Journal of Sustainable Development in Africa (Volume 15, No.7, 2013)
ISSN: 1520-5509
Clarion University of Pennsylvania, Clarion, Pennsylvania

RURAL COMMUNITY RESPONSES TO CHANGING AND VARIABLE CLIMATE

Vincent R. Nyirenda[1] Chansa Chomba[2] & Victor M. Siamudaala[3]

[1] Directorate of Research, Planning, Information and Veterinary Services, Zambia Wildlife Authority, Chilanga, Zambia
[2] Disaster Management Training Centre, Mulungushi University, Kabwe, Zambia
[3]The Nature Conservancy, Zambia Programme, Lusaka, Zambia

ABSTRACT

Climate change and variability is eminent challenge in Southern Africa. Despite global awareness creation, in-depth understanding of rural community responses is still limited. Responses are localized due to socio-economic, ecological and cultural factors. This study unravels mechanisms and events in communities of practice, influencing social learning and participation in sustainable natural resources management. Multi-stage sampling was employed. Rapid rural appraisal instruments: case study, personal interviews, semi-structured questionnaires, focus group discussions and field direct physical observations by transect walks were used. Conceptual framework was developed for analysis of interactions between climate change, natural resources utilization and rural community responses. Climate change and variability escalated usage of natural resources by rural communities, dictated by intricate traditional establishments with constituencies of actors, practice and events. We propose that relationships between climate change, natural resources utilization and community responses be developed through constructive social capital and adaptive governance processes and structure.

Key words: impacts, perception, social-learning, sustainable utilization, resilience, Zambia.

INTRODUCTION

Climate change is periodic modification of Earth's climate as a result of changes in the atmosphere and interactions between the atmosphere and geologic, chemical, biological and geographic factors (Hyndman & Hyndman, 2009). Climate is, therefore, defined loosely as the average weather at a particular place, incorporating such factors as temperature, precipitation, humidity and windiness. This definition acknowledges that weather is always changing owing to the instability in atmosphere. As weather varies from day to day, so too does the climate vary. This article addresses the concept of climatic change and variation within a set of integrated natural resource utilization patterns and rural community responses to such variable and changing climate.

Impacts of climate volatility in rural Africa, for instance, included serious consequences of extreme weather events that encompass changes in ecological processes and loss of biodiversity (Pachauri & Reisinger, 2007; Zhao & Running, 2010). Stern (2007) reviewed economic impacts of climate change on land use systems and outlined associated externalities in form of global causes and consequences, causes of long term and persistent impacts, risks and uncertainties. The review stressed ferocity of climate change and variability in Africa, than elsewhere. Thurlow, Diao, and Zhu (2009) outlined the vulnerability of rural communities to climate change and variability in terms of damage to agricultural activities and associated costs, which exacerbates poverty at local and national levels. Therefore, understanding key aspects of climate change and variability processes, mechanisms and events through which rural communities respond, forms premise for collective action among the communities of practice, as stakeholders and actors concede to making co-operative contribution. Communities of practice share concerns about matters affecting them, such as climate change and variability and how to deal with them in a social fabric through social learning by interactions (Wenger, 1998).

Collective and ameliorative actions are required to obviate accumulative costs associated with belated actions on climate changes and variability as postulated by Stern (2007). In order for the positive collective action to effectively take place, there is need for constructive perception, to enforce sustainable adaptation initiatives. Perception is defined as a process of complex compact and unique personality, which can precipitate feelings, emotions, values, attitudes, needs, motives, previous experiences and knowledge (Düvel, 1975). Perceptions manifested by individuals are influenced by the social capital that governs their collective actions. Social capital, on the other hand, encompasses features of social organization such as trust, norms or common rules, commitment, reciprocity, sanctions, infractions, connectedness and networks (Ballet, Sirven, & Requiers-Desjardins, 2007; Pretty, 2003; Putnam, 1993). According to Collier (1998), and Woolcock and Narayan (2000), importance of social capital is evinced as effective insurance and defense instrument against adversaries, which include the perturbations of climate change, food insecurity and poverty. Building of social capital embraces various elements of social-ecological systems (Folke, Hahn, Olsson, & Norberg, 2005). Social-political-cultural, ecological and economical realities, for instance, are assimilated into the lifestyles and practices by rural communities by use of experiences and networks, which impact on the resource utilization.

Pegram, von der Heyden, and Eaglin (2009) considered that actual adaptation to climate change happens at the base levels through actions and behavior by local constituencies. Hitherto, however, understanding of various relationships at the base level is still limited. Therefore, this study aims at contributing at the base level with a focus on sustainable natural resources utilization. Drawing from insights by Anderies, Janssen, and Ostrom (2004), climate change adaptation response framework is proposed for rural community actors. The framework has four major components: human, ecological, social-cultural and economic capital. It aims at elucidating in holistic manner relationships that exist in selected districts of Zambia between climate change impacts, natural resources utilization and rural community responses. We explore the question of whether positive rural community responses lead to sustainable natural resources utilization and resilience to climate change impacts, in the three Agro-Ecological Zones in Zambia. The study aims at contributing to base level community structures to enhance their capacity to respond to the consequences of extreme weather events.

MATERIAL AND METHODS

Study Site

The study was conducted in the three major Agro-Ecological Zones (Zone I, II and III) of Zambia (Figure 1). Zone I has rainfall exceeding 1,200 mm with summer temperatures ranging from 18-30 °C. Zone II is characterized by rainfall ranging from 800 mm to 1, 200 mm with summer temperatures ranging from 20-33 °C. Zone III is situated in the Zambezi and Luangwa Valleys which experience lowest rainfall of ≤ 800 mm, with recurrent floods and droughts, and summer temperatures exceeding 38 °C. (Conservation Farming Unit, 2009).

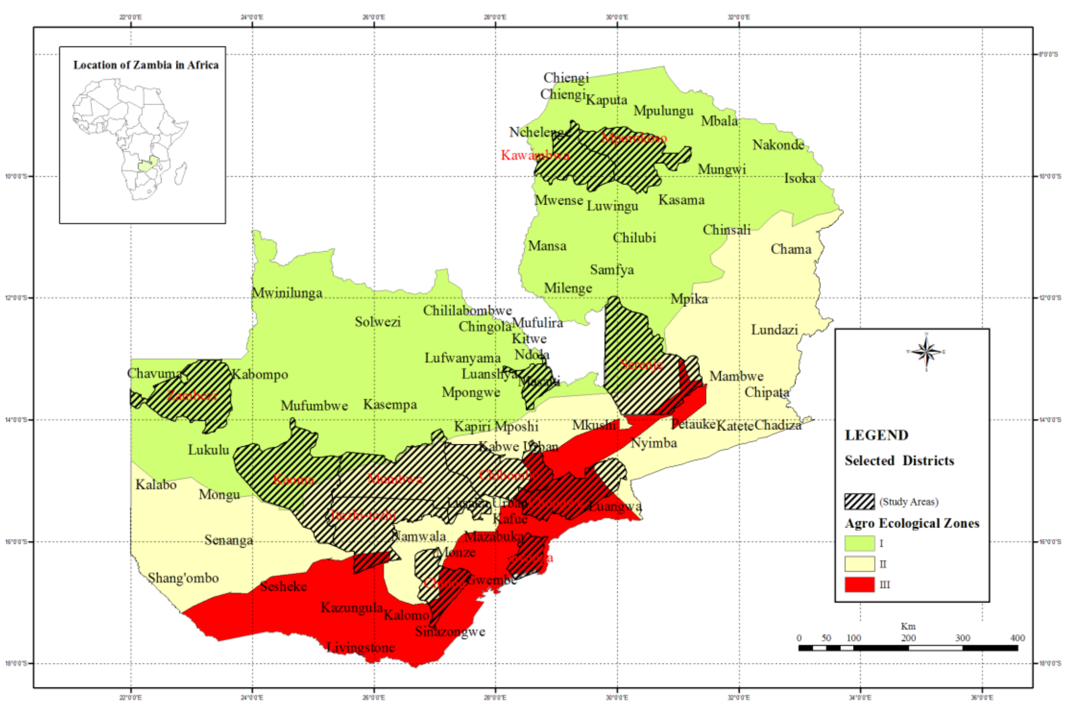

Figure 1: Geographical location of Study Area and Agro-Ecological Zones in Zambia, 2010.

Data capture protocols

Qualitative field research methods were used to collect data on relationships between various concepts and themes from a sample of 689 respondents, focussing on indigenous knowledge as described by Strauss and Corbin, 1998. The methods provided in-depth understanding of the social perspective of each theme, investigating linkages between natural resources utilization and community responses to changing and variable climate at base levels. Twelve districts and eighteen local communities occurring in eight provinces of Zambia (Figure 1) were selected by multi-stage sampling method in this case study as described by Yin (1993). Surveys were undertaken between June, 2010 and December, 2010 using 25 trained field assistants.

Rapid appraisal methods used were personal interviews, semi-structured questionnaires, focus group discussions and field direct physical observations by transect walks in accordance with protocols suggested by Bradburn, Sudman, & Wansink (2004). Open ended questions were administered to respondents to avoid predetermining their responses (Patton, 2002). Data was gathered for the period between 1980 and 2010. We assumed the target respondents, who were above 40 years old, remembered major elements under investigation. Three decades, 1980-1990; 1991-2000 and 2001-2010, were devised to derive periodic trends. The same key questions were administered to each of the respondents, who had historical perspective of the issues under discussion in English or vernacular. In the field, facilitators observed self-reflexivity for research validity as proposed by Lather (1986).

Statistical analyses

Respondents' frequency was categorized according to weather and biophysical elements (Table 1). Empirical interpretive analyses were conducted using emergent patterns, categories and themes along with data gathering. A conceptual framework was developed and used to categorize concepts and themes associated with the study.

RESULTS

Rural community indigenous knowledge

From the indigenous knowledge systems, rural communities evinced various levels of climate change and variability impacts across the three Zambia's Agro - Ecological Zones (Table 1). Greatest impacts were experienced in Agro-Ecological Zone III, followed by Zone II. Agro - Ecological Zone I was the least affected of the three zones. Weather elements were characterized by late setting of rains, shorter rainy season, escalating drought and flood frequency, excessive temperatures, colder dry seasons, shifting annual coldest period and sturdy prevailing winds over the past three decades.

Results on biophysical elements showed that negative impacts of climate change and variability increased in magnitude (Table 1). In Zone III, there was loss of vegetation cover in managed areas ($\geq$5%), $\geq$50% perennial rivers turned ephemeral, $\geq$60% water wells dried up, crop annual production failed 6 times per decade due to droughts and floods, wild plant production declined by $\geq$10% and belated flowering of wild plants. Most of the respondents (n=614, 89.11%) indicated they observed some form of loss of biodiversity. The loss included drying up of wetlands such as non-edaphic grasslands "*dambos"*, *Oyster* mushroom production failures, local disappearance of spike rush *Eleocharis angulata* plants, and grass thatch (*Hyparrhenia spp.*) production reduction for rural housing. Pervasive late flowering of up to November instead of September were more frequent (up to 6 times in a decade), coupled with fruit failure in wild fruiting trees such as *Uapaca spp., Anisophyllea spp., Parinari spp, Flaucortia spp., Strychnos spp., Azanza spp., Schionziophyton spp., Adansonia spp., Berchemia spp. and Ziziphus spp*. Late flowering was accompanied by late leaf tree shedding in *Brachystegia spp.* A total of 196 (79.35%) respondents observed late fruiting in Mango *(Mangifera indica)* in Agro - Ecological Zone III. Animal die-offs, spread of obnoxious invasive plants and weeds, and disease epidemics increased by ≥8%.

Table 1: Indigenous knowledge of rural communities on causal evidence of climate change and variability in Agro-Ecological Zones of Zambia for the period 1980-2010.

Parameter	**Attributes of Agro-Ecological Zones**											
	Agro-Ecological Zone III				**Agro-Ecological Zone II**				**Agro-Ecological Zone I**			
	Attrib.* (1980-1990)	(1991-2000)	(2001-2010)	**(n; %) Respondents**	**Attrib.*** (1980-1990)	(1991-2000)	(2001-2010)	**(n; %) Respondents**	**Attrib.*** (1980-1990)	(1991-2000)	(2001-2010)	**(n; %) Respondents**
Weather Elements												
1) Setting of rains (by month) from normal of October prior to 1980.	Oct.	Nov.	Dec.	239; 94.76	Oct.	Nov.	Nov.	163; 76.52	Oct.	Nov.	Nov.	204; 89.08
2) Rainy season (in days) from normal of >150 rainy days in 1980.	≥120	≤90	≤70	228; 92.31	≥120	≤100	≤80	160; 75.11	≥120	≤110	≤90	198; 86.46
3) Drought frequency.	2	3	5	215; 87.04	2	3	4	167; 78.40	2	3	4	148; 64.63
4) Floods frequency.	2	3	4	211; 85.42	2	3	3	165; 77.46	2	3	3	153; 66.81
5) Mean annual maximum temperatures (°C).	≤38	≥38	≥40	224; 90.69	≤30	≥30	≥32	178; 83.57	≤24	≥25	≥28	187; 81.66
6) Mean annual minimum temperatures (°C).	≤24	≤22	≤20	226; 91.50	≤24	≤24	≤22	184; 86.38	≤24	≤20	≤18	223; 97.38
7) Coldest month of the year.	June	July	August	223; 90.28	June	July	August	167; 78.40	June	July	August	217; 94.76
8) Wind speed (in m/s).	≤2	≥4	≥4	170; 68.82	≤5	≥6	≥6	181; 84.97	≥7	≥8	≥10	215; 93.89

Biophysical Elements

1) Loss of vegetation cover (%) in managed areas.	≥1	≥3	≥5	208; 84.21	≥1	≥2	≥4	170; 79.81	≥1	≥2	≥3	149; 65.06
2) Perennial rivers turned ephemeral (%).	≤25	≥45	≥50	237; 95.95	≤25	>25	≥30	195; 91.55	≤20	≥25	≥30	158; 68.99
3) Water wells dried up (%).	≤20	≥40	≥60	231; 93.52	≤20	≥30	≥40	186; 87.32	≤10	≥20	≥30	164; 71.62
4) Crop production failure frequency, (times per decade).	3	4	6	240; 97.16	3	3	4	189; 88.73	2	3	4	175; 76.41
5) Loss of plant production (%).	≤2	≥5	≥10	218; 88.26	≤2	≥4	≥5	195; 91.55	≤2	≥4	≥5	216; 94.32
6) Flowering of vascular plants (by month).	September	November	November	196; 79.35	September	November	November	185; 86.85	September	September	November	218; 95.20
7) Wild fires frequency (%).	≤5	≥20	≥30	208; 84.21	≤5	≥10	≥20	199; 93.42	≤5	≥10	≥15	216; 94.32
8) Animal die-offs (%) in drought.	≤1	≥5	≥8	234; 94.74	≤1	≥3	≥5	181; 84.98	≤1	≥2	≥5	192; 83.41
9) Animal die-offs (%) in floods.	≤1	≥2	≥5	225; 91.09	≤1	≥2	≥3	187; 87.79	≤1	≥2	≥2	204; 89.08
9) Leaf shedding of trees (by month).	August	September	October	177; 71.66	August	September	November	169; 79.34	September	October	November	194; 84.71
10) Disease epidemics (%) in plants, animals / livestock and people.	≤1	≥5	≥10	137; 95.95	≤1	≥3	≥5	194; 91.08	≤1	≥2	≥7	214; 93.45
11) Coverage (%) of obnoxious invasive plants and weeds.	≤1	≥5	≥8	214; 86.64	≤1	≥4	≥5	206; 96.71	≤1	≥3	≥10	219; 95.63

*Attrib. = Attributes

Rural community responses

There were several ways in which rural communities respond to climate change and variability. In respect to extraction of forest and non-forest products, a total of 437 (63.42%) respondents resorted to increasing charcoal production. Large number of respondents (n=479, 69.52%) reported an increase of up to 8% of hand crafty, basketry, carving, seasonal wild fruit harvesting and bushmeat intake. During years of drought, a mean number of 91 weirs and 200 dams were constructed and shallow wells (≤8 m) were deepened for water harvesting. A total number of 581 (84.32%) respondents reported digging deeper water wells in excess of eight meters to access water in the last two decades. In farming, respondents (n=588, 85.34%) contended that a number of farmers abandoned cultivating late maturing crop varieties for early maturing and drought tolerant rain-fed crop varieties of millet (*Eleusine* sp.), cassava (*Manihot esculenta*) and sorghum (*Sorghum vulgare*). Uptake of conservation agricultural practices aimed at optimizing land use in confrontation with climate volatility was also reported to have escalated by at least 60% in the last decade. In the same practice, farmers planted and preserved *Faidherbia albida* trees in the crop fields to maintain soil fertility and to prevent wind erosion. Pervasive alluvial wetlands became preferable agrarian areas for their moisture and nutrients holding capacities. In high erosion risk zones, particularly in Siavonga of the Zambezi Valley, farmers grew *Euphorbia sp.* and other native plants as an erosion control measure. During droughts and floods, respondents (n=501, 72.71%) reported internal displacement of up to 100% of community members from affected areas to perceived safer areas including urban areas. The movements were largely voluntary, and sometimes assisted by external actors.

Response framework for climate change and variability at base level

Typical relationships and sources of disturbances in Social-Ecological System of rural communities in respect to climate change and variability were described based on community response conceptual framework in Figure 2.

The ecological sub-system (*constituent E*) played host to the natural capital that encompassed natural resources (*constituent A*). The natural resources included forests, wildlife, fisheries and agricultural landscapes. Ecological services provided to rural communities included: water for domestic use, proteins from wildlife, fertile alluvial soils for crop farming and assimilative aquatic habitats for fish and non-forest products such as indigenous vegetables, mushrooms, caterpillars and wild fruits.

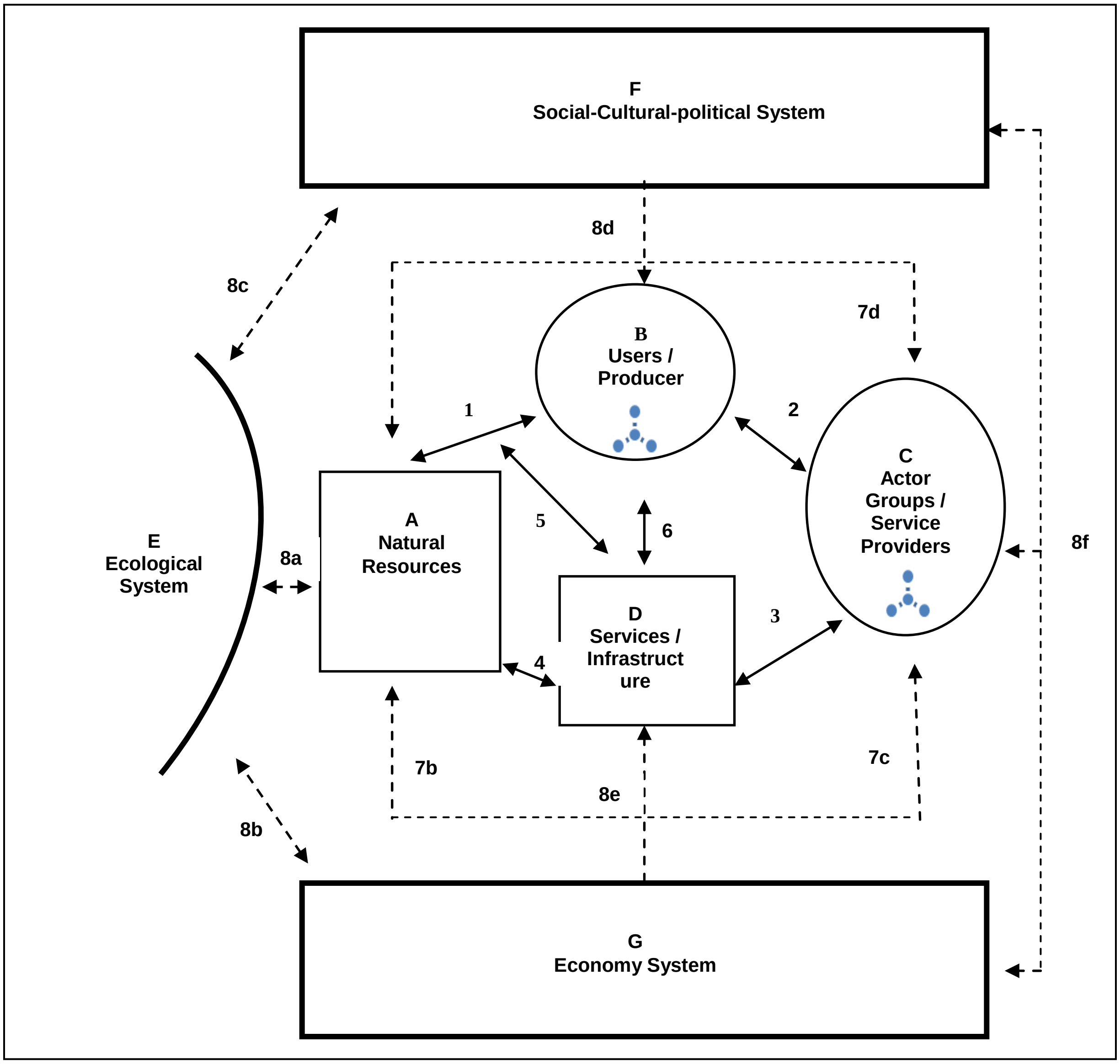

Figure 2. A reconstructed conceptual model for rural community responses to climate change and variability as a social-ecological system, in selected districts of Zambia (Adopted and modified after Anderies *et al*., 2004)

The ecological sub-system interacted with the social-cultural-political (*constituent F*) and economic (*constituent G*) sub- systems. Social-cultural-political sub-system constituted human capital that regulated use of natural capital through intricate value and norm systems (*relationship 1*). Impact on the natural resources by rural community utilization levels was influenced by social learning. Where the social learning was one-way and did not have much expert input, open access was inevitably the outcome. However, where two-ways (dualistic) approaches of social learning was interactively adopted in a shared vision between the rural communities and resource experts, resultant fusion of traditional and expert knowledge improved natural resources sustainability. Social learning maintained the capacity of different local authorities, theme experts, interest groups or actors, and rural communities to manage natural resources in sustainable manner for the benefit of social-ecological system, even in confrontation by a multiple and competing interest situations. The system was predisposed by traditional leadership, community and faith based organizations, non-governmental organizations, interest group associations, unions and societies, and government agencies in a persuasive style.

The ecological sub-system risked receiving rural community pressure, triggered by extreme weather events, high human population growth or increased agrarian activities among others, exerted by the social-cultural-political sub-system, which negatively impacted on resource base (*relationships 1 & 7a*). On the other hand, ecological sub-system had potential of positively contributing to the human development in the form of natural resources based skills. Traditional social and technical knowledge on the ecological aspects was utilized to take advantage of the ecological setting. It contributed to evolving traditional responses to climate change and variability. Climate change and variability description and definitions had been internalized at base level, particularly as they relate to extreme weather events that were experienced. However, incorporation of science based and adaptive traditional methods on ecology were challenging, yet integrative approaches by stakeholders through social learning (including situated learning) fostered enhancement of fusion of knowledge. For instance, flooded alluvial zones were cultivated in subsequent years to improve crop yields. Understanding of ecological aspects led providers of services (*constituent C*) into appropriately cooperating with the rural communities. Collaborative approaches encompassed integrative planning, implementation and monitoring of natural resources.

The social-cultural-political sub-system was built around pervasive traditional structures, with the traditional leaders at their helm. Traditional leaders were advised by traditional councils, whose membership constituted traditional leaders' advisors, influential members of the communities, village headmen and the royal family members with representation at base levels, the villages. There were also informal traditional gatherings by males at secluded places, locally called "*Insaka"* where issues such as impacts of extreme weather events were discussed along gender lines. In addition, women and the youth collectively acted in small gatherings in undertaking their daily chore. Informal and formal traditional structures participated in key roles of communications and refining ideas and information, which contributed to rural community responses through diffusing potential key problems (*relationship 8e*). New ideas and innovations were welcomed by members of rural communities insofar as the ideas were not contradicting with or perceived as undermining the traditional setup. The infusion of ideas depended on the social memory of the societal members about the social-ecological landscape and their ability to hand over the information by oral methods and demonstrations across the horizontal societal structures.

Mechanisms of acquiring knowledge was through traditional norms and rules, superstitions, myths, infractions and sanctions, and took pursuit of indigenous information transfer channels and protocols that were mainly along the traditional, kinship and clan affiliations. Besides, social networks developed even beyond the traditional boundaries in vertical social structures with the neighboring communities and the other allied associations. These communities were associated (*relationship 2*) with the interest actors / service groups (*constituent C*) who had interest to assist the local communities in adapting to climate change and variability. Such groups were able to do so insofar as they had their interests mutually politically, ecologically or economically met by the respective rural communities. They secure their interests through both informal and formal contracts (*relationship 6*) with the concerned communities, largely through political structures within the communities and at high representation levels. In this context, agreed rules assisted in regulating contribution by the parties involved and as such certain conditionalities (*relationship 4*) were met for the service to be provided. The service was in form of capacity building through training, provision of materials and knowledge packages in identified needy areas. Due to complex effects of climate change and variability, the actor groups or service providers faced pressure of providing more technical and material support (*relationship 6*), confronted with limited financial capital (*constituent G*). The service providers included government departments, non-governmental organizations and private sector with interest in local responses to climate change and variability. As a result, positive bonding effect of the social networks within rural community structures and both bridging and linking effects with the outsiders strengthened the social capital. Consequently, collective action towards dealing with disturbances, crises and changes in social-ecological system garnered support among rural communities.

The actor groups which included cooperating partners and local associations depended on the collaboration of the rural communities. Their strengths to continue with the support, which was drawn in diverse social networks not only on local levels but also at regional and international levels, hinged on the ability for the communities to cooperate and participate in the multi-scale landscape management of various environmental resources. The interventions associated with the provision of infrastructure and services (*constituent D*) not only considered the appropriateness of the technology in the context of social-ecological system but also sustainability of the solutions in local context (*relationship 3*). The actor groups/service groups were sensitive to and constrained by the market forces and economic environment (*relationship 8f*).

Emergent environmental forces (*relationship 1 & 5*) such as climate change and variability introduced dynamics to natural resources through human responses. Systematic monitoring of the impacts of these forces was inadequate, but indigenous social and technical knowledge had potential to enhance it. Besides, market forces in the economic realm (*relationships 7b, 7c, 8b, 8e and 8f*) brought about some disturbances, surprises and sense of dependence on external influence in social-ecological system. From historical perspective, during the pre-colonial epoch, the value for materialism was very low as there were limited perceived items of value for the exchange of goods and services on barter basis. The local populace relied on favors called "*Mbasela*" which worked on the principle of trust and reciprocity. On the whole, that lowered the transaction costs that could have been otherwise borne by individuals or communities at higher opportunity costs. With introduction of use of money in its 'liquid' form, the inhabitants perceived that there was propensity for resource commercialization. The challenge, though, was that community institutions were still weak to guarantee sustainable resource commercialization without high risks of failure. Market forces impacting on the natural resource propelled the conservation financing institutions to bring about sustainable resource utilization. International financing policies, supporting reduction of the abuse of common resource pool allowed for availability of more and secure funding towards community conservation projects.

DISCUSSION

Indigenous knowledge system and social learning related to climate change and variability

Causal evidences, provided by rural communities, of changing and variable climate abound at base level and are supported by documentations by GRZ (2007), Pachauri and Reisinger (2007), Sichingabula (1994), Stern (2007), and Zhao and Running (2010). Indigenous knowledge plays a critical role in comprehending the impacts and solutions. It is transmitted through basic traditional, kinship and clan affiliations, which form communication channels that provide means for social learning. However, social learning through informal and kinship networks might not be commonly utilized to broadcast specialized knowledge, intensive technologies and innovations as also reported by Kiptot, Frazel, Hebinck, and Richards (2006), despite being relevant in integrating local technical knowledge on natural resources (Berkes, 2004). This underpins importance of input from other actors for incorporation in indigenous knowledge system. Rural communities, which are communities of practice, place themselves in situations of climate change and variability from which they draw experiences in what could be said as "situated learning". In return, rural communities adaptively respond to extreme weather events. For instance, local solutions to climate change and variability being employed by rural community include selective tree planting for household shades as protection against profuse heat along regular tree planting for forest regeneration and land canopy cover in desolate areas. Other innovations have included adoption of use of energy saving technologies and utilization of flooding zones for food production. Enhanced use of water by means of recycling, in integrated water management setup also manifest where rural communities reduce on wastage of water and apply limited water to different livelihood activities. It is acknowledged that integration of combined approaches for control of soil erosion, siltation and soil fertility improvement, for instance, through fusion with traditional practices gives better outputs.

The effective social learning processes that are taking place among the rural communities can be categorised as dualistic, whereby the rural communities mutually learn from each other and expert knowledge. However, experts also learn from rural communities who interact with situations relatively more than them. Therefore, social learning provides an avenue for community participation, which involves meaningful interaction of members of communities of practice with divergent interests, norms, values and constructions of realities (Glasser, 2007; Wals, 2007). Wenger (1998), for instance, found that social learning on novel and pragmatic practices by local communities increased uptake of early maturing crop varieties, resilient to prevailing drought conditions. He further elaborated that the concept of practice connotes adaptive learning and management through local actions and interactions, where situated learning occurred in robust, complex and social environments. Fusion of traditional technical knowledge with scientific knowledge has been challenging but with intensive extension work by the service providers, some desired results bear fruit. Though, full impact of these interventions can take long span of time and considerable resources.

Social learning effectively takes place in a participatory environment, which could be "one-one" contacts, organized tours, workshops and seminal presentations, functional demonstration sites and innovations of technologies and practices. The other gateway for knowledge transfer is through participatory action research. Participatory action research approaches incorporate free pre-informed consent in various technological applications and give freedom of choice of uptake by the users while increasing the opportunities for success. They involve science based advocacy and lobbying, providing context specific information which is community and expert driven that leads to enhanced community participation.

The link between social learning and information dissemination renders evolution of communities' knowledge driven establishments. It is plausible to have serious gaps in national, regional and international policies due to failure to encapsulate relevant issues relating to rural communities. The impacts of such failures have been consistent with collapse of interventions that are implicitly meant to revamp resilience of the rural communities to adapt to emerging challenges. Combined information transfer approaches facilitate affirmative actions through identification of local strategies necessary to respond to disturbances, crises and challenges such as climate change challenges. Consequently, local resilience to climate disasters is improved while cushioning pervasive dependence on natural resources. The cushioning is supported by public awareness creation. Deliberate and firm established networks with external organizations are essential to development of resilience by rural communities. Participation of broad-based stakeholders like civil society organizations has the potential to increase rural knowledge through awareness creation, science based advocacy and lobbying that would draw participation of communities and other stakeholders to address the challenges. Shackleton, Shackleton, and Cousins (2000) further argued that training of the human capital plays main role in enhancing participation of stakeholders for sustainable resource management.

Linkages between natural resource utilization and rural community responses

Ecological elements risk being affected directly by climate change and variability but also by anthropogenic impacts through natural resource over-utilization by the rural communities to alleviate or cope with disasters, crises and challenges. According to Coomes, Barham, and Takasaki (2004) and Takasaki, Barham, and Coomes (2004), rural communities regress to natural resources for livelihoods provision in times of adversaries. For instance, Zambia looses forests to deforestation rates ranging from 250, 000 to 300,000 ha annually (Zambia Forestry Department & Food and Agriculture Organization, 2008). Chundama (2009) identified climate change and variability as one of drivers of deforestation in Zambia. The rural communities tend to over-utilize the resources during hard times in order to alleviate the associated impacts. Rural communities supplement their dietary with wild fruits (e.g. *Uapaca spp., Schynziophyton spp., Azanza spp., Anisophyllea spp. Afromomum spp., Parinari spp., Flaucortia spp., Strychnos spp., Adansonia spp., Berchemia spp.* and *Ziziphus spp.*), indigenous vegetables (e.g. *Amaranthus spp., Cochurus spp., and Sesamum spp.),* native orchids tubers (e.g. *Satyria spp.*), roots *(*e.g. *Rhynchosia spp.)* and caterpillars. The harvesting of these non forest products, including rattan (*Calamus deeratus*), is unsustainable because the methods and quantities of harvest are often wasteful, especially where weak traditional leadership and social units have not instituted natural resources utilization rules coupled with incidents of production failure. Noncompliant community members receive punitive sanctions against their infractions in communities where by-laws are enforced. The sanctions include simple fines and, in exceptional cases, the offenders are secluded from community participation in roles and consequently lose social recognition and respect. The overexploitation ensues more with the frequency of extreme weather events, primarily because of short time lapse for resilience to meaningfully occur in between such events. However, where interventions are implemented, complex interaction of various elements in the ecological sub-system provides facilitational conditions for the resilience of the ecological system and its natural resources.

The rural community responses underscore the need for sustaining their livelihoods to promote their participation in the natural resource conservation (Barrow & Murphree, 2001; Hulme & Murphree, 2001). Coupling the social learning is the development of capacity in rural communities from appropriate knowledge and skills for effective participation, which contributes positively to problem solving and conflict resolution. In seeking solutions to hardships, the burden of adapting to calamities such as climate change and variability by the rural communities is lessened. However, sustainable resource use at base levels demands that various stakeholders cooperatively act through integrative approach, which is an essential institutional dimension of multi-scale and inter-disciplinary structures beyond catchment and administrative boundaries. The closer they fit between the various subsystems (e.g. ecological, economical and social-political and cultural sub-systems), the more effective the solutions become.

Social capital provides a degree of institutional panacea that communities use to react to adversaries such as disturbances, uncertainties, risks and crises, which can be enhanced by developing adaptive governance structures and processes. Consequently, Herrfahrat-Pahle (2010) indicated that institutions were a critical link between various systems as they controlled utilization and overuse of resources. As the purpose of such community institutions is to participate in the management of natural resources, they are intended to be institutions of sustainability. Institutions of sustainability ensure that natural resources are not depleted due to overuse, regardless of drivers of change (Hagedorn, 2008). At most, they aim at avoiding Hardin's (1968) tragedy of the commons. Inversely, change in status of natural resources has potential of changing economic and socio-cultural-political systems. Ostrom, Burger, Field, Norgaard, and Policansky (1999) and Barret, Brandon, Gibson, and Gjertsen (2001) postulate strong institutions with adequate authority; capacity to manage access to resources; creativity to innovatively construct the rules, monitor their compliance, and enforce them; to provide adequate incentives for conservation efforts; and to resolve emerging conflicts in natural resource management.

The functional tenets for improving the structures would be through the management processes which include devolution of rights, roles and responsibilities of entities of the structures that convey appropriate measure of power and authority beyond structural requirements to local communities (Nyirenda, Chansa, Myburgh, & Reilly, 2010). Proprietary rights, authority and power by rural communities over natural resources are a critical development factor (Murombedzi, 2001). Ostrom (2005) suggests that community response options can be enhanced by relationships within polycentric structures, which could also improve the outcomes of responses to perturbations and crises. Such responses, according to Folke *et al.* (2005), are premised on the existence of effective leadership in various organizational structures and taking advantage of the social memories of the social-ecological systems. Therefore, renewal of community structures may be required to improve relations among rural communities and with actor/service groups (Jones & Murphree, 2004; Ostrom, 2005; Tongson & Dino, 2004). The intricacy related to spatio-temporal interdependencies between actions and actors requires well-functioning institutions and appropriate governance architecture, through such initiatives as conceptualization of institutions for sustainability (Hagedorn, 2008).

MANAGEMENT IMPLICATIONS

Management actions should be premised on both internal and external legitimization of rural community processes and structures. Internal legitimization can be achieved through deliberate institutional strengthening of the community institutions and social units, by building capacity in the rural communities to enable them undertake resilient cooperative actions for climate change and variability adaptation. Rural communities need material, financial and technical assistance towards development of alternative livelihoods and entrepreneurship to traditional practices such as charcoal production, encouraging them to conserve natural resources. Well planned and subsidised projects such as rural electrification, water conservation and harvesting, offshore fish and *ex-situ* organic mushroom production, traditional erosion and siltation controls, and non-forest products development, which would benefit majority of the rural communities, would be required in addition to traditional agro-forestry practices. Self-reorganization of myriad multi-level community institutions such as community and faith based organizations and traditional institutions is critical to enforcing relational social capital that pragmatically regulates land use practice. Community institutional adaptive governance at base level supports the concept of subsidiarity (Cumming, 2004; Hegadorn, 2009). Subsidiarity concept relates to delivery of collective action by “grass root” institutions which tend to be sustainable and more effective than at higher levels of organization. With decentralization policies in force, it is through local organizations that the interest actors/service groups perform their actions related to natural resource management.

External legitimization of the rural community participation in natural resources management can be enhance by effective legislation, which conveys rights, powers and authority to rural communities. In addition to enacting and revising legislation, appropriate locally developed monitoring and evaluation systems are important and include key indicators in respect to natural resource management, sanctioned or relinquished rights and power, and wealth creation. Monitoring may encompass ecological monitoring by local communities on such parameters as breeding success of bird species such as guinea fowls (*Numida meleagris* and *Guttera pucherani*) and red billed quelea (*Quelea quelea*), which risk being negatively impacted upon by climate change and variability. Another means of external legitimisation encompasses participatory action research into adaptive measures against climate change and variability such as energy saving technology transfer to rural communities to avoid wanton fuel wood harvesting, cultivating in wetlands during drought seasons and pond fish production in floodplains (aquaculture). In executing various interventions, there is need for constant engagement with rural communities.

CONCLUSION

This study found that perceptions formed by social learning processes play a key role in influencing rural community responses to climate change and variability. We conclude that social capital and adaptive governance processes and structures can influence rural community responses in fostering sustainable utilization of natural resources as alleviation and coping strategies. By communities of practice developing sustainable social capital in adaptive governance style, natural resources utilization would be sustainable even during times of climate induced adversaries. Therefore, while we acknowledge poverty and legislation as important drivers in determining rural community responses to disturbances and crises, we propose that mechanisms and events in communities of practice that influence their social learning and participation in adaptative and sustainable natural resource management should be considered. Further research is required to determine levels of tolerance by rural communities, associated with natural resource overexploitation and biodiversity loss induced by extreme weather events.

ACKNOWLEDGEMENT

The study benefited from partial involvement of Zambia Civil Society Climate Change Network (ZCSCCN) in data gathering. We gratefully acknowledge participation of field assistants in data gathering. Part of the study grant came from Department for International Development (DFID). The map in this publication was produced by Gabriel Mushinge, GIS specialist. We are also grateful to two anonymous reviewers that constructively critiqued the initial manuscript.

REFERENCES

Anderies, J. M., Janssen, M. A. & Ostrom, E. (2004). A framework to analyze the robustness of social – ecological systems from an institutional perspective. *Ecological Society,* 9(1), 18. Retrieved from: http://www.ecologyandsociety.org/vol9/iss1/art18, on 5 March 2009.

Ballet, J., Sirven, N. & Requiers-Desjardins, M. (2007). Social capital and natural resource management: A critical perspective. *Journal of Environment and Development,* 16(4): 355-374.

Berkes, F. (2004). Rethinking community based conservation. *Conservation Biology*, 18: 621-630.

Barret, C. B., Brandon, K., Gibson, C. & Gjertsen, H. (2001). Conserving tropical biodiversity amid weak institutions. *BioScience*, 51, 497-502.

Barrow, E. & Murphree, M., (2001). Community conservation from concept to practice: a framework. In D. Hulme & M. Murphree (Eds.), *African Wildlife and Livelihoods: The Promise and Performance of Community Conservation* (pp. 24-37). New Hampshire: James Currey.

Bradburn, N., Sudman, S. & Wansink, B. (2004). *Asking questions: the definitive guide to questionnaire design–for market research, political polls, and social and health questionnaires*. Revised edition. California: Jossey-Bass.

Conservation Farming Unit, 2009. Conservation Farming and Conservation Agriculture Handbook for Hoe Farmers in Agro-Ecological Regions I and IIa, Flat Culture. Lusaka: Conservation Farming Unit.

Chundama, M. (2009). *Preparing for REDD in dryland forests: investigating the options and potential synergy for REDD payments in the Miombo eco-region. Zambia Country Study.* London: International Institute for Environment and Development.

Collier, P. (1998). *Social capital and poverty*. Social Capital Initiative Working Paper No. 4. Washington, D.C.: The World Bank, Social Development Family, Environmentally and Socially Sustainable Development Network. Retrieved from: http://www.siteresources.worldbank.org/intsocialcapital/resources/social-capital-working-paper-series/sci-wps-04.pdf, on 9 March 2011.

Coomes O. T., Barham, B. L. & Takasaki, Y. (2004). Targeting conservation–development initiatives in tropical forests: insights from analyses of rain forest use and economic reliance among Amazonian peasants. *Ecological Economics,* 51: 47-64.

Cumming, D. (2004). Performance of parks in a century of change. In B. Child (Ed.), *Biodiversity, rural development and the bottom line.* London: Earthscan.

Folke, C., Hahn, T., Olsson, P. & Norberg, J., 2005. Adaptive governance of social-ecological system. *Annual Review of Environmental Resources,* 30: 441-473.

Glasser, H. (2007). Minding the Gap: The role of social learning in linking our stated desire for more sustainable World to Our everyday actions and policies. In A. E. J. Wals, (Ed.). *Social learning: Towards a sustainable World.* Wageningen: Wageningen University Press.

GRZ (Government of Republic of Zambia) (2007). *Formulation of the National Adaptation Programme of Action on Climate Change*. Lusaka: Ministry of Tourism, Environment and Natural Resources.

Hardin, G. (1968). The tragedy of the commons. *Science*, 162, 1243-1248.

Hagedorn, K. (2008). Particular requirements for institutional analysis in nature-related sectors. *European Review of Agricultural Economics,* 35 (3): 357-384.

Herrfahrat-Pahle, E. (2010). South Africa water governance between administration and hydrological boundaries. *Climate and Development Journal*, 2:111-127.

Hulme, D. & Murphree, M. (2001). Community Conservation as Policy: Promise and Performance. In D. Hulme & M. Murphree (Eds.), *African Wildlife and Livelihoods: The Promise and Performance of Community Conservation* (pp. 280-297). New Hampshire: James Currey.

Hyndman, D. & Hyndman, D. (2009). Natural hazards and disasters. Belmont: Brooks Cole.

Jones, B. T. & Murphree, M. W. (2004). Community based natural resource management as a conservation mechanism: lessons and directions. In B. Child (Ed.), *Biodiversity, rural development and the bottom line*. London: Earthscan.

Kiptot, E., Frazel, S., Hebinck, P. & Richards, P. (2006). Sharing seed and knowledge: Farmer to farmer dissemination of agroforestry technologies in western Kenya. *Agroforestry Systems*, 68(3), 167-179.

Lather, P. (1986). Issues of Validity in Openly Ideological Research: Between a Rock and a Soft Place. *Interchange,* 17 (4): 63-84.

Murombedzi, J. (2001). Why wildlife conservation has not economically benefited communities in Africa. In D. Hulme & M. Murphree (Eds.), *African Wildlife and Livelihoods: The Promise and Performance of Community Conservation* (pp. 208-226). New Hampshire: James Currey.

Nyirenda, V. R., Chansa, W. C., Myburgh, J. W. & Reilly, B. K. (2010). Social capital and community responses to natural resource management in the Luangwa Valley, Zambia. *Journal of Sustainable Development in Africa, 12(8): 158 – 179.*

Ostrom, E. (2005). *Understanding institutional diversity*. Princeton: Princeton University Press.

Ostrom, E., Burger, J., Field, C. B., Norgaard, R. B. & Policansky, D. (1999). Sustainability – Revising the commons: Local lessons, global challenges. *Science*, 284, 278-282.

Pachauri, R. K. & Reisinger, A. (Eds) (2007). *Climate Change: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change (IPCC)*. Cambridge: Cambridge University Press.

Patton, M. Q. (2002). *Qualitative Research and Evaluation Methods.* Third Edition. London: Sage Publications.

Pegram, G., von der Heyden, C. & Eaglin, F. C. (2009). Strategic Transboundary water assessment. Regional Climate Change Programme. Cape town: Department for International Development.

Pretty, J. (2003). *Social capital and connectedness: Issues and implications for agriculture, rural development and natural resource management in ACP countries*. CTA Working Document No. 8032. Pp. 46.

Putnam, R. D. (1993). *Making democracy work: Civic traditions in modern Italy*. Princeton: Princeton University Press.

Shackleton, S., Shackleton, C. & Cousins, B. (2000). *Re-valuing the Communal Lands of Southern Africa*. NRP, No.62. London: ODI

Sichingabula, H. M. (1994). *Some historical perspectives on drought in Zambia. Paper presented at the International Conference on Climate and Survival in Southern Africa*, sponsored by The British Council, Victoria Falls, Zimbabwe, February 21-25, 1994.

Stern, N. (2007). *The economics of climate change: The Stern Review.* Cambridge: Cambridge University Press.

Takasaki Y., Barham B. L. & Coomes O. T. (2004). Risk coping strategies in tropical forests: floods, illnesses, and resource extraction. *Environment and Development Economics,* 9: 203-224.

Thurlow, J., Diao, X. & Zhu, T. (2009). The impact of Climate Variability and Change on Economic Growth and Poverty in Zambia. Discussion Paper 00890. Lusaka: IFPRI.

Tongson, E. & Dino, M. (2004). Indigenous peoples and protected areas: The case of the Sibuyan Mangyan Tagabukid, Philippines. In T.O. McShane & M.P. Wells (Eds.), *Getting Biodiversity Projects to Work: Towards More Effective Conservation and Development* (pp. 181-207). New York: Columbia University Press.

Wals, A. E. (Ed). (2007). *Social Learning Towards a Sustainable World: Principles, Perspectives, and Praxis*. First Edition. Netherlands, Wageningen: Wageningen Academic Publishers.

Wenger, E. (1998). *Community of Practice: Learning, Meaning and Identity*. Cambridge: Cambridge University Press.

Woolcock, M. & Narayan, D. (2000). Social capital: implications for development theory, research and policy. *World Bank Research Observations,* 15(2): 225-249.

Zambia Forestry Department & Food and Agriculture Organization, 2008. Integrated land use assessment (ILUA), Zambia, 2005 – 2008. Lusaka: Zambia Forestry Department & Food and Agriculture Organization.

Zhao, M. & Running, S. W. (2010). Drought – induced reduction in global terrestrial net primary production from 2000 through to 2009. *Science,* 329 (5994): 940 – 943.

ABOUT THE AUTHORS:

Vincent R. Nyirenda: Directorate of Research, Planning, Information and Veterinary Services, Zambia Wildlife Authority, Chilanga, Zambia

Chansa Chomba: Disaster Management Training Centre, Mulungushi University, Kabwe, Zambia

Victor M. Siamudaala: The Nature Conservancy, Zambia Programme, Lusaka, Zambia.