooperation and development [Internet]. [cited 2011 Dec 12]. Available from: <http://www.oecd.org/dataoecd/60/27/2502872.pdf>
- Oriandi VA, And Zakieldeen SA. 2006. Integrating adaptation to climate change in to development plans and policies in Sudan. Nairobi (Kenya): African Centre for Technology Studies (ACTS) (Ecopolity series 17).
- Pathak A, Bouare D. 2009. Climate change impacts on livelihoods of poor and vulnerable communities and biodiversity conservation: a case study in Banke, Bardia, Dhading and Rasuwa district of Nepal. Strengthened Actions for Governance in Utilization of Natural Resources (SAGUN) Program [Internet]. Kathmandu (Nepal): CARE Nepal. p. 1–55. Climate Changes Study Report; [cited 2011 Dec 12]. Available from: [http://www.careclimatechange.org/files/reports/Nepal\\_CC\\_Study.pdf](http://www.careclimatechange.org/files/reports/Nepal_CC_Study.pdf).
- Phiri M, Ibrahim G, Shaka Alex R. 2005. The impact of changing environmental conditions on vulnerable communities of the Shire valley, Southern Malawi, Lilongwe, Malawi [Internet]. In: Lee C, Schaaf T, editors. The future of drylands. Dordrecht (The Netherlands): Springer; Paris (France): United Nations Educational, Scientific and Cultural Organization (UNESCO). p. 545–559. [cited 2012 Jul 10]. Available from: [http://www.actionaid.org.uk/doc\\_lib/malawi\\_climate\\_change\\_report.pdf](http://www.actionaid.org.uk/doc_lib/malawi_climate_change_report.pdf)
- Salick J, Byg A, editors. 2007. Indigenous peoples and climate change [Internet]. Oxford (UK): Tyndall Centre for Climate Change Research; [cited 2011 Dec 12]. Available from: <http://www.tyndall.ac.uk/publications/indigenouspeoples.pdf>
- Schmidhuber J, Tubiello FN, 2007. Global food security and climate change. *Proc Natl Acad Sci USA* [Internet]. [cited 2011 Sep 10]; 104(50):19703–19708. Available from: [http://www.pnas.org\\_ogi\\_doi\\_10.1073\\_pnas.0701976104](http://www.pnas.org_ogi_doi_10.1073_pnas.0701976104)
- Thornton PK, Jones PG, Alagarswamy G, Andresen J. 2009. Spatial variation of crop yield response to climate change in East Africa. *Global Environ Chang.* 19(1):54–65.
- [UNFCCC] United Nations Framework Convention on Climate Change Secretariat. 2006a. Background paper – impacts, vulnerability and adaptation to climate change in Latin America [Internet]. Bonn (Germany): United Nations Framework Convention on Climate Change Secretariat; [cited 2011 Dec 12]. Available from: [http://unfccc.int/files/adaptation/adverse\\_effects\\_and\\_response\\_measures\\_art\\_48/application/pdf/200609\\_background\\_latin\\_american\\_wkshp.pdf](http://unfccc.int/files/adaptation/adverse_effects_and_response_measures_art_48/application/pdf/200609_background_latin_american_wkshp.pdf)
- [UNFCCC] United Nations Framework Convention on Climate Change Secretariat. 2006b. Background paper on impacts, vulnerability and adaptation to climate change in Africa [Internet]. Bonn (Germany): United Nations Framework Convention on Climate Change Secretariat; [cited 2011 Dec 12]. Available from: [http://unfccc.int/files/adaptation/adverse\\_effects\\_and\\_response\\_measures\\_art\\_48/application/pdf/200609\\_background\\_african\\_wkshp.pdf](http://unfccc.int/files/adaptation/adverse_effects_and_response_measures_art_48/application/pdf/200609_background_african_wkshp.pdf)
- [UNFCCC] United Nations Framework Convention on Climate Change Secretariat. 2007a. Vulnerability and adaptation to climate change in small island developing states – background paper for the expert meeting on adaptation for Small Island developing states [Internet]. Bonn (Germany): United Nations Framework Convention on Climate Change Secretariat; [cited 2011 Dec 12]. Available from: [http://unfccc.int/files/adaptation/adverse\\_effects\\_and\\_response\\_measures\\_art\\_48/application/pdf/200702\\_sids\\_adaptation\\_bg.pdf](http://unfccc.int/files/adaptation/adverse_effects_and_response_measures_art_48/application/pdf/200702_sids_adaptation_bg.pdf)
- [UNFCCC] United Nations Framework Convention on Climate Change Secretariat. 2007b. Climate change: impacts, vulnerabilities and adaptation in developing countries. Bonn (Germany): United Nations Framework Convention on Climate Change Secretariat.
- World Bank. 2007. World Development Report, 2007: development and the next generation [Internet]. [cited 2011 Oct 10]. Available from: <http://www.ctc-health.org.cn/file/enwdr2007.pdf>
- Zakieldeen SA. 2009. Adaptation to climate change: a vulnerability assessment for Sudan. London (UK): Sustainable Agriculture, Biodiversity and Livelihoods Programme (Gatekeeper series 142).