Climate Change Adaptation: Institutional Approaches for Developing Countries

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Abstract The purpose of this chapter is to analyse the institutional development approaches that may be adopted to enhance the capacity of developing countries to adapt to the consequences of climate change. The approach of the chapter is to reflect on the impacts of climate change on developing countries in the context of their peculiar vulnerabilities as a step towards identifying the institutional development approaches which could adequately respond to those vulnerabilities and support climate change adaptation mechanisms in those countries. The chapter argues that the impact of climate change in the developing world would be exacerbated by excessive reliance on natural resources, poverty, weak technical and organisational capacity and a potential socio-cultural resistance to scientific and technical adaptation mechanisms. To respond to these challenges, the chapter dwells on experiences in Ghana to discuss national- and local-level institutional reforms as well as international cooperation that could be adopted by developing countries to enhance their resilience to the impacts of climate change, with an emphasis on sustainable agriculture and food security. The chapter would be a useful guide to governments in the developing world in preparing their nations to adapt to climate change, as well as non-governmental and international organisations involved in supporting developing countries in that pursuit.

Keywords Climate change · Adaptation · Institutions · Institutional development · Developing countries

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1 Introduction

Two broad issues dominate the global debate on climate change; these are prevention and adaptation. The world is giving much attention to the development and use of sustainable energy options and industrial practices that would lead to cuts in greenhouse gas emissions. This is expected to slow down, if not reverse, the rate at which the global environment is changing. Equal attention is being given—or perhaps should be given—to preparing the world, especially the most vulnerable, to cope with the harm that climate change has already caused and is expected to cause (UNFCCC 2007). The latter (adaptation to climate change), which is now recognised as a fundamental response to the threat of current and anticipated global change (IPCC 2007; UNFCCC 2007), is the course which this chapter seeks to contribute to.

The main objective of the chapter is to discuss some institutional development approaches developing nations may adopt to build up a strong adaptive capacity or resilience to the impacts of climate change. Emphasis is laid on adaptation to sustainable agriculture and food security, which is of high priority to governments in developing countries. Specific institutional approaches from Ghana are discussed to draw lessons for other developing countries. To make the discussion of the institutional approaches more responsive than generic, it is preceded with an analysis of the peculiar challenges which make developing nations more vulnerable to climate change in order to highlight the basis of potential institutional interventions.

1.1 What is Adaptation?

The climate change literature is full of diverse definitions of the term *adaptation*, the origin of which has been traced to the natural sciences, particularly evolutionary biology (Smit and Wandel 2006). In relation to climate change, adaptation has been explained to reflect a rational adjustment in the genetic or behavioural make-up of organisms or systems, driven by a survival instinct, to cope with variations in the global climate or minimise the ensuing impacts (Pielke 1998; Smit et al. 2000; Kitano 2002; Brooks 2003; TCCC 2004).

Brooks (2003, p. 8) defines adaptation as "adjustments in a system's behaviour and characteristics that enhance its ability to cope with external stress." In their definition, Smit et al. (2000) indicate what kind of systems may undergo adjustments to cope with variations in the environment. They define climate change-induced adaptation as "adjustments in ecological-socio-economic systems in response to actual or expected climate stimuli, their effects or impacts" (ibid., p. 225). Thus, it can be inferred that an adaptation process may be initiated in anticipation of some "expected climate stimuli", which may never occur after all. Dwelling more within the social interface, Pielke (1998, p. 159) defines adaptation

in the context of climate change as "adjustments in individual groups and institutional behaviour in order to reduce society's vulnerability to climate change."

Adjustments are bound to lead to the development of new traits that differ from those previously existing. It is those emergent traits (genetic or behavioural), which result from the rationally selected adjustment process to enhance the survival of the individual organism or system, that have been commonly referred to as *adaptation features* (Dobzhansky et al. 1977; O'Brien and Holland 1992). Since adjustments are made in "response to actual or expected climate stimuli", as in Smit et al. (2000, p. 225), the resulting adaptation features cannot be delinked from the actual or anticipated stimuli. In other words, adaptation features are directly related to an expected or experienced environmental stimulus.

Perhaps the most important benefit derived from the successful development of adaptation features is that they make the impacts less noticeable. Dietz and Ruben (2004) found that, although empirical evidence indicates the late 1980s to be the worst climatic years in northern Burkina Faso, according to local perception, the 1970s and early 1980s were the worst. They argue that by the late 1980s, people had already adapted to harsh climatic conditions and so did not feel the impacts of "bad" climate as much as they did in the 1970s and early 1980s.

1.2 Adaptive Capacity and Vulnerability

Closely associated with *adaptation* are the terms *adaptive capacity* and *vulnerability*. Adaptive capacity is a term used to indicate the ability of a system, say a community or an ecosystem, to cope with new (usually adverse) conditions (IPCC 2001; TCCC 2004; Nielsen and Reenberg 2010). The International Panel on Climate Change (IPCC) defines adaptive capacity in the context of climate change as "the ability of a system to adjust to climate change (including climate variability and extremes), to moderate potential damages, to take advantage of opportunities, or to cope with the consequences" (IPCC 2001, p. 982). Thus the adaptive capacity of a system is a measure of the ability of the system to cope with climate risks. The concept of resilience is frequently used in place of adaptive capacity, just like a host of others, including adaptability, robustness, coping ability and stability (Jones 2001; Brooks 2003; Fraser et al. 2003; TCCC 2004; Thompkins and Adger 2004; Füssel and Klein 2006).

In a community or locality, a number of factors combine to determine the adaptive capacity to climate change; these include "management ability, access to finance, technological and information resources, infrastructure, the institutional environment within which adaptation occurs, political influence, kinship networks, etc." (Smit and Wandel 2006, p. 287).

Vulnerability to climate change, on the other hand, is a measure of a system's susceptibility to adverse climatic conditions (IPCC 2001; TCCC 2004). The IPCC defines vulnerability as "the degree to which a system is susceptible to, or unable to cope with, adverse effects of climate change, including climate variability and

extremes" (IPCC 2001, p. 995). For a given severity of climate change, different systems would experience different impacts within a given period of time, while the impact felt by a particular system may vary with time. Such differences in the felt impact of the change are reflective of the differences in the vulnerability of the different systems or variations in the vulnerability of any particular system with time (Brooks et al. 2004; Smit and Wandel 2006).

Primarily, a system's vulnerability to the impacts of climate change is consistently treated in the climate change literature as a function of the sensitivity of the elements of the system to the particular change in climatic conditions and the adaptive capacity of the system (IPCC 2001; Brooks et al. 2004; Smit and Wandel 2006). "Generally, a system (e.g. a community) that is more exposed and sensitive to a climate stimulus, condition or hazard will be more vulnerable, ceteris paribus, and a system that has more adaptive capacity will tend to be less vulnerable, ceteris paribus" (Smit and Wandel 2006, p. 286). For instance, a community that is heavily dependent on rain-fed agriculture is sensitive to variations in rainfall intensity and would be more vulnerable to drought, but the level of vulnerability would reduce, should such a community develop an irrigation system with adequate water storage capacity.

It has been observed that many of the determinants of sensitivity are similar to those that constrain the adaptive capacity of a system (Smit and Wandel 2006), while many synergies exist between those actions which reduce climate change risk and the development of adaptive capacity (Harmeling 2009).

2 Challenges of Developing Countries

The consequence of climate change is largely "global" in character but, as noted earlier, the adaptive capacity and, for that matter, vulnerability to the impacts of a particular adverse phenomenon are system-specific (Brooks et al. 2004; Smit and Wandel 2006). Between developing countries and their developed counterparts, it is generally upheld that the former have a lower adaptive capacity and tend to be more vulnerable to climate change (Harmeling 2009; UNDESA 2007; UNFCCC 2007; Brooks et al. 2004). For instance, the Germanwatch Global Climate Risk Index 2010 (Harmeling 2009) ranks countries according to their exposure and vulnerability to extreme weather events for the period between 1990 and 2008. The rankings reveal that "the ten most affected countries were developing countries in the low-income or lower-middle income country group" (ibid., p. 5). Indeed, developing countries are projected to experience a disproportional impact of climate change (Ludwig et al. 2007; Stern 2007).

An attempt to develop institutions to prepare developing countries to deal with the effects of climate change needs to be preceded with an analysis of the factors which make them more vulnerable in order to make the outcome of the institutional development exercise responsive to the peculiar challenges and realities of

those countries. While admitting that vulnerability is context-specific, some common trends are observed in developing countries.

The vulnerabilities of developing countries are rooted in a number of socio-economic factors and constraints commonly associated with them. These include, but are not limited to:

- dependence on natural resources;
- poverty;
- weak technical and organisational capacity;
- informal social constraints.

2.1 Dependence on Natural Resources

Developing countries tend to depend more on natural resources than developed countries (UNFCCC 2007; Thomas and Twyman 2005; World Bank 2000). In other words, livelihoods in developing countries are more closely linked to natural resources. In Africa, for example, it is estimated that about 75 % of the population live in rural areas, where almost all of the labour force is engaged in agricultural production (WRI 1994; IPCC 1997). Consequently, about a third of Africa's land area is used permanently for agricultural production, which accounts for about 30 % of the continent's gross domestic product (GDP) (ibid.). Land products are estimated to account for up to 60 % of rural African income (Ellis 1998).

However, resource-dependent industries and, for that matter, nations are more vulnerable due to the high sensitivity of natural resources to climate variability (Marshall 2010). The high sensitivity of natural resources to environmental change implies livelihoods in developing countries are highly susceptible to shocks and stresses resulting from changes in the natural environment. Such susceptibility of livelihoods to shocks and stresses is generally regarded as the most significant form of vulnerability to climate change impacts (Beg et al. 2002; Metz et al. 2002; Sokona and Denton 2001; Adger 2000; Moser 1998).

Hence, it is commonly agreed that the tropical and sub-tropical agricultural systems in the developing world are the most vulnerable to the impacts of global temperature and climate changes during the twenty-first century (Kasei 2009; Tol et al. 2000), with Western and Southern Africa noted to be among the most vulnerable (Denton et al. 2000; Kikar 2000).

Most rural communities in West Africa, for example, practise rain-fed agriculture (Kasei 2009) as a primary means of livelihood. Niasse et al. (2004) underscore the significant contribution rain-fed agriculture makes to the economy of the sub-region. However, agricultural productivity within the Volta Basin, as in other parts of the sub-region, is said to be highly dependent on the available soil moisture (Rockström and Falkenmark 2000). Consequently, any climate variation that leads to drought could have far-reaching implications for food security in the sub-region. It is estimated that by the year 2020, the Volta Basin's yield from rain-fed agriculture could

be reduced by up to 50 % (Kasei 2009). This dependence on rain-fed agriculture is certainly one of the reasons why West Africa is regarded as one of the most vulnerable regions in the world as far as climate change is concerned.

2.2 Poverty

The income disparity between the richest and the poorest nations continues to widen, reflecting an increasing disparity in their capabilities to respond to the effects of global change. As shown in Fig. 1, the ratio of the income shares of the richest 20 % to the poorest 20 % of the world's population increased from 32:1 in 1960 to 45:1 in 1980 and 74:1 in 1999 (UNDP 1992, 1999). It must be stated, however, that another school of thought argues that if adjustments are made for the low cost of living in the poorest countries, the disparity in income shares will rather be diminished with increased globalisation over the past two decades.

Although the sudden provision of financial and material resources to developing countries will not automatically translate into the same level of adaptive capacity as in the developed world, the absence of it is recognised as a key factor that makes developing countries more vulnerable (UNFCCC 2007; Harmeling 2009).

The concept of external and internal sides of vulnerability put forth by Chambers (1989) offers a basis for explaining the relationship between poverty and vulnerability in developing countries. Chambers argues that vulnerability has both external and internal sides. The external side of vulnerability consists of risks, shocks and stresses, while the internal side consists of a lack of defence or a means to cope with the external side. Lack of financial resources to develop the kind of infrastructure required to cope with the impacts of climate change is an example of the internal side of vulnerability. The experience of drought or delayed rains in rain-fed agriculture-dependent communities, for instance, poses a serious risk to food security, which can be managed through the development of irrigation schemes to tide farmers over until the next rains come. But pressure on the national purse in many developing countries often makes such a solution far-fetched.

Thus poverty exacerbates vulnerability in developing nations by denying them a means to develop resilience to cope with climate change, thus making them defenceless.

2.3 Weak Technical and Organisational Capacity

The ability to respond rapidly to climate change can be greatly affected by the capacity of a nation to accomplish at least two important tasks. These are the capability to:

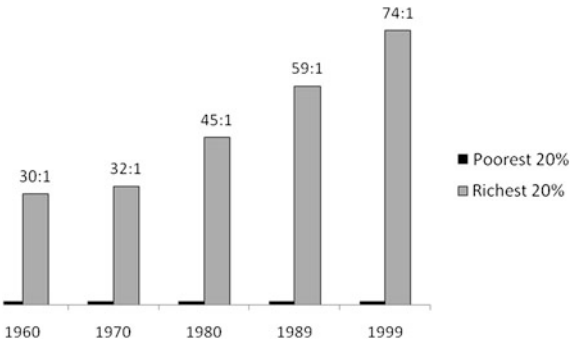

Fig. 1 Income disparity between the world's richest 20 % and poorest 20 %. *Source* UNDP (1992, 1999)

- gather relevant data about climate change and its impacts on its people to guide planning and policy formulation; and
- undertake research to develop new technologies to support local industries/entities that are sensitive to climate change.

Developing nations lag behind their developed counterparts in the ability to accomplish both tasks. The capacity to gather relevant data, such as temperature, rainfall and the frequency of extreme events, is critical to planning, capacity building and climate policy formulation. This is because a strong database is required to assess the impacts of and vulnerability to climate change and to determine the requirements for adaptation (UNFCCC 2007). The United Nations Framework Convention on Climate Change (UNFCCC) notes that "if the capacity for assessing climate change is not there, countries are limited in their ability to plan adaptation measures and adapt effectively" (ibid., p. 13). The low capacity of developing countries to maintain a strong database for development planning and policy formulation is a major setback in international cooperation.

The commitment and capacity to undertake research and understand climate-related issues have been used among other variables for assessing vulnerability of nations to climate change (Brooks et al. 2004). Brooks et al. used the percentage of GNP spent on research and development as a proxy for commitment and resources for research. They also used the number of scientists and engineers in research and development per million populations as a proxy for the capacity to undertake research and understand issues. The result of that study, like those of Harmeling (2009) and a host of others, found developing countries to be the most vulnerable. Recognising the weak capacity of developing countries to undertake cutting-edge research, Article 5 of the UNFCCC urges the international community to support developing countries to develop climate research and systematic observation systems.

2.4 Socio-Cultural Constraints

In developing adaptation mechanisms for developing countries, some critical questions need to be answered, such as the following:

- Will access to technology and climate change adaptation techniques in developing countries necessarily imply the acceptance and use of them?
- Will traditions, beliefs and practices in developing countries support climate change adaptation technologies?
- Would the peasant farmer in Africa whose farming practices are rooted in some age-long traditional beliefs heed technical advice that suggests the thinking of his ancestors is no longer valid because of a so-called climate change?

In the developing world, Africa for example, informal institutions (traditions, beliefs, practices, etc.) have a large impact on the social and economic life of the people. While some informal institutions tend to promote best technical practices, others have a tendency to interfere with them (Alaerts 1997). Thus the promotion of technologies that conflict with informal institutions could encounter significant resistance. This is because informal institutions and constraints are the major determinants of the commitments of various stakeholders to the success of formal institutions or technologies (Vogler 2003). For instance, where the planting or harvesting season is sanctioned by a traditional authority after the observance of one festival or another, the mere availability of technology to forecast earlier rains than expected may not be very useful if the traditional authority does not openly support the alteration of the traditional farming calendar. Similarly, where cultural or religious values insist on a given standard of decency in dressing, adaptation mechanisms to high temperatures would attract the wrath of the cultural or religious authority if they promote what may be perceived as indecent dressing. Consequently, a conservative society would ignore such adaptation mechanisms.

The opposition of informal institutions or socio-cultural constraints could pose a formidable challenge to the dissemination of climate change adaptation technologies in developing countries and, consequently, affect their adoption. That would lead to a weak defence and, hence, high vulnerability.

3 Institutions and Adaptations

3.1 What are Institutions?

Institutions are often confused with organisations. Though the two terminologies may be used interchangeably under some conditions, they are not necessarily the same. A widely accepted definition of institutions is found in North (1990). North defines institutions as “formal rules, informal constraints—norms of behaviour, conventions and self imposed codes of conduct—and their enforcement

characteristics." Institutions, thus, comprise rules or norms of behaviour, on the one hand, and their enforcement agencies or organisations on the other. Institutions, defined as rules and norms of behaviour, are referred to as "the rules of the game", while organisations are said to be "how we structure ourselves to play" (DFID 2003). Where mention is made of institutions and organisations, institutions specifically refer to rules or norms of behaviour, which are not the same as organisations.

Both institutions and organisations may be formal or informal. Formal institutions come in the form of laws, policies, regulations, guidelines, bureaucracies, codes and standards, etc., while informal institutions exist as customs, traditions, beliefs, values and cultural practices, etc. Informal institutions are the unofficial arrangements in societies or organisations. They can be described as the *unwritten rules* that govern behaviour (Helmke and Levitsky 2004).

Organisations, in general, are groups of individuals engaged in purposive activity (North 1990; Saleth 2006). Formal organisations are those with some form of officially recognised authority. Government ministries and agencies, municipal authorities, non-governmental organisations (NGOs), etc., are among the formal organisations that play one role or another in climate change adaptation. They are the primary custodians of formal institutions. On the other hand, informal organisations constitute the enforcement characteristics of informal institutions. They comprise community-based organisations, opinion leaders, traditional leaders, gender groups, local religious bodies, etc.

3.2 Relationship Between Institutions and Adaptation

A reflection on some cornucopian views of sustainable development reveals a relationship between institutions and adaptation to climate change. In simple terms, the cornucopian view of sustainable development argues that there could ever exist a blissful planet earth with unlimited resources provided man would not fail to apply ingenuity to get his institutions right (Beckerman 2003; Simon 1981). This view is contrary to the proposition of Thomas Malthus that if population explosions and human consumption are left unchecked, the earth would run out of resources (Malthus 1798; Meadows et al. 1972). Proponents of the cornucopian view, including Boserup (1981), believe "necessity is the mother of invention" so if the earth's population increases, human ingenuity will rise to the challenge to develop new technologies to produce more food. In relation to climate change, a nation develops adaptive capacity when it develops institutions (organisations, systems, procedures, etc.) to rapidly respond to the challenges posed by climate variableness.

The proposition that the future is only limited by human ability to get its institutions right is, to a large extent, affirmed by the difference exhibited by the developed world and the developing world in the management of municipal waste. While the developed world generates more waste than the developing world, the

former does not have as much problem managing its waste as the latter because developed countries have developed strong institutions to manage their waste, while the developing world appears to have failed to get its waste management institutions right (Ogawa 2000; GDRC, undated).

Thus, the institutional endowment to deal with developmental issues like climate change constitutes a key difference between the developed and developing worlds, quite apart from the strengths of their economies. In fact, from the cornucopian viewpoint, it may be argued that many nations in the developing world are poor because they lack the right institutions (political, economic and cultural) to create worth. The same reason may account for why developing nations are lagging behind developed nations in climate change adaptation.

4 Responsible Institutional Approaches

This section dwells on institutional approaches adopted by Ghana, a developing country in Sub-Saharan Africa, to adapt to climate change in its agricultural sector. In Ghana, the effects of climate change are seen in:

- an irregular rainfall pattern;
- a long draught period, especially in the northern part of the country; and
- an increase in flooding, which destroys crops and other landed properties.

Diverse institutional approaches are employed in mitigating these effects. Some are national whilst others are local; there are public as well as private institutional changes to adapting to climate change.

4.1 National-Level Policy Formulation and Legislation

Ghana's agricultural policy has five key objectives:

- ensuring food security and adequate nutrition for the population;
- promoting supply of raw materials for other sectors of the economy;
- contributing to export earnings;
- increasing employment opportunities and incomes of the rural population; and
- generating resources for general economic development.

The relevance of irrigation water management in the realisation of these objectives is a well-established fact (FAO 2005). The key issue in the development and utilisation of water resources is to ensure sustainability, while giving preference to domestic water requirements in case there are competing uses of the resource.

The policy reform strategy within the irrigation sub-sector is to increase agricultural production through development and management of water resources for irrigation to combat the adverse effects of climate change. The reforms include:

- limiting the cost of irrigation projects to not more than USD 600/ha;
- recovery of at least operation and maintenance costs;
- handing over the management of projects to farmers' associations;
- involving farmers from the inception, selection of technologies through to the decision-making stages of irrigation projects, unlike in the past when management was largely in the hands of the Ghana Irrigation Development Authority (GIDA); and
- contribution of between 10 and 25 % of project costs by beneficiary communities or associations for small-scale projects.

The National Water Policy (MWRWH 2007) acknowledges that the availability and ease of access to water in sufficient quantities for the cultivation of food crops, watering of livestock and sustainable freshwater fisheries is a precondition for the achievement of food security and self-sufficiency in food production to meet the nutritional needs of the population. To accomplish this, the government has committed itself to:

- support the establishment of micro-irrigation and valley bottom irrigation schemes among rural communities;
- strengthen district assemblies to assume a central role in supporting community operation and maintenance of small-scale irrigation and other food production facilities;
- promote partnership between the public and private sector in the provision of large commercial irrigation infrastructure;
- encourage the efficient use of fertilisers to reduce pollution of water bodies, as well as high-yielding crop species and agricultural extension services to ensure conservation of water;
- promote and encourage water use efficiency techniques in agriculture and reduce transmission losses of irrigation water in irrigation schemes;
- manage land use and control land degradation, including bush fires, to reduce soil loss and siltation of water bodies;
- develop a pricing system and a mechanism for delivering irrigation water that is affordable to farmers and also ensure cost recovery on investments made in infrastructure; and
- utilise data and information on water cycle, land cover/use, soils and socio-economic elements for the planning, design and development of agricultural schemes.

The Ghana Irrigation Development Authority (GIDA) is directly responsible for regulating irrigation systems in the White Volta Basin of Ghana. The regulatory activities of GIDA are dictated by the Irrigation Development Authority Regulation, 1987 (Legislative Instrument (L.I.) 1350). This L.I. provides the procedure for managing irrigation projects as well as water management within such projects.

In addition, the GIDA's Technical Guidelines for Irrigated Agriculture (2004) gives further details on how to effectively manage water for irrigated agriculture, including water supply, distribution and application management.

In 2006, amendments were made to the L.I. 1350 to make it more responsive to the needs of the sector in the face of changing demands due to climate change. The passing of this legislative instrument promoted farmer participation in the management of irrigation projects, and also legalised and streamlined the GIDA staff management role in project management. The L.I. stipulates that "there shall be established on each irrigation project a project management" which shall ensure the implementation of the policies of the GIDA. Section 6 of the amended version makes room for the formation of Farmers' Cooperative Societies which shall be subject to the provisions of the Cooperatives Society Decree, 1968 (N.L.C.D. 252) as far as its administration and financial management are concerned. Thus community participation became a critical issue in the institutional adaptations to managing water for rural livelihoods. Subsection 3 of Sect. 1 provides for the inclusion of at least two of the users' representatives in the management of a project. This is an attempt to allow for representative participation of the user group in management decisions.

The L.I. further makes room for the formation of a Land Allocation Committee (LAC) (Sect. 3) and the establishment of a Disciplinary Committee by the management of the project (Sect. 9). The LAC is meant to find solutions to land conflicts in project areas. It is also meant to minimise the interference of the traditional landlords in land allocation. The Disciplinary Committee is responsible for investigating any infringement or alleged infringements of any rules issued by the management and imposing the appropriate sanctions, when necessary. These are meant to address the principles of justice, equity, participation and transparency in the management of water for irrigated agriculture.

The farmers' cooperatives philosophy has led to the establishment of Water User Associations (WUAs) at the irrigation project sites. The WUAs were formed as the water resources management component of the Land Conservation and Small Holder Development Project (LACOSREP). These are working groups at the dam sites whose activities are monitored by the Ministry of Food and Agriculture (MOFA) extension department. These WUAs are responsible for the day-to-day management of the dams/dug outs. They have their own internal arrangement for the benefit of their group members.

4.2 Local-Level Action: Introduction of the Third Cropping Season

The discussions here are limited to the White Volta Basin. The area is characterised by an erratic rainfall pattern and other natural hazards like floods as a result of climate change. This situation has kept food production far behind the

consumption requirements of the people, thus creating a longer period of hunger and intense poverty. This necessitated the placement of emphasis on the development of small-scale dams for irrigated agriculture to ensure efficient use of water bodies within the White Volta Basin. This is part of the reason for the introduction of the LACOSREP by the MOFA, supported by the International Fund for Agricultural Development (MOFA/IFAD 2003).

Under LACOSREP I and II, 73 small dams were constructed to aid dry season farming. This was a strategy for promoting dam reservoir construction as a means of improving incomes and the general livelihood of farmers in the face of the adverse effects of climate change. These were meant to enhance irrigation and livestock production. Table 1 gives an indication of the spread of dams within the Upper East Region of Ghana, which is located within the Basin. It shows the number of dams constructed by the District Assembly and NGOs combined, and those constructed by LACOSREP I and II, as well as the total number of dams existing in each district of the region.

These dam sites are noted for vegetable production (okra, onions, tomatoes, etc.). For the efficient and profitable utilisation of these dams, a dry season second cropping scheme was introduced by the Ministry of Agriculture in 2003. A dry season third cropping scheme was subsequently introduced in the basin in 2008 to promote the production of 90-day early-maturing high-protein quality maize cultivation.

Rain-fed agriculture is referred to as the first cropping season, the normal cropping season (May/June to September). This is followed by the second cropping scheme from October to December/January in the dry season, using water from the White Volta Basin and dam sites. The crops usually cultivated in the second cropping period are largely for commercial purposes. These crops include onion, tomato, pepper, okra, leafy vegetables, rice, water melon and garden eggs. After the droughts and floods which occurred in the region in 2007, this second cropping scheme was strengthened by collaboration between the Ministry of Food and Agriculture and FAO to support farmers with inputs for intensive cultivation of the second crop.

The period between March and early June is considered as the "hunger period" of the region, when most farm families would have exhausted their food items from the harvest of the previous year. This was considered a "resting" period by the people, but in reality it is a wasted (unproductive) period since no work goes on among the predominantly farming families. The hunger period is sometimes a result of crop failures due to drought and/or floods.

As a strategy for achieving all-year-round food security and improving incomes during this slag period, MOFA decided to promote the production of a 90-day early-maturing high-protein quality maize cultivation using pump irrigation. Thus pump-irrigated agriculture was introduced as a measure to ensure efficient and maximum utilisation of water from the White Volta and other streams within the region. MOFA assisted some farmer groups to acquire pump machines for pumping water directly from the river for irrigation. This ushered in the dry season third cropping scheme between March and June.

Table 1 Total number of small dams by district in the Upper East Region of Ghana, 2008

Districts	Small-scale dams				Area under cropping (hectares)
	District assemblies and NGOs	LACOSREP I	LACOSREP II	Total no. of dams	
Bolgatanga	–	5	4	9	81.35
Bongo	–	8	2	10	89.5
Talensi Nabdam	19	1	1	21	161.7
Bawku Municipal	3	8	6	17	277.8
Bawku West	14	8	4	26	385.1
Garu Tempane	5	4	2	11	523.0
Kassena Nankani	1	5	4	10	74.5
Builsa	–	5	6	11	109.7
Total	42	44	29	115	1,702.65

Source MOFA, Regional Office [Bolgatanga, Ghana [(2008)]

The input support provided by MOFA with assistance from FAO includes water pumps, pipes, maize seed and fertiliser. A significant effect of the support increased the area under cultivation, for example, from 29 hectares in 2007 to 146.4 hectares in 2008. This policy direction has drastically increased the use of pumps in the basin from just 20 pumps in 2002 to 165 in 2008.

The increase in cultivated acreage and subsequent output increases translate into increased income for the households within the basin. Farmers in vegetable production, such as tomatoes and onions, during the third cropping period receive more than twice the prices of the normal season's produce. This period directly precedes the main farming season. Farmers obtain a lot of investment money from these activities, making the outlook brighter for farming households in the basin.

There is an estimated irrigable area of 1,702.65 hectares for the small-scale dams. Together with pump irrigation, the dams have yielded the outputs indicated in Table 2. The outputs of these vegetable crops for a 4-year period have had a significant impact on the lives of the people of the Upper East Region.

The increase in output has contributed considerably to incomes, which households indicate they use to help pay children's school fees, meet health needs and buy grain to supplement losses for the rain-fed crops and take care of other household needs. These adaptations are well accepted by the communities because they are seen to promote their livelihoods.

Table 2 Area and production figures for irrigated crops for 4 years

Crop	Area cultivated (hectares) and crop production (metric tonnes) per year							
	2003/2004		2004/2005		2005/2006		2006/2007	
	Area	Prod.	Area	Prod.	Area	Prod.	Area	Prod.
Tomato	879	1063	628	6594	655.89	7805	1085	12,478
Onion	63	625	50	420	207.9	1892	211.6	2,010
Pepper	38.5	89	45.4	11.34	57.8	109.8	65.8	170.0
Okra	4.9	4.41	8.1	16.2	4.7	10.34	10.5	22.1
Leafy vegetables	10.4	20.8	18.6	29.76	15.4	12.32	25.6	35.84
Rice	1091	4910	900	3660	896.5	3407	623.0	2804
Maize	–	–	8.0	30	71.0	85.2	678.0	1492

Source MOFA, Bolgatanga (2008)

4.3 Citizen (Community) Participation

To ensure effective running of the irrigation facilities, the LACOSREP project encouraged and facilitated the formation of WUAs at all the dam sites. The beneficiaries of these dam sites became one of the stakeholders in managing the water resources. This was done for the purposes of instilling the concept of community ownership and management of the irrigation facilities to ensure sustainability and profitability of the irrigation facilities. The activities involving this concept have been extended to cover other small dams constructed prior to the LACOSREP project.

The WUAs are responsible for protecting the catchment areas of the dams, resolving conflicts among WUA members, controlling the use of irrigation water, generating revenue to support the routine maintenance of irrigation facilities, as well as offering members the opportunity to access services provided by development partners, such as District Assemblies and NGOs.

The WUAs have been developed into cooperatives with the assistance of the Department of Cooperatives, registering them as limited liability business enterprises under the cooperative societies law NLCD 252. Based on the recommendation of the Department of Cooperatives in 2002 after undertaking an assessment of the operations of the WUAs, the formation of District WUA councils was brought into the arrangement for the management of the resources. These councils are the mouthpiece of WUAs to liaise with District Assemblies, the Regional Coordinating Council and other development partners for the proper functioning of these groups.

4.4 International Cooperation

It is admissible that successful adaptation to climate change, like the Millennium Development Goals (MDGs), cannot be achieved by developing countries without international aid and cooperation (UNDESA 2007) due to poverty and weak

technical capacity. There is the need for international support to augment the effort of developing countries. One of the problems facing farmers and communities in the Northern, Upper East and Upper West Regions of Ghana has been the incidence of floods on a virtually annual basis, especially when the spillways of the Bagre Dam at upstream Burkina Faso are opened. What makes matters worse is the low capacity for the collection of hydrological data to provide early warning systems.

To help address this problem, the Canadian International Development Agency (CIDA) is assisting both Ghana and Burkina Faso to establish a gauging system along the White Volta to collect hydrological data to give early warning to downstream communities. While the north–south cooperation between Canada and the two West African states is commendable, other developing countries can also emulate the south–south cooperation between Ghana and Burkina Faso in the area of information sharing.

5 Conclusion

We conclude that developing countries are more vulnerable to the impacts of climate change due to factors including their excessive reliance on natural resources, poverty, weak technical and organisational capacity and socio-cultural resistance to scientific and technical adaptation mechanisms. By developing strong institutions, developing countries stand the chance of enhancing their adaptive capacity and resilience to climate change. There is the need for national-level leadership in formulating policies and legislation to provide a framework for dealing with the impacts of climate change. Community-level strategies should also be developed with the full participation of community members in order to commit the grass root citizenry to take their survival into their own hands by cooperating with formal and informal arrangements put in place by their governments and non-governmental organisations. There is also the need for developing countries to cooperate with each other in sharing information while they engage their developed counterparts in collaborations that would build their organisational and technical capacity to deal with the impacts of climate change.

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