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THE USE OF INDIGENOUS KNOWLEDGE IN FLOOD DISASTER FORECASTING FOR FLOOD DISASTER RISK REDUCTION IN NORTHERN KATSINA STATE

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ABSTRACT

This study investigates the use of indigenous knowledge by the communities of semi-arid areas of Katsina state in forecasting/predicting the risk of flood disaster. Data were collected through semi-structured interviews with purposefully selected respondents and focus group discussions. It was found that indigenous knowledge of disaster monitoring, prediction and early warning is based on the observation of behaviors of animals, birds, insects, shrubs, trees, wind, temperature, and cloud among others. The communities of northern Katsina state faces other natural disaster challenges, flood is among the major disaster risk experienced by the population and over the years they have evolved indigenous ways that helped them not only in predicting this natural disaster but also in devising techniques and mechanism of dealing with it. Documentation of disaster risk reduction information and development of disaster risk reduction policy was recommended to deal with the situation.

Keywords: Indigenous knowledge, flood, disaster, forecasting, disaster risk reduction.

INTRODUCTION

Flood disaster poses a serious threat to the environment in both urban and rural areas. It is described as an overflow of water on the normally dryland (Tschakert, 2009). Some have argued that incidences of floods were not widely studied as drought disasters in dry land of West Africa (Kundezwez, 2014).

Relief Web (2019) quoting the report of the Centre for Research in the Epidemiology of Disaster indicated that in 2018, flood affects more people than any other natural disaster with 127 major cases and 24% of the total death from natural disaster. Jain et al., (2018) claimed that between 1900 – 2006 floods accounted for nearly 50% of the total natural disasters, claiming 19% of the total fatalities and affected 48% of the total number of people affected by different forms of natural disasters. They projected an increase in losses due to the effect of climate and land-use changes, deforestation, rising sea level, population increase in flood risk areas causing the number of people susceptible to flood disaster to increase globally. In the 1970s and 1980s different types of indices and computational models were developed with a view of providing timely, relevant and comprehensive information on impending flood to mitigate and minimize their impact (Jain et al., 2018). But flood early warning system depends on the weather forecast and most African countries weather forecast is bedeviled with many problems including inadequate coverage of weather station, very poor facilities and the content of the forecast reports and channels used in the dissemination of the reports do not take cognizance of the farmers' needs and is largely irrelevant at the local level. Hence communities in different parts of Africa relied on their indigenous knowledge to forecast weather in making decision in each step of the farming process and other activities.

As a result of the increasing effect of flooding worldwide, experts (e. g. Tschakert, 2009) have called for a paradigm shift from giving priority to structural measures to increasing emphasis to non-structural flood protection measures, which included optional flood forecasting system and warming system with a view of alerting the general public and the authorities concerned of an impending flood. But in African countries data gathered from weather forecasts are not widely accessible, lacked the desired scalability, instrumental discrepancies and unlocalized data set or inapplicable to local situations. (Masinde, 2018). In other words, apart from the problem of reliability shortcomings, scientific forecasts have spatial and temporal limitations for use at village level. Also, persistent rainfall variability in West Africa has increased uncertainty in seasonal rainfall prediction, thereby posing a greater challenge to scientists in their effort to improve forecast accuracy and reliability (Tedesse et al., 2008). It is increasingly acknowledged that scientific data alone cannot give precise information on local climatic variation to effectively address the problems posed by flood challenges. Indigenous knowledge of flood disasters needs to be investigated and integrated with scientific perspectives and come up with the acceptable proposal for ameliorating the flood challenges (Okoya, et al., 2017).

It is widely documented that small-holder farmers in most African countries relied on indigenous knowledge of weather to make a critical farming decisions and to improve weather and climate disasters preparedness. The frequent reoccurrence of disasters, low literacy and technical knowledge, lack of access and ineffectiveness of formal disaster management agencies have compelled many communities to rely heavily on traditional and local coping strategies to mitigate disaster risk (Ngwese et al., 2018). Intergovernmental Panel on Climate Change (IPCC) (2010) acknowledges that "indigenous and traditional knowledge may prove useful for understanding the potential for certain adaptation strategies that are cost-effective, participatory and stainable''. Such knowledge system and practice are being used to minimize the effect of flood disaster risk. Even though the importance of Indigenous

Knowledge (IK) had been widely recognized, its relevance in disaster risk reduction is yet to get the desired attention. This study attempt to document information related to the role and the use of IK in flood disaster forecasting in northern Katsina State, an area described as ecologically fragile where the majority of the population could not produce enough food for year consumption (Abdulrashid, 2012; 2020).

LITERATURE REVIEW

Flooding

Floods occur when peak discharge exceeds channel capacity and this is brought about by intense precipitation. Due to the uncertainty surrounding the magnitude, timing and place of occurrence, geographical extent, and geophysical interaction of floods, it is often not possible to completely control them. Floods can be of many different types and scales. Jain et al., (2018) distinguish five different types of landscape with characteristics flooding behavior:

(a) High mountain ranges, which are mainly subject to flash floods and geophysical flow

(b) Foothill areas where floods are caused by intense rainfall and snow-melt and where invasion is widespread,

(c) Large flood plains where velocities are low and floods occur because the landscape is unable to quickly pass all the incoming flows.

(d) Urban areas where flooding is generated by inadequate sewer capacity and numerous barriers of flow and

(e) Coastal areas

The purpose of flood forecasting and warning system is to alert the general public and authorities of an impending flood in advance and with much reliability, as possible. The main components of a flood forecasting and warning system include:

(i) Data (hydrological, meteorological) collection and transmission

(ii) Forecasting involving analysis of observation as well as prediction of future rainfall, water elevation and discharge for periods varying from a few hours to days ahead.

(iii) Dissemination of information to user's agencies and communities. (Jain et al., 2018).

Indigenous Knowledge: Definitions and Perspectives

There has been growing awareness that scientific knowledge alone is not adequate for solving climate-related disasters, the knowledge of local and indigenous people is increasingly recognized as an important source of information that will be used to reduce disaster risk in different part of the World (Masinde et al., 2018)

Indigenous knowledge (IK) has been leveled differently in the literature including traditional knowledge, traditional ecological knowledge, local knowledge, farmer's knowledge, indigenous science, folk knowledge, ethnoscience and folk knowledge. Hence different researchers and scholars define indigenous knowledge in different ways. Thus, several perspectives need to be reviewed to have a better understanding of the term indigenous knowledge. Berkes, (2012) sees indigenous knowledge as "a cumulative body of knowledge practice and belief, evolving by adaptation process and handed down through generations by cultural transmission, about the relationship of living beings with their environment". These knowledge systems are transmitted and renewed by each succeeding generation, ensuring the well-being of people by providing food security, environmental conservation and early warning system for disaster risk reduction. Indigenous knowledge is also seen as a knowledge system and skills which people in particular geographical area possess, and which enable them to get the most out of their natural environment (Ajibade and Eche, 2017).

Indigenous knowledge is also viewed as a piece of knowledge, skills and practice that are developed, sustained and passed on from generation to generation within a community, often forming part of its cultural or spiritual identity (Eyong, 2007).

It has also been referred to as knowledge that people in each community have developed over time and continue to develop, often tested over centuries, adapted to the local culture and environment and embedded in community practices, institutions relationships and rituals. (Motongoya et al., 2017)

The knowledge and skill passed by successive generations and often by the new generation is in a constant adjustment to changing circumstances and environmental conditions. In defining IK, it is important to take cognizance of the changing physical and social environment and associated generation of contemporary ways of knowing (Iloka, 2016).

However, it is important to bear in mind that indigenous knowledge may not be a panacea for all environmental problems and not all indigenous ways of living are sustainable (Ngwese et al., 2018)

Disaster and Disaster Risk Reduction

Disaster

The United Nations Strategy For Disaster Reduction (UNISDR, 2002) defines disaster as a ‘’serious disruption, of the functioning of a society causing widespread human, material or environmental loses, which exceed the ability of the affected society to cope using only its resources ‘’ it is also seen as an unusual natural or man-made event, including an event caused by the failure of the technological system, which temporarily overwhelms the response capacity of human communities, groups of individuals or natural environment and which cause massive damage, economic loss, disruption, injury and/or loss of life. (Iloka, 2016). This indicates that not all adverse events are disasters only those overwhelm response capacity.

Disaster Risk Reduction

There are numerous definitions of Disaster Risk Reduction in the literature but the most widely cited definition is the one used by UNISDR, (2002) it defines disaster risk reduction as "as the systematic development and application of policies strategies and practice to minimize vulnerabilities and disaster risk throughout a society, to avoid (prevent) or to limit (mitigate and prepare for) the adverse impact of hazards, within the broad context of sustainable development". Also, UNISDR (2009) reports described Disaster Risk Reduction as the concept and practice of reducing risk through systematic efforts to analyze and manage the causal factors of disasters, including through reduced exposure to hazards, lessened vulnerability of people and property, wise management of land and the environment, and improved preparedness for any such adverse events.

Baumwoll (2008) view disaster risk reduction as the steps taken before disaster occur, or the pre-disaster activities and these steps were taken to reduce the impact any disaster may have. Disaster risk reduction therefore, refers to action taken before and after a disaster that are aimed at preventing, reducing and limiting the negative impact of a disaster. From these perspectives, it can be deduced that disaster risk reduction has three important elements: minimization of vulnerabilities, avoidance of the hazards, and the limitation of the impacts of the disasters.

MATERIALS AND METHODS

Geographic Setting of the Study:

The study area is located between latitude 12o52'N and 13o19'N and longitude 7o16'E and 7o43'E. Six villages were selected Birni Kuka, Sawani, Bumbum, Magama, Dankama and Yakubawa). In other words, one village was selected from of each one of the six local governments (Jibia, Kaita, Mashi, Maiadua, Zango and Baure) of Katsina State that share a border with the Niger republic. The landscape is underlain by sedimentary rock, dominantly flat with an average height of 300 meters above sea level (Abdulrashid, 2012). Local vegetation adapts to the climatic rhythm of long dry season and short wet season. The dominant trees in the area developed long tap roots, thick barks which allow them to withstand the long dry season and bush fire. The rainfall is received between May-September; the annual average is below 700mm. Temperature are high most part of the year with the mean daily between 27oc to 40oc between March and May and 18oc to 25oc in November-February (Tomlinson, 2010). The soils are sandy ferruginous type of latosols, highly weathered, altered and slightly acidic due to low organic matter content and phosphorous, subsistence rainfed farming is the major economic activity; scattered irrigation farming is also being practiced along the river plain flood (Abubakar, 2006).

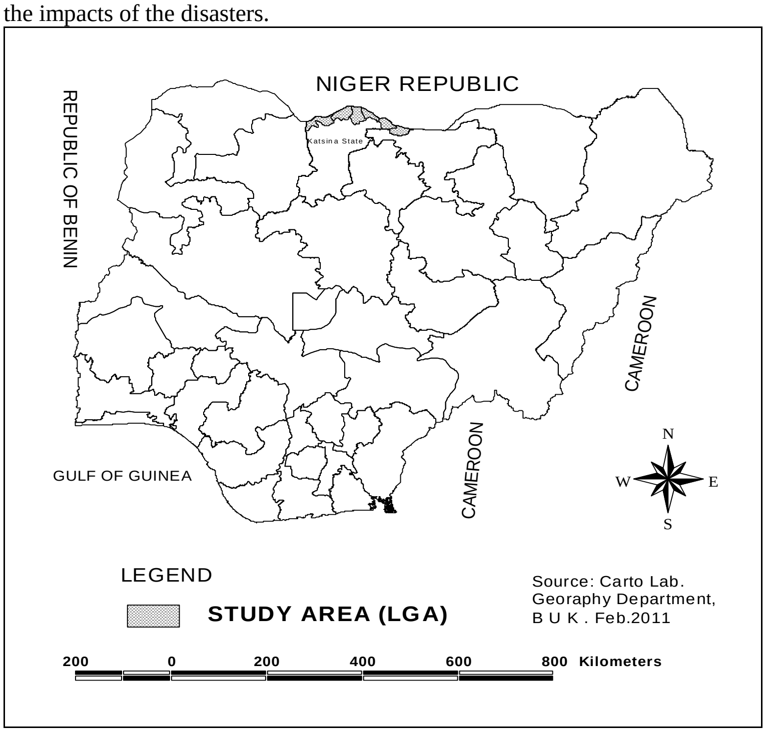

Figure 1: Location of Study Sites within Katsina State and Nigeria

Reconnaissance and Pilot Surveys

Data were collected between15th July – 10th August 2019. A Reconnaissance survey was conducted to increase familiarity with the study area and the purposes of the research were explained to the local traditional rulers to get their permission and maximum cooperation from their subjects.

The villages were systematically selected and the number of respondents chosen in each village takes into consideration its population size. A pilot survey was conducted to test the reliability and viability of the research tool and technique. All the research assistants that help in questionnaire administration are tertiary institution students and are well familiar with the terrain of the villages and fluent in the local language (Hausa) spoken by the majority of the population.

Table 1: **Sample Sizes and Some Characteristics of the Study Area**

Local Govt.	Villages	Location (Coordinate)	Estimated Population	Sample taken	Dominant tribe
Baure	Sawani	$12^0$52'N, $8^0$49'E	1,300	23	Hausa/Fulani
Maiadua	Bumbum	$13^0$16'N, $8^0$07'E	1,700	27	Hausa
Mashi	Birnin Kuka	$13^0$19'N, $07^0$59'E	3,200	42	Hausa/Fulani
Jibia	Magama	$13^0$06'N, $07^0$16'E	3,600	46	Hausa
Kaita	Dankama	$13^0$18'N, $07^0$47'E	4,500	55	Hausa/Fulani
Zango	Yakubawa	$13^0$04'N, $08^0$29'E	1,800	28	Hausa/Fulani
Estimated Population and Samples sizes respectively			16,100	221	

Sources: Field Work (2019)

Semi structure questionnaires with open-ended and close-ended questions were used to get information on the available indicators used to predict the occurrence of the flood in each village (Ngwese et al., 2018).

Focus group discussions (FGD) were held in each of the six villages. The FGD is aimed at weighing and balancing the information derived from questionnaire administration with a view of getting a consensus and develops a generalization on the use of IK in forecasting floods in each village. Selection of the FGD members take into consideration age, gender, literacy (Western or Arabic/Islamic knowledge's) and social status of the participants as these factors are believed to affect variation in traditional knowledge in communities (Mogotisi et al., 2011)

Local plant names mentioned by the respondents and verified during the FGD were later matched with scientific ones using the following references; Von May dell (1990) and Blench (2007).

RESULTS AND DISCUSSION

Questionnaires (221) were administered to men (77%) and women (23%). Only 34% of the respondents have a formal education but all have attended Quranic schools. Farming is the primary occupation of 96% of the respondents. Different types of domestic animals were kept by the villagers, goats, being the most common (81%) owned by the household. Other animals include sheep (52%); cattle (22%); donkeys (13%); camel (7%). Four types of domestic birds were kept chickens (61%); ducks (5%); pigeon (3%); Guinea fowl (22%). Most of the respondents (54%) kept domestic animals for their cash value, not for their food potentials. Money obtained from the sale of animals was used to purchase food to fill in the harvest deficit, buy cloth and finance other expenses particularly wedding ceremonies.

The Majority of the respondents practiced rainfed cultivation but fadama cultivation was practiced by thirty-seven percent of the respondent most of them from Jibia, Kaita and Maiadua Local Governments. Most planting of Fadama occurred late spring before the arrival of first rain. The most prominent cultivars grown in the Fadama include tomato, Onion, chill pepper, sweet potato, lettuce, Okara cabbage, carrot, watermelon and others. Also grown in the Fadama together with the domesticated crops were numerous so-called "edible weed" of agriculture define as volunteer species and recognized as food resource (Acharya A and Peader, 2016)

Type of Disasters experienced in northern Katsina state

Frequent floods cases are common disasters related to climate affecting Northern Katsina State. Farmers can recall severe drought that occurred in the 1940s, 1950s, 1970s, 1980s, 1990s and 2000s (Abdulrashid, 2020) and floods that occur almost every year. The communities acknowledge that they could not stop the disasters once they occurred, but could mitigate them in the form of preventive or remedial measures. The approach or measure taken depends on the prediction/forecasting of disaster and its possible severity and consequences. The communities largely depend on indigenous knowledge to forecast or anticipate most of the disasters that affects them particularly weather and climate-related disasters.

The major disaster hazards mentioned and prioritized by the respondents were presented in table 2. Base on the potential risk they posed on farming and pastoral communities source of livelihood. The highest proportion of the respondents (82%) believed that drought followed by desertification (66%) and flooding (62%) were the most devastating disasters in the area. This could be attributed to the impact of drought, desertification and flooding experienced and documented in the past years such as the decrease in water and pasture availability, crop failure, increase food, insecurity and malnutrition, increase susceptibility in human and livestock diseases, migration and increase in school drop-out due to community migration in search of pasture and water, farmers and herders conflict.

Table 2: Severity Ranking of Types of Disasters Mentioned By Respondents

No.	Major Hazards	Severity Rank	% of the Respondent
1	Droughts	1	82
2.	Desertification	2	66
3.	Floods	3	62
4.	Bush fires	4	52
5.	Farmers/herders Conflicts	5	50

Indigenous Techniques of Floods Forecasting For Disaster Risk Reduction

Communities of Northern Katsina State used different strategies to forecast flood hazards by assessing and interpretation of locally observe variable such as biological/indicators (plants, animals and insects) meteorological, astronomical and historical events as outlined in table 3.

Table 3: Biological Indicators of Floods Prediction/Forecasting

Indicator	Signs	Prediction
Biological indicators Plant phenology	• Dense Flowering of *Acacia nicolita,* heavy rain expected in the season • An abundance of *Adansonia digitata* tree fruits • Late appearance of *Alyiscapus vaginalis* in the farms (locally called gadagi), is an indication of prolong rainfall season. The plant grows normally at the end of the rainy season • The decrease in harvest of *Cucumus melo* (Gurji) • Growth of dense leaves of *ficus polita(* Durumi*)* The Abundance of the fruit of *Lannea acida* (faru) • Abundance of leves of *Guiera senegalansis* in the rainy season (Sabara) • Abundance of fruit of *Tamarindua indica* (tsamiya)	Flood is expected Flood is expected Food is expected Flood is expected Flood is expected Flood is expected Flood is expected
Nest of Birds	• Nesting of quail birds high on trees near rivers • Other birds make more nest	Flood is expected Flood is expected
Migration of birds	• Delay in migration of certain birds in the rainy season from north to south indicate prolong the rainy season and possibility of flooding	Flood is expected

Source: Fieldwork (2019)

The communities during FGD have mentioned how they cope and survive natural disasters, by monitoring the environmental condition around their areas and make meaningful predictions and take appropriate actions to mitigate the disasters and associated hazards. Also, the communities have demonstrated that a well-conserved environment helps to prevent or minimize the occurrence of natural disasters and also enables people to mitigate and cope with natural disasters when they occur.

The communities have repertoires of early warning indicators for coming disaster as shown in table 3. The Adasonia digitata is one of the important plants used as indigenous early warning indicators for rainfall occurrences and the potential of flooding in all the villages visited. The tree shed all leaves at the end of the long rainfall season and remains leafless during the long dry season. The communities also use the fruiting pattern of the tree to forecast the likely performance of the season; especially rainfall failure and drought. Also, the communities used the height of the nest of quail birds locally called gado to predict floods. When floods are likely to occur, the nesting of the quail birds is very high up the trees close to the river and when floods are unlikely, the nest are down. These correspond with the account given by the communities as reported by Joshua et al., (2017) in Malawi; Ajibade and Eche (2017) in Central Nigeria, Okonja et al., (2017) in Uganda; Iticha and Husen (2015) in Ethiopia.

The sound produces by livestock, birds and insects before the onset of rainfall is observed as a warning sign of imminent rainfall and the potential of flood, the electromagnetic field that happens before extreme events like tornadoes, the animals may be reacting to ultrasound or micro temblors which cannot be heard by human (Matongoya, et al., 2017)

Table 4: Metrological Indicators of Flood and Drought

Indicators	Prediction/Forecast
Meteorological	
The dark cloud in the rainy season	Flood is expected
Excessive cold in the rainy season	Drought is expected
Excessive wind and dark cloud	Flood is expected
Frequent appearance of rainbow	Drought is expected
High temperature & dark cloud	Flood is expected.

Source: Fieldwork (2019)

Meteorological indicators such as temperature, humidity, clouds and wind direction before or during the rainy season are used by the communities of the study area to forecast the timing, intensity and duration of rain which in turn is used to ascertain the potential of flood in conjunction with biological and astronomical indicators. In other words, flood forecasting signs are observed through the specific behaviour of locally available plants and animal behavior, monitoring weather and climatic elements changes, and through the nature of the behavior of celestial bodies (Iloka, 2016). The indicators are locally-bound and case-specific, they stem from the community close relationship to the surrounding environment. The use of meteorological indicators in predicting flood and drought is a common phenomenon as indicates in different studies (Nwese et al., (2018) in Ghana; Masinde et al., (2018) in South Africa, Iticha and Husen (2018) in Ethiopia

Astronomical indicators, in comparison with other groups of indicators, constitute a smaller group as shown in table 5. Many communities cited concentric rings around the moon as a sign of heavy rainfall and potential for the flood. Communities in other part of the world were also using moon position to predict the occurrence of environmental hazard (e.g. in India as reported by Achyara and Poddar (2016). Also, solar eclipse is being used by the communities to forecast the occurrence of drought by recording moon and sun eclipse and determine the time of occurrence of drought.

Table 5: Astronomical Indicators of Floods and Droughts

Indicator	Sign and symbols	Prediction
Astronomical indicator Moon Star	• Frequent eclipse of the moon in the rainy season	Flood is expected
	• Morning star (*Suraiya*) observed 240 days without eclipse	Flood is expected
	• Moring star (*Suraiya)* hide from view for more than 60 days	Drought is expected.

Flood Mitigation and Adaptation Strategies Used By the Communities

Communities of northern Katsina state were using variety of coping, adaptation and mitigation strategies to minimize the effects of flood hazards. The strategy of cultivation of different crops is widely used. This strategy helps to reduce total crop failure due the varying tolerance of crops to environmental stress. Mixed cropping was used by the communities to stabilized yields, preserved soils and makes it possible to harvest different crops at the same time; growing water-resistant and early maturing indigenous crop varieties; gathering wild fruits and vegetables; planting of crops that require more water in flood susceptible areas. The communities also use different mechanical methods to minimize the effect of flooding which include the use of grass strip to control flooding, most of the grass species used in making the strip are grasses that grow naturally at the beginning of the rainy season. As soon as they reached a certain stage of growth, farmers transplant them to areas with a high susceptibility of erosion or flooding in a strip form to minimize the effect of runoff and flooding. Grass such as Adropogon psedopricous or "cuchi," as it is called in Hausa, was observed in Sawani and Cassia tora or "tafasa," in Dankama. Cut-off drains were also observed in Magama. It is an open trench with an earth embankment on the lower side designed to protect large areas of land against severe overland flow. A Large cut–off drain was also used close to Birnin Kuka Village. According to the local farmers, it was built by the company that constructed the Mashi – Birni Kuka road. It was designed to collect and lead excess run off to the nearby river. It was built along the slope to ease the draining of runoff and minimize flooding of nearby farms and prevent erosion of the road shoulders. Trash lines barriers were also used to minimize the effect of flooding; these barriers are made of up removed weeds, e.g. in Bumbum, or sacks filled with sand as observed in Dankama. Trash lines function like a grass strip by reducing run-off velocity and the erosive power of run-off, it helps to trap sediment, increase infiltration and retain soil moisture around the vicinity of the barrier at the same time releasing the excess water. Stone lines were also used to minimize the effects of flooding; they are lines of stone laid out parallel or in a grid pattern. The stones are not placed on top of each other or in any way jointed, but are placed where runoff concentrate and where the slope is not very sleep. In Yakubawa, most of the farmers who used this technique admitted that the stones may not reduce the run-off, but could only reduce its velocity, slow down the flow of rainwater, facilitate to a certain extent the deposition of sediments, increase infiltration and help to retain some organic matter.

Stone bounds were also observed in Yakubawa. They are multiple stone piles on top of each other to create higher and longer barriers to intercept eroded soil from a nearby hill. These bounds, according to the farmers in Yakubawa reduce erosion from the hills down to the nearby farms. However, it was observed that due to insufficient vegetation on the hills, it could not prevent the erosion of the hills and sedimentations of the eroded materials and flooding in the nearby farms.

Diversion ditches were constructed in Bumbum and Sawani to drain off excess water to nearby drainages in anticipation of high rainfall. Diversion ditches are normally constructed in places where run-off enters the farmland. According to the farmers, most of the diversion ditches were made during farmland preparation hence are not permanent structures. Sometimes they are filled with sediments before the end of the rainy season; hence, they are often excavated to avoid flooding the farms.

Infiltration ditches were also used as an alternative to cut off drains, particularly where there is no place for water discharge, and as a water harvesting structure. Some farmers used it to trap water for rice cultivation, e.g. in Birnin kuka, others use it to store water to attract livestock during the dry season, to benefit from their droppings e.g. in Sawani. Some farmers construct the ditches to store water for dry season irrigation, e.g. in Yakubawa. Some farmers used it as a trap for sediment that comes from nearby hills, e.g. in Bumbum. Infiltration ditches also serve as drinking water for farmers and animals, as seen during the visit in many parts of the study area.

CONCLUSION AND RECOMMENDATIONS

The communities have their approaches using their indigenous knowledge to forecast the occurrence of any weather and climates related hazards and have been observing changes in their environmental quality and are using their local knowledge to address the environmental challenges. Hence any effort aimed at helping the communities toward achieving sustainable development particularly in tackling environmental challenges, there is the need to identify and promote indigenous practices which are sustainable and proved capable in meeting the need and aspiration of the people.

Also, local forms of resources use and management that for long sustain people in the fragile environment must be supported unless and until the genuinely superior form of resources use have been developed and proved. However, it is important to stress that recognition of the relevance of indigenous knowledge in achieving sustainable environmental management does not imply a complete rejection of modern technologies. The support for the use of indigenous knowledge should not be seen as a plea for uncritical use of local adaptation and mitigation strategies when better alternatives are available. During designing or implementing a development program or project, three scenarios are normally observed in most developing countries. Firstly, where the development strategies rely entirely or substantially on indigenous knowledge; secondly, override indigenous knowledge or thirdly, incorporates indigenous knowledge. But careful coordination of indigenous knowledge and scientific knowledge is the most promising. As Lal (2009b) rightly suggested “indigenous Knowledge and modern innovation go hand-in-hand, one cannot solve current global issues without the other.'' Also ‘’we can develop upon traditional knowledge but those who ignored modern innovations must be prepared to endure more suffering.” (Lal, 2009a). In other words, sustainable development could be achieved only by devising a way that could coordinate the two knowledge systems, rather than integration (blending the two systems). It involves interaction and collaboration between indigenous knowledge and modern science base on mutual understanding and respect of the two systems. Therefore any effort toward improving the quality of life of any community in addressing environmental challenges, such as flooding and other related hazards, it is important to understand how communities adapt to these challenges, then builds and improved on the established system, rather than introducing new and complex techniques and technology which majority of the target population cannot afford, manage and sustain.

Bodies responsible for emergency management should incorporate indigenous knowledge in disaster risk reduction policy especially at the local level. The indigenous knowledge could provide the necessary grass root information from the historical and cultural context, which could enhances understanding of how things work or operate at the local level, this will help in developing disaster risk reduction initiative applicable to the local situation.

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