Environmental Variability and Vulnerable Livelihoods: Minimising Risks and Optimising Opportunities for Poverty Alleviation

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Abstract

Contributing to and providing links between environmental variability and adaptive livelihood strategies, household well-being and development policy, this paper presents an analysis that explores theoretical and policy debates on whether livelihood adaptations and emerging strategies within the context of current environmental change have received the required policy attention and intervention. Livelihood diversification as a poverty reduction strategy has been argued to result in improved well-being or perpetuates a cycle of impoverishment. The paper focuses on communities in vulnerable environments with limited well-being and poor assets. The study examines the changing livelihood strategies and livelihood options of households located within ecosystems perceived to be experiencing environmental change in Northeastern Ghana. On-farm and non-farm diversification and migration as livelihood strategies considered as survival strategies in environments experiencing rising temperatures and erratic rainfall patterns. It is argued that diversified livelihoods are operated within a cycle of impoverishment. The paper calls for geographically and locally sensitive policy intervention approaches that can sustainably expand the livelihood options of the poor in changing environments.

Key words: Sustainable livelihoods, environmental change, ecosystems, poverty, vulnerability, policy

1.0 Introduction

Humans are dependent upon the natural environment and ecosystems for their livelihoods. The dependence is more pronounced for the poor, as this is the primary source of materials required for their survival and livelihood security. Climate is one phenomenon that has played and continues to play a major role in shaping the environment that serves as a source of livelihood for man. The effects of its elements on man and the environment are so vital that it can hardly be ignored. Current environmental variability and consequent climate change is predicted to cause increasing global temperatures, changing weather, rising sea levels and more frequent and intense extreme weather events (IPCC, 2007). Africa is one of the most vulnerable continents to environment and climate variability change because of multiple stress and low adaptive capacity (IPCC WG II, 2007).

Considerable uncertainty surrounds long-term patterns of environmental variability and their likely impacts on the livelihood activities and options of the poor (Brown and Crawford, 2008). The predicted consequences of environmental variability and climate change are diverse (Stern, 2007). Amongst them, projections suggest that by the end of the 21st century, they will have substantial impact on agricultural production and consequently the scope of reducing poverty in sub Saharan Africa, where the majority of the population reside in rural areas and depend on smallholder agriculture for their livelihood (Slater *et al.* 2007). Environmental change emerging through the driver of climate change could inflict harsh and extreme environmental

conditions upon rural smallholder farmers and therefore has direct implications for creating unsustainable livelihoods and or reduce the livelihood options of poor farm households, especially within the agricultural and livestock sector (Brown and Crawford, 2008). Such a scenario could thereby exacerbate existing patterns of poverty and undermine policy attempts towards poverty alleviation and improvement in household well-being (Assan, 2008).

The prospects that research and policy will have time to respond to some impacts of environmental variability and emerging climate change in developing countries are presently unlikely, partly due to the absence of local empirical understanding and the absence of regional and national policy frameworks on the subject (Brown and Crawford, 2008). Arvai *et al.* (2006, p.217) argued that ñeffective policy responses to climate change impacts and anticipatory interventions aimed at enhancing the resilience of social and natural systems (adaptation) have been difficult to formulate and often based on educated guessesò. It is therefore urgent to understand the livelihood options available to the poor and how policy can be employed to sustain the livelihoods of those living in ecosystems experiencing environmental variability. The paper seeks to contribute to the growing empirical and policy discourse on environmental variability by examining its effects on rural livelihoods in vulnerable environments and ecosystems.

The paper presents empirical evidence to argue that climate change threatens to exacerbate rising temperatures with erratic and declining mean rainfall in northern parts of Ghana. This has important policy implications for sustainable livelihoods and requires systematic policy interventions. The paper is organised as follows. Section 2 reviews the effect of environmental variability and climate change on livelihoods of the poor and the role and impact of non-farm livelihood diversification as an adaptive strategy for household well-being. Section 3 describes the context, background and the systematic fieldwork strategy employed during the data collection process conducted as part of the study on which this paper is based. Section 4 presents discussion of empirical results from both quantitative and qualitative data generated by the study. Concluding remarks, policy implications and policy recommendations are found in section 5.

2 SUSTAINABLE LIVELIHOODS AND LIVELIHOOD OPTIONS FOR THE POOR

In his examination of poverty reduction options for smallholder farmers in vulnerable environments, Tschakert (2007) advocates for institutional and policy-restructuring necessary to enhance sustainable livelihoods and household resource management as possible avenues out of the predicted and prevailing vulnerability and impoverishment associated with their environment. A sustainable livelihood is described as comprising the capabilities, assets, and activities required for a means of living (Chambers and Conway 1992). In the context of the environment, a livelihood is considered sustainable when it can cope with and recover from shocks, and maintain or enhance its capabilities and assets, while not undermining the natural resource base (Jones and Carswell, 2004). Variability in climatic elements increases the vulnerability of rural livelihoods and reduces the ability of smallholder householdôs to deal with risks, shocks and stresses (Prowse, 2008). Prowse argues that the limited nature of assets of those in this category exposes them to further risk and lessens their ability to cope. Several households within this category are reported to employ non-farm diversification, on-farm diversification and migration as adaptive strategies (Ellis, 2000). It is important to understand how diversification could shape the sustainability of the livelihoods of vulnerable and marginal communities experiencing environmental variability.

Barrett *et al.* (2001, p.316) argued, ñnon-farm diversification activities positively correlated with income and wealth in rural Africa and thus seem to offer a pathway out of poverty if non-farm opportunities can be seizedò. Livelihood diversification, involving non-farm and off-farm activities have over recent years become an important poverty reduction and income generating strategy for peasants and rural small farm households especially in vulnerable and marginal environments throughout the developing world (Reardon, 1997; Ellis, 2000 and Bryceson, 2004).

Permanent and temporary migrations are becoming important parts of the livelihood strategies of the rural poor in residing in vulnerable environments. Deshingkar and Anderson (2004) suggest that these patterns are rising in many developing countries. Forces that influence these patterns of movement are location-specific and include environmental variability (Deshingkar (2004). The objective of such movement is often to improve household income sources and individual well-being (Assan, 2009). Both van der Geest (2003) and Deshingkar and Anderson (2004) argue that in south Asia and Africa, remittances from ruralï urban migrants are overtaking incomes from agriculture in sheer size and importance, as persistent socio-economic and structural problems continue to depress the levels of rural wages and work availability.

2.1 Environmental variability and rural livelihoods

The specific effect of environmental climate variability on the poor and vulnerable societies (especially in economies that are based primarily on agriculture) from a policy perspective is so crucial that one ignores it to his own peril (Drexhage et al, 2007). As a dynamic entity, climate varies across time and space thus making large areas of the earth, especially sub-humid, semi-arid and arid areas, experience severe uncertainty. Environmental variability and climate change occurs when there is any change in climatic elements and factors over time, whether due to natural variability or because of human activities (IPCC WG1, 2001, p.3). As a global phenomenon with peculiar characteristics, environmental variability and climate change involves complex interactions between climate, environment and economic, political, institutional, social, technological and policy processes and consistent with the framework convention on climate change.

According to the IPCC Plenary XXVII (2007) both natural ecosystems and human systems are extremely sensitive to variability in environmental factors but limited in their capacity to adapt. This article will thus concentrate on environmental climate variability, (rainfall and temperature) over Ghana and rural livelihoods. Of all the elements of climate, those commonly cited with tremendous impact on agriculture are rainfall and temperature.

According to the IPCC (2001, pp.5-6) the projected and potential impacts of climate change on environmental systems and geographical regions are diverse. It projects both beneficial (increased rainfall and potential increase in crop yields in parts of North America) but adverse impacts (general reduction in potential crop yields and increase in temperature) in most tropical and sub-tropical regions (Africa, Asia and Latin America). Nonetheless, climate change will affect land based rural livelihoods and its long-term nature makes it quite difficult to study its impact on agriculture (Brown and Crawford, 2008; IPCC WG II, 2001). This is particularly so in developing countries and in deprived sub-humid, semi-arid and arid regions in particular where agriculture is largely rainfed.

Dietz *et al* (2000, p.80) show that the most engaged in rain fed agriculture in dry and vulnerable environments and ecosystems would be confronted with intra-annual and inter-annual rainfall variability. Their relevance stems from the fact that they directly and indirectly affect the production of crops whenever they occur. Inter-annual variability makes the prediction of the rainfall pattern for a particular year difficult and sometimes impossible. Intra-annual variability adds to the problem by keeping farmers guessing as to when the rains are likely to start, how wet it will be, how long it will last and whether the rainy season will be interrupted by a dry spell. Moreover, dry spells occur at certain critical stages of crop production, for example, during germination, just after germination, tasselling and grain filling. Dry spells at these times can result in yield reduction or complete crop failure and subsequently making agricultural livelihoods unsustainable.

Hesselberb and Yaro (2006) reveal that climatic variability, especially rainfall fluctuations is a major constraint to agricultural livelihoods. This feature has a doubleedge impact in the context of low rainfall amounts and variable occurrence, both of which militate against sustainable agricultural productivity. They argued that adequate rainfall does not always translate into adequate moisture conditions for crop cultivation. A policy challenge in this regard is how to plan for peasant strategies in the area of production, exchange and claims to enhance their levels of entitlement (Yaro, 2004a). It is important to note that diversification per se does not lead to livelihood security as clearly indicate by Yaro (2006), as few profitable livelihood options exists for the several rural and peri-urban households whose livelihoods are directly affected by climatic variability.

Understanding the livelihood implications of environmental and climatic variability and the options that could be available to smallholder peasant farmers although has been identified as urgent, continues to be a challenge for policy experts and scientist (Yaro, 2002). This paper aims at contributing empirically to this policy gap by examining the livelihood options of poor farm households in Northern Ghana who are experiencing climactic/environmental variability and livelihood insecurity.

3.0 COUNTRY CONTEXT AND FIELDWORK STRATEGY

This study was carried out in Northeastern Ghana known administratively as the Upper East Region. The region falls within latitudes 78 and 128 N of the equator and longitudes 30W and 18E. It is located at the boundary with the Sudano-sahel region and thus experiences sub-humid and semi-arid climatic conditions in good rainfall years and poor rainfall years respectively. The region is amongst the poorest region in the country with a significant proportion of its residents living below the one dollar a day poverty line (GSS, 2000). The majority of the population of the region reside in rural areas and are engaged in agricultural and land based economic activities. The Upper East region is the driest part of the country with generally low rainfall amounts throughout the year (about 1000mm/yr on the average). The rainfall pattern of the region is unimodal and occurs between April-May and September-October with about 95% of precipitation occurring during this period. The mean number of rainy days is 73. The rainfall season is followed directly by a long dry season from October to April.

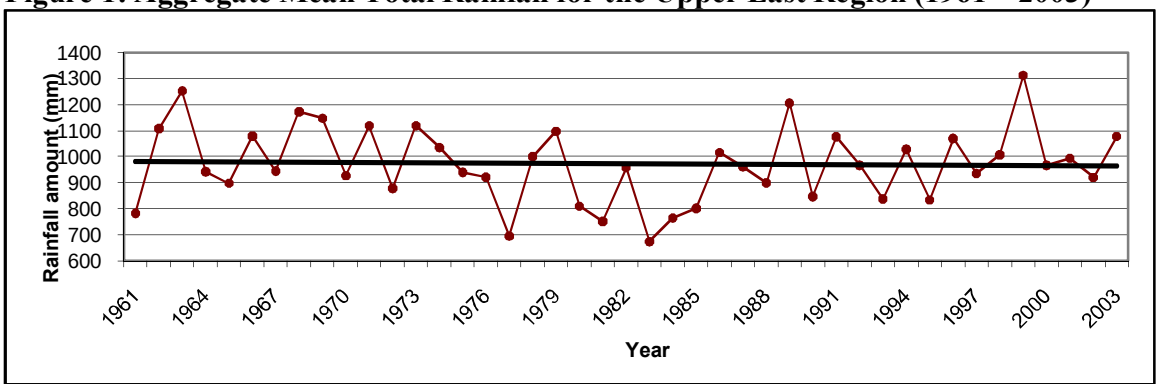
Two districts were selected in the region for this study, namely, Bongo and Bolgatanga Districts. Both primary and secondary sources of data were explored. The study triangulated primary qualitative data with secondary quantitative data. The primary quantitative data

employed household questionnaire survey involving 200 households. The qualitative data collections involved four focus group meetings and key informant interviews. Secondary quantitative data were collected on rainfall and temperature from the regional office of the Meteorological Services Agency. Rainfall and temperature data were obtained from three reliable weather stations in the region covering the period 1961 to 2003. The data were analysed separately for the three stations and then aggregated to present one scenario for the region. For this article, however, we have presented only the results of the analysed aggregate data for rainfall and temperature. In order to highlight climate projections over Northern Ghana for the 21st century, the coupled model integrations performed for the fourth assessment report of the Intergovernmental Panel on Climate Change (IPCC) are examined. Twenty-one models are analysed for both the 20th (20c3m) and the 21st century projections respectively, based on the historical emissions as SRESA1B scenario integration.

4.0 RESULTS AND DISCUSSION

The aggregate mean total rainfall graph (Figure 1) depicts the very variable nature of rainfall in the region. The cycle of the fluctuation continued until 1999 when the region recorded the highest rainfall amount of 1312.5 mm for the whole period under discussion. Figure 1 shows a reduction in the mean total rainfall from 1961 to 1990, followed by a partial recovery during the 1990s. The distribution line starts from an amount of about 980 mm in 1961 to about 960 mm in 2003. The regional Ministry of Food and Agriculture (MoFA) has observed that the minimum amount of rainfall required for crop production is 950 mm. Amounts less than this figure present risk situations for the region. Using the 950 mm as the basis for determining risky years in the area, the analysis revealed that there has been 20 years of risky crop production years over a period of 42 years. An erratic pattern in rainfall and a decline in total mean annual rainfall for the region could adversely affect crop cultivation.

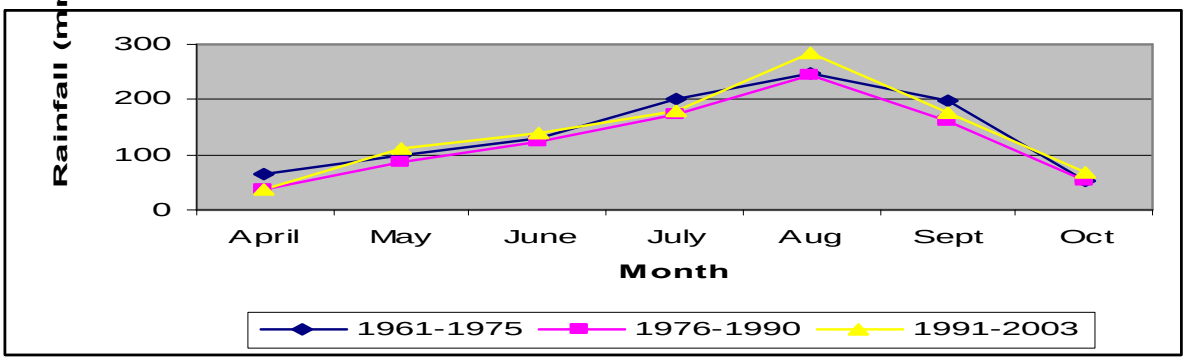
Figure 1: Aggregate Mean Total Rainfall for the Upper East Region (1961 – 2003)



Source: Meteorological Services Agency, Bolgatanga, Ghana

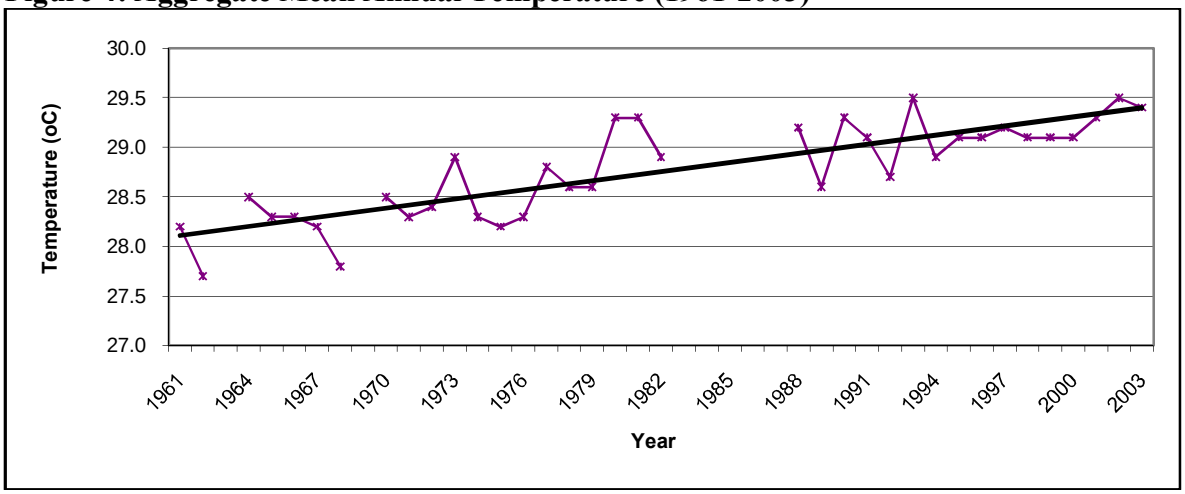
It is evident from Figure 2 that rainfall amounts/spread during the rainy season have declined over the decades in the area. This has implications for available soil moisture for crop roduction, as crops are sensitive soil moisture for growth and attaining optimal yield. The detailed escription of the models set-up is available at www-pcmdi.llnl.gov/ipcc/model_documentation/ipcc_model_documentation.php.

Figure 2: Fifteen year mean monthly rainfall amounts (1961-1975; 1976-1990; 1991-2003)



Source: Meteorological Services Agency, Bolgatanga, Ghana

Figure 4: Aggregate Mean Annual Temperature (1961-2003)



Source: Meteorological Services Agency, Bolgatanga, Ghana

Another element of climate of vital importance to agriculture and rural livelihoods is temperature. Figure 4 shows variability in the temperature of the area. The general trend suggests a gradual increase in the aggregate mean annual temperature from 1961 to 2003. From a low of 27.6^{o}C in 1962, temperatures have increased to 29.5^{o}C in 2002. This shows an increase of 1.9^{o}C. The effect of rising temperatures on agriculture is enormous. Increases in temperature lead to increases in evaporation and evapotranspiration rates and these together reduce soil moisture. Table 1 shows a rise in mean annual temperature, evaporation and evapotranspiration for three periods within 1931 and 2003 for Navrongo in the Upper East region.

Table 1: Temperature and calculated monthly evaporation and evapotranspiration, Navrongo: 1931-1960 (1), 1961-1990 (2) and 1991-2003 (3)

	1931-1960	1961-1990	1991-2003

Month	T (1) ºC	E (1) mms	ETP (1) mms	T (2) ºC	E (2) mms	ETP (2) mms	T (3) ºC	E (3) mms	ETP (3) mms
Year	28.3	2712	2170	28.7	2752	2202	28.6	2746	2197

Source: Temperature values from the Meteorological Services Agency, Bolgatanga, Ghana

There is clear decrease in rainfall amounts over the periods under comparison. Whilst 1931-1960 recorded a mean total rainfall of 1100 mm, 1961-1990 and 1991-2003 recorded 986 mm and 980 mm respectively (Figure 5). Between 1931-1960 and 1991-2003, there was a decrease of 20.5 mm in rainfall. P/ETP is generally defined as the degree of aridity of the soil (sometimes referred to as aridity index), the smaller the P/ETP the drier the environment. This ratio is used in order to determine whether the northern part of Ghana experienced a significant change in terms of soil properties during the twentieth century. The P/ETP reduced from 0.51 during 1931-1960 to 0.45 for 1961-1990 and 1991-2003, an indication of less soil moisture available for crop utilisation (Figure 5). This decrease is also well pronounced during the wettest month of the rainy season (July-September). The reduction in yearly mean P/EPT values (0.51 ï 0.45) imply that the area is gradually changing from a sub-humid climate to a semi-arid climate.

Figure 5: Rainfall and P/ETP change in Navrongo: 1931-1960, 1960-1990 and 1991-2003 compared. Source: Meteorological Services Agency, Bolgatanga, Ghana.

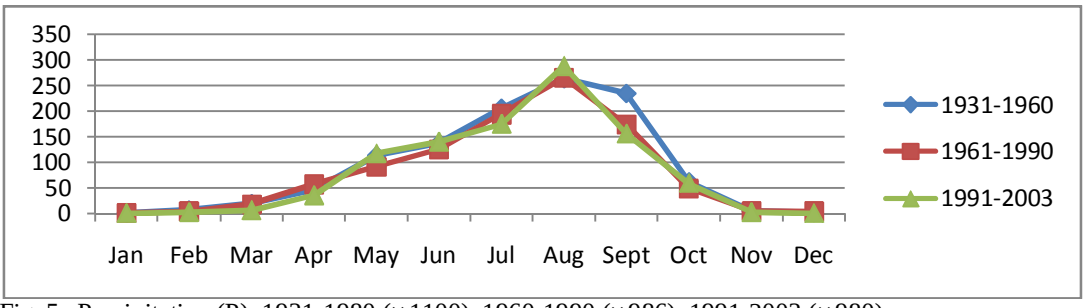


Fig. 5a Precipitation (P): 1931-1980 (×1100), 1960-1990 (×986), 1991-2003 (×980)

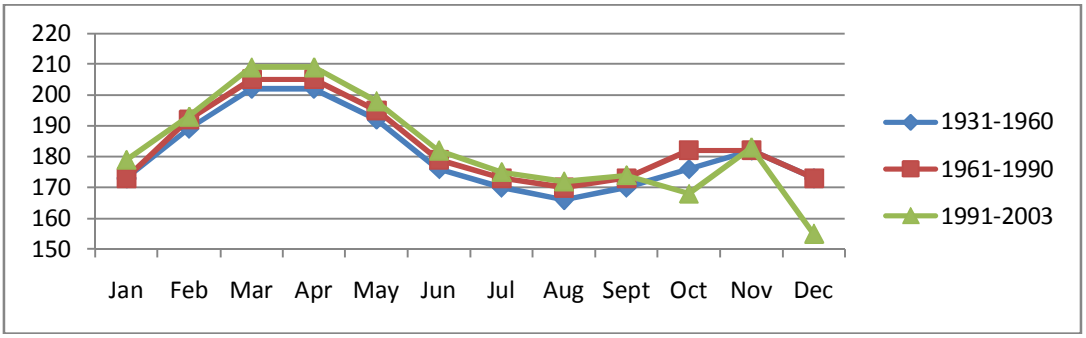


Fig. 5b Evapotranspiration (ETP): 1931-1960 (×2170), 1961-1990 (×2202), 1991-2003 (×2197)

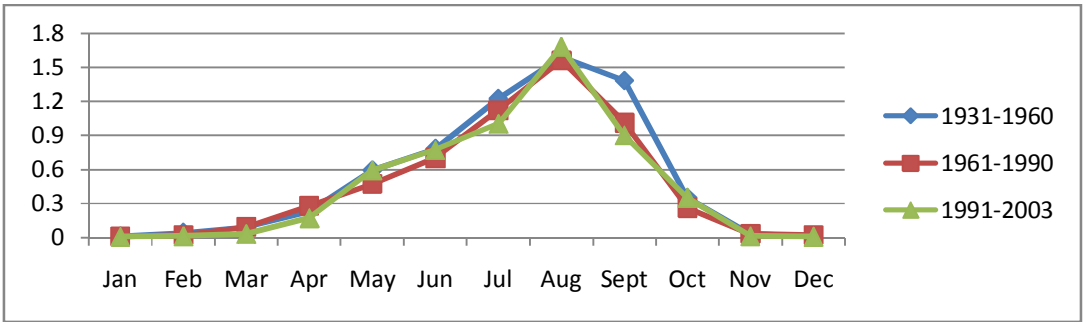


Fig. 5c Potential Evapotranspiration (P/ETP): 1931-1960 (×0.51), 1961-1990 (×0.45), 1991-2003 (×0.45)

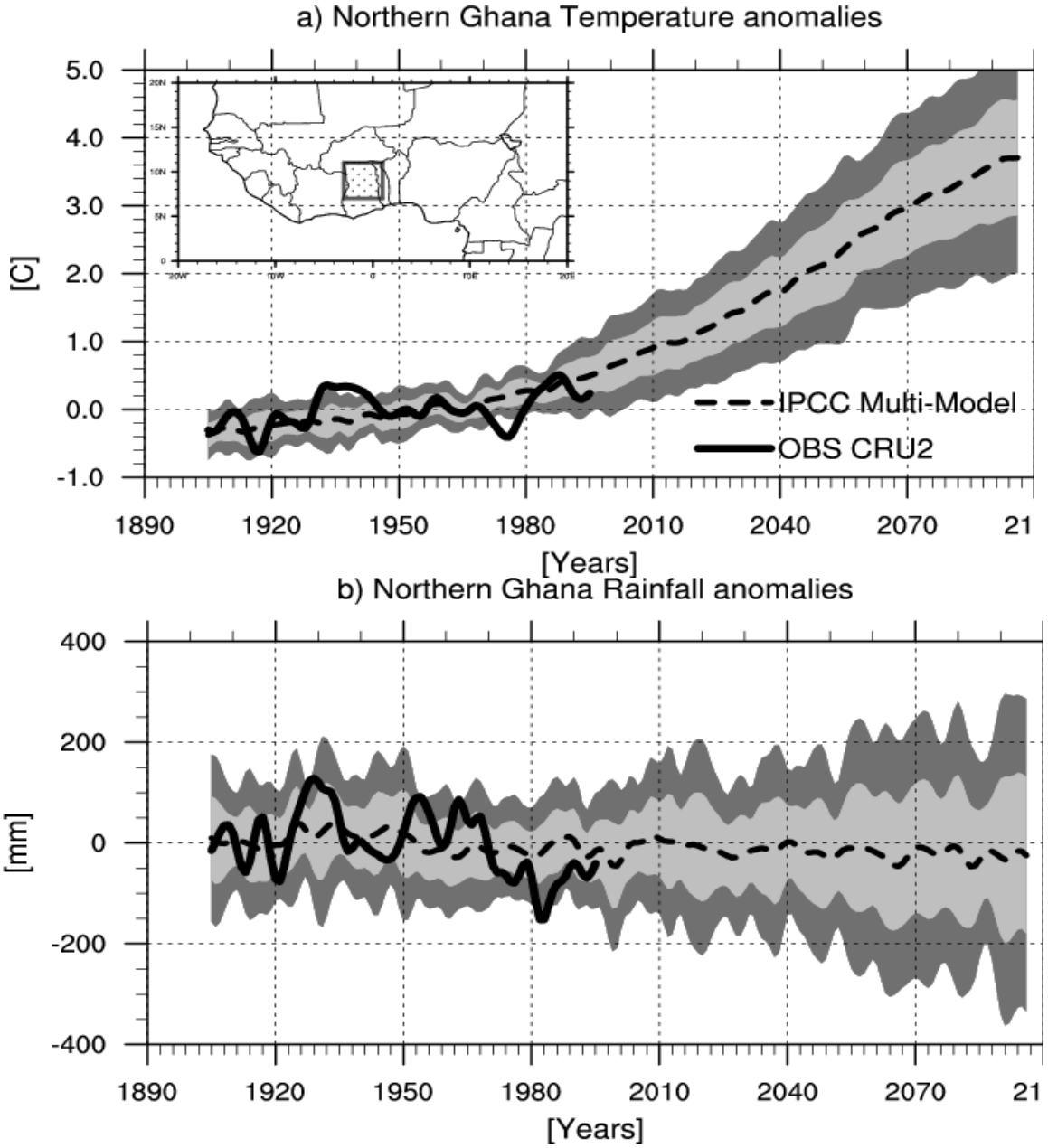
Dietz et al (2004) found out that an increase in temperature by one to two degrees on the average and a 20% decrease in rainfall will change the climate of the Upper East Region from sub-humid to semi-arid (P/ETP < 0.45). Born et al (2004) report of a predicted decrease in rainfall to an average level of 20-30 percent below the current levels and an increase in temperature and evapotranspiration in the western and central drylands of West Africa in the period until 2050.

The observed patterns lend more credence to the fact that available soil moisture for crop cultivation is reducing over the decades. Water deficit is on the increase even in the growing season. Ofori Sarpong (2001) contends that climate change has affected rainfall, evaporation, and runoff and soil moisture storage in the Upper East Region. He states further that the region is a moisture deficit one where moisture stress during flowering, pollination and grain filling is harmful to most crops. As a result of the variability, erratic and declining rainfall amounts and rising temperature over the decades, the region is contending with annual intermittent droughts and floods. With a decrease in the number of rainy days in the region and an increase in temperature and evapotranspiration the region could be susceptible to droughts.

4.1 Future climate scenarios

Figure 4: Mean Annual a) Temperature and b) Rainfall anomalies for the 1901-1999 climatology over Northern Ghana.

The observed mean annual temperature over northern Ghana increases over the 20th century (Figure 6a). The warming is really pronounced over the 1980-2000 period.



Sources: Generated by authors (2008) from ensemble CRU (Climate Research Unit) observed dataset(Mitchell and Jones, 2005) and IPCC model outputs from the CMIP3 database. The gray envelope represents the multi-model range uncertainties.

However, the magnitude of warming is relatively small (by about 0.8°C) compared to previously highlighted results based on Ghana rainfall stations (almost 1.9°C trend). Nevertheless, all, the models simulate a warming trend over the 20th century with the simulated temperatures continuing to rise dramatically over the 21st century. The multi-model ensemble mean simulates a temperature increase of 2.5°C in 2050, the warming reaching 3.8°C in 2100. At the end of the 21st century, the multi model spread ranges between approximately 2°C and 5°C.

Conversely, the simulated rainfall dynamics over Northern Ghana shows a clear variability that widens over time (Figure 6b). This is relatively more consistent with Sahelian patterns. Indeed a wet period occurred from 1950-1970 contrasting with a period of desiccation from 1970 to 1990, followed by a partial recovery during the last decade of the 20th century. In fact, the multi model ensemble mean depicts rainfall anomalies and the uncertainties (spread depicted by the gray envelope) predicting wide variation which are rather large to conclude on a clear rainfall scenario for the future. This deduction also makes rural livelihoods more vulnerable as most farmers make decisions based on the behaviour of climatic elements like rainfall (Caminade et al, 2009). In addition, Giannini et al (2006) and Caminade et al (2009) discuss the failure of the state of the art climate models in reaching a robust agreement concerning the 21st outlook for rainfall patterns in West African. Furthermore, the physical mechanisms responsible for Sahelian rainfall changes (or more generally for monsoon systems) in warmer climates are complex and often counteract each other, leading to significant uncertainties for future rainfall scenarios (Giannini et al, 2006).

The impacts of such warming and erratic behaviour in rainfall on rural livelihoods could be enormous. Boko et al. (2007) argue that agricultural production and rural livelihoods including access to food in many African countries could be severely compromised if the appropriate livelihood options are not developed. Studies by Bates et al. (2008) for the IPCC VI on Climate and Water suggests that unless efficient adaptation policies and practices are implemented, agricultural and rural livelihoods could suffer a crop net revenue loss of up to 90 per cent by 2100 with small farm households being the most affected. The study therefore proceeded to conduct primary household livelihood analysis. We ascertained the perception of the sampled householdôs regarding observed climate variability and its implications for livelihood options and adaptation in the study area.

4.2 Climatic variability and livelihood adaptations for the poor

The qualitative data generated by the study provided evidence to confirm the increasingly erratic nature of the rainfall pattern in the area. In four different focus group discussions with the farmers of the sampled area, there was a consensus between both genders in all the different interviews and discussion groups that rainfall patterns have been erratic over the last three decades. These views are based on their local and indigenous knowledge. A female farmer argued, ótthe variability in rainfall pattern makes it increasingly difficult to plan land preparation and planting times as well as predicting the rainfall pattern for any year using our indigenous knowledge systemsô. A male farmer commented by saying ódroughts have become more frequent and severe and the rains start late now: late May or early June instead of April or early May and end in early September instead of late Octoberô. A male key informant explained during the individual interviews ófarmers are becoming increasingly uncertain as to when exactly the rainfall season will start to structure their farm managementô. These views are consistent with those of Ofori-Sarpong (2001) who found that the number of wet months for crop production in the region has reduced to 3.5 months, thus making farming more risky. The study also revealed that the observed erratic rainfall patterns and high temperatures have already resulted in livelihood insecurity and the sampled households have already employed strategies to adapt to the emerging climatic change.

4.2.1 Out Migration

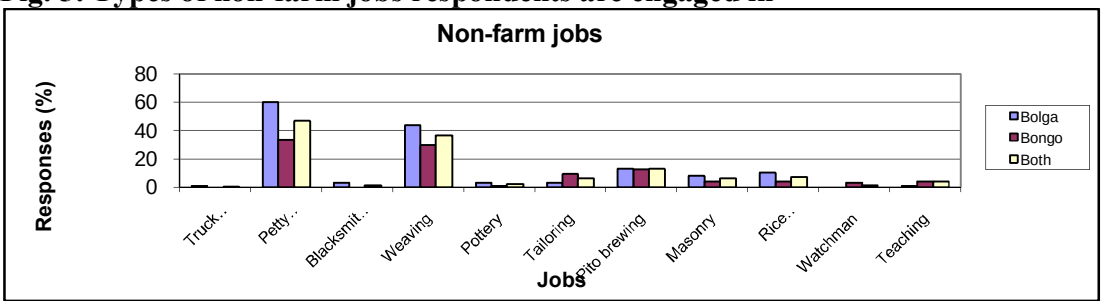
The households survey and key informant interviews revealed that several households are involved in migration and non-farm economic activities. The households and key informants interviews in Bongo and Bolgatanga confirmed the perception that the occurrence of drought increases migration. Key informant in Bongo explained that ón their attempt to avert the impacts of increasing high temperatures and erratic rainfall patterns, farm households in the study area have diversified their livelihoods to incorporate outmigration (mainly internal) and non-farm diversificationô. A strong inverse relationship between out-migration and rainfall was revealed by the household survey and focus group discussions. The survey showed that migration rates increased in years of low rainfall. A female respondent in Bolgataga revealed, óthe numbers of families who migrate during drought years are increasing. I did not use to migrate but my husband and I have migrated seasonally in the last two years due to the poor rains.

These observations are consistent with those of Waddington and Sabates-Wheeler (2003, p. 11) who found that in resourcepoor areas, out-migration might be the main livelihood option and income source towards improvement in well-being. They stated further that where rural dry land communities are faced with risky environments entire communities might follow circular migration routes. The perceived effect of drought on migration is very high (64.3% for Bolgatanga, 63.3% for Bongo and 63.8% for both areas). Out-migration is employed as a survival and adaptive strategy against the food scarcity hunger/famine associatedwith absence of adequate rainfall. The study also showed that more people migrate in drought years, and the year of first-outmigration for most of the respondents (58.9%) coincided with those recorded by the Ghana Metrological Service as severe drought years in the Upper East Region of Ghana (data from 1954 to 2003). This finding is consistent with those of Prah (1979),Webster (1979), Ezra and Gebre-Egziabher, (2001), Mensah-Bonsu (2003) and Deshingkar and Grimm (2004).

4.2.2 Non-farm economic activities

The study revealed a growing involvement in non-farm activities by the sampled households (Figure 7) The household survey showed that 54.9%, are engaged in non-farm economic activities. Petty trading is reported as the important non-farm economic activity in the study districts. Women dominate the trading enterprises and are more prominent in Bolgatanga than in Bongo.

Fig. 5: Types of non-farm jobs respondents are engaged in



Wares traded in include foodstuffs, cooked food and drinks, handicrafts, provisions, cooking utensils, fabrics, auto-parts and simple farm tools and implements. This livelihood option is also of particular importance during the off-farm season. Mulat and Regassa (1995) found that in Ethiopia (North Shewa) that trading and handicraft dominated the non-farm economy in vulnerable communities. It is worthy to note that females form the majority (60.3%) of the non-farm respondents. Gordon and Craig (ibid, p.9) also give many examples of non-farm activities undertaking by women in sub-Saharan Africa as beer brewing, fish processing, crochet, pottery, rice husking, groundnut shelling, preparation and sale of prepared foods and petty trading. This is largely because women tend to share the greater burden of managing the household economy in Ghana (Assan, 2008).

This survey also found out that farmers intensify their engagement in non-farm economic activities in years which record poor rainfall with 56% indicating that they undertake non-farm activitiesô in bad rainfall years. Poor rainfall often results in low crop thus, exposing the household to food insecurity (Yaro 2004a, 2002). To make up for the food deficit farmers resort to undertake non-farm economic activities to enable them generate some income to meet household and personal needs. Yaro (2006) also found an increase in participation in NFEA during years of low rainfall in the Upper West Region of Ghana

Table 2: Engagement in non-farm economic activities by gender and rainfall

Period of engagement	Participation in NFEA	% of respondents starting NFEA	Engagement in non-farm economic activities by gender	
	%	%	Male (%)	Female (%)
Good rainfall years	45.5	48.4	41.2	45.2
Poor rainfall years	54.5%	51.6	58.8	54.8
Total	100	100	100	100

Gender-specific engagement in non-farm economic activities is also noted to be higher in poor rainfall years (Table 2). For the males, engagement in non-farm activities increased from 41.2% in good rainfall years to 58.8% in poor rainfall years, an increase of 17.6%. The females recorded an increase of 9.6% between the good and poor rainfall years (45.2%) in good rainfall years to 54.8% in poor rainfall years). This implies that social roles could also vary with climate change and therefore require corresponding adaption strategies.

5.0 Conclusion:

Policy lessons towards minimising risks and optimising opportunities for Poverty Alleviation

The paper presents empirical to argue that climate and environmental variability threatens to exacerbate rising temperatures with erratic and declining mean rainfall in the Upper East Region of Ghana. Preliminary research into how past climate variability has influenced NFEA suggests greater household involvement in years of limited rainfall. It is apparent that the current and future climatic variability would influence existing livelihood strategies and available options. However, the ability of the NFEA to act as a coping strategy in years of limited rainfall may well be limited or unreliable.

The policy challenge is how to sustain rural livelihoods and direct investments in ways that would maximize rural growth and sustain livelihoods (Chamberlin *et al,* 2006). To minimise

the risk and potential negative impacts high temperatures and extreme rainfall patterns, the IPCC Impact, Adaptation and Vulnerability Report for Africa (2007) recommends policies that enhance social and economic resilience (Parry et al, 2007). Highlighted policy approaches to deal with such variability include strengthening of local institutions; providing formal support and development of social capital networks; building support for social and economic equinity and reducing inequalities; encouraging sustainable diversification approaches; developing appropriate and efficient forecasting technologies and infrastructure that would help the vulnerable to adapt appropriately (see figure 6). Such policy strategies must also underscore geographical heterogeneity to ensure efficiency. It is therefore critical to introduce policy frameworks that incorporate social protection schemes and social enterprise programmes and facilitate the generation, management and development of diversified enterprises beyond the level of survival benefits (Climate Change, 2007). Identifying non-farm activities are able to thrive under potential rising environmental temperature would have the potential of alleviating poverty.

Environment induced migration has become part of the economic strategy in vulnerable ecosystems with diverse impacts including the loss of farm labour and introduction of remittances to households and local economy (van der Geest, 2004). Managed migration through skill development and vocational training for potential migrants is perceived as a viable option for reducing drought risk and as a response to the long dry seasons (Assan, 2008). Nonetheless, poverty alleviation programmes involving the introduction of affordable and accessible irrigation facilities that are affordable and accessible could allow the majority of households to engage in dry season farming. Investment in agro-based industries, the establishment and regeneration of the food processing plants could help reduce environmentally induced unemployment and increase processing of primary agricultural products.

The role of NFEA in adaptation to climate change re-opens policy debates on the relative merits of investing in low potential/lagging regions (infrastructure, irrigation) or providing social protection measures for a residual population left behind after the able bodied and young migrate to high potential or urban areas.

References

Assan, J., K. (2008) ógenerational Differences in Internal Migration: Derelict Economies, Exploitative Employment and Livelihood Discontentô, *International Development Planning Review,* 30 (4):377-398.

Assan, J., K (2009) Rural Out-migration of Young Peasants: The Struggle for Survival and the Hidden Cost of Internal Mobility, *Antipode* (Forthcoming).

Bahiigwa, G., Mdoe, N. and Ellis, F. (2005) Livelihoods Research Findings and Agricultural Growth, *IDS Bulletin* 36(2): 115-120.

Barrett, C.B., Reardon, T. and Webb P. (2001) Non-farm Income Diversification and Household Livelihood Strategies in Rural Africa: Concepts, Dynamics, and Policy Implications, *Food Policy* 26(4): 315ï 331.

Boko, M., I. Niang, A. Nyong, C. Vogel, A. Githeko, M. Medany, B. Osman-Elasha, R. Tabo and P. Yanda, 2007: Africa.

Brown, O. and Crawford, A. (2008) Assessing the Security Implication of Climate Change for West Africa, IISD, Winnipeg, Manitoba.

Bryceson, D. F. (2004) Agrarian Vista or Vortex: African Rural Livelihood Policies, *Review of African Political Economy* Volume 102: 617-629.

Caminade, C., Terray, L. (2009) 20th century Sahel rainfall variability as simulated by the ARPEGE AGCM, and future changes, *Climate Dynamics* (Forthcoming).

Chamberlin, J., Pender, J., and Yu, B. (2006) Development Domains for Ethiopia: Capturing the Geographical Context of Smallholder Development Options, DSGD Discussion Paper No. 43.

Chambers, R. and Conway G. (1992) Sustainable Livelihoods: Practical Concepts for the 21st century, *IDS Discussion Paper* 296, Brighton: Institute of Development Studies.

Climate Change (2007) Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change, M.L. Parry, O.F. Canziani, J.P. Palutikof, P.J. van der Linden and C.E. Hanson, Eds., Cambridge University Press, Cambridge UK, 433-467.

Climate Change (2007) Synthesis Report and Summary for Policymakers: An Assessment of the IPCC Plenary XXVII (Valencia, Spain, 12-17 November 2007).
Climate Change (2007) Synthesis Report Summary for Policymakers
http://www.ipcc.ch/pdf/assessment-report/ar4/syr/ar4_syr_spm.pdf

Deshingkar P. and Anderson E. (2004) ôPeople on the Move: New Policy Challenges for Increasingly Mobile Populationsõ, *Natural Resources Perspectives* Number 92. Overseas Development Institute: London.

Deshingkar, P. and Grimm, S. (2004) Voluntary Internal Migration. An Update. ODI,

Deshingkar, P. and Start, D. (2003) Seasonal Migration for Livelihoods in India: Accumulation and Exclusion. ODI Working Paper 220. London, Overseas Development Institute, August 2003.

Dietz, T. Millar, D. Dittoh Saa, Obeng, F. and Ofori-Sarpong, E. (2004) óClimate and Coping, In Madalon T. H. (ed)

Drexhage, J. Murphy, D. Brown, O. Cosbey, A. Dickey, P. Parry, J. Van Ham, J. (2007) Climate Change and Foreign Policy, IISD, Winnipeg, Manitoba.

Ellis, F. (2000) *Rural Livelihoods and Diversity in Developing Countries*. Oxford, Oxford University Press.

Ellis, F. (2003) A Livelihoods Approach to Migration and Poverty Reduction. DFID,

Ezra, M. and K. Gebre-Egziabher (2001) Rural Out-migration in the Drought Prone Areas of Ethiopia: A Multilevel Analysis. In *International Migration Review.* Vol. 35, Number 3

Ghana Statistical Service (GSS) (2000) *Ghana Living Standards Survey: Report of the Forth Round,* Accra: Ghana Statistical Service.

Giannini A, Biasutti, M., Held, I. M., Sobel, A. H. (2006) A global climate system perspective on African climate. *Climatic Change* 90 (4) 359-393.

Gordon, A. and Craig, C. (2001) Rural Non-farm Activities and Poverty Alleviation in Sub-Saharan Africa. Policy Series 14. Chatham, UK: Natural Resource Institute

Haroun A. and M. Oduro, A. (2002) Access to Markets, Income Diversification and Sustainable Livelihoods, *Ghana Centre for Policy Analysis Issues Paper on Agriculture*, Accra.

Hussein, K. and Nelson, J. (1998) Sustainable Livelihoods and Livelihood Diversification, *IDS Working Paper* Number 69*,* Brighton: Institute of Development Studies.

Jones, S. and Carswell, G. (2004) Environment, Development and Rural Livelihoods, London, Earthscan.

Livelihood Changes in North East Ghanaô In *The Impact of Climate Change on Dry lands With Focus on West Africa.* A. J. Dietz, R. Ruben and A. Verhagen (Eds). Kluwer Academic Publishers. Dordrecht/Boston/London. Pp. 149-172.

Reardon, T. (1997) Using Evidence of Household Income Diversification to Inform Study of the Rural Nonfarm Labour Market in Africa. *World Development,* Vol 25, No. 5, Pp 735-748

Mensah-Bonsu, A. (2003) Migration and Environmental Pressure in Northern Ghana. Ph. D. Thesis submitted to Tinbergen Institute, Vrije Universiteit, Amsterdam.

Mitchell T, Jones P (2005) An improved method of constructing a database of monthly climate observations and associated high-resolution grids. *International Journal of Climatology*, 25:693-712.

Mulat, D. and R. Teferi (1995) Non-farm Activities in Ethiopia: The Case of North Shewa. Paper presented at the Fifth Annual Conference on the Ethiopian Economy, Addis Ababa, Nov.-Dec. 1991. (http://www.ossrea.net/ssrr/no15/no15-04.htm

Newman, C. and Canagarajah, R. Sudharshan (2000) ñGender, Poverty, and Nonfarm Employment in Ghana and Ugandaò. World Bank Policy Research Working Paper No. 2367. (http://ssrn.com/abstarct=630739, 23/2/05).October 2003.

Prah, K. K. (1979) Some Sociological Aspects of Drought. In Proceedings of the Symposium on Drought in Botswana. 5th-8th June 1978. Botswana Society in Collaboration with Clark University Press.

Prowse, M. (2008) Pro-poor adaptation: The role of assets, *Opinion,* ODI, London.

Reardon, T. (1997) Using Evidence of Household Income Diversification to Inform Study of the Rural Non-farm Labour Market in Africa, *World Development* 25(5): 735ï 747.
September

Tschakert, P. (2007) Environmental Services and Poverty reduction: Options for Small farmers, *Agricultural Systems* 94 (1): 75-86.

van der Geest K. (2003) Rural Migration and Livelihood Security in Ghana, *Sussex Migration Working Paper*. Sussex Centre for Migration Research: Brighton.

van der Geest, K. (2004) ñWeôre Managing!ò Climate Change and Livelihood Vulnerability in Northwest Ghana. African Study Centre, Research Report 74/2004, Leiden

Waddington, H. and Sabates-Wheeler, R. (2003) How Does Poverty Affect Migration Choice? A Review of Literature. Development Research Centre on Migration, Globalisation and Poverty, Working Paper T3. University of Sussex, Brighton

Webster, J. B. (1979), Drought and Migration: The Lake Malawi Littoral as a Region of Refuge.

Yaro, J., A. (2002) The Poor Peasant: One Label, Different Lives. The Dynamics of Rural Livelihood Strategies in the Gia Kajelo Community, Northern Ghana. *Norwegian Journal of Geography*, 56:10-20

Yaro, J., A. (2004) Theorising Food Insecurity: Building a Livelihood Vulnerability Framework for Researching Food Insecurity, Norwegian *Journal of Geography*, 58:23-37.