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A Systematic Approach to Disaster Vulnerability Assessment in Kano Region, Nigeria

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Abstract

This study assesses the vulnerability of households to natural disaster in Kano Region, Nigeria. To obtain a representative sample, the region was divided into three agro-ecological zones based on isohyets limits with zone 1 within 500-650 mm annual rainfall, zone 2, + 650-800 mm and zone 3, +800–1000 mm. Data was collected from each zone by interview of households and disaster management officers covering issues such as disaster occurrence, impact of the most recent disaster and coping strategies. A total of 150 households in each of the zones were selected through stratified sampling and eight officers of different ranks from disaster management agency. The data was analyzed to determine variation in vulnerability between the zones. To determine comparable measure of coping strength between the zones, an index of the relative strength of coping measures at each zone was calculated. The result indicated a marked difference in the disaster occurrences and ranking between the zones as well between the household and disaster management institution. Further, results also indicated variations between the zones in coping strength and vulnerability index which implies varying local coping capacities. The study recommends that there should be a risk transfer mechanisms whereby those in hazard prone areas are protected against potentially large losses from disasters by undertaking extra measures to reduce the post financial consequences.

Keywords: Natural Disaster, Isohyets, Agro-Ecological Zone, Coping, Vulnerability Index, Natural Hazard.

1. Introduction

Despite increasing concern about natural disasters among the international community, it continues to kill legions of people and disrupts economic and social infrastructures all over the world both in developing and developed countries. For instance, in a developed country like the United States, which has extensive experience with natural catastrophes and resources to adequately prepare, a series of hurricanes made landfall in 2008, causing billions of dollars in direct economic losses [1]. Also, in 2012 Nigeria experienced an unprecedented flood disaster that affected half of the 35 states in varying degree with 7 million people affected; 21 million people displaced; 597,476 houses destroyed or damaged; over 363 people killed with estimated loss of N 2.6 trillion equivalent to $ 2 billion [2].

An important feature of these natural disasters have been their occurrence at an accelerating pace, a signal that we have entered a new era of large-scale catastrophes with devastating consequences [3-5]. Also, although the absolute magnitude of the economic losses is greatest in the developed countries, their impact is more devastating and enduring in developing countries particularly in Kano region where the significant increase in population coupled with more intense weather related catastrophes that is possibly due to climate change. Also the growing interdependencies between nations and markets means natural disasters in developing countries are of concern for developed countries as well, since more and more of their activities are either outsourced to suppliers located there. Furthermore, the lack of capacity to limit the impact of hazards remains a major burden as the traditional coping mechanisms have come under severe pressure and adaptation strategies, once valid, are no longer appropriate.

Yet it is now apparent that identification of particularly vulnerable regions i.e. those that are least well equipped to cope with the impacts of disaster can act as an entry point for both understanding and addressing the processes that cause and exacerbate vulnerability. Also, because disasters occur at the local level, understanding local vulnerability should be available for small geographical areas [6], as they provide information for developing systematic and coherent strategy that will lead to the development of strategies that will guide policies to avoid future catastrophic human and economic losses. This paper provides a systematic approach to disaster vulnerability assessment in Kano region.

1.1. Conceptual Framework

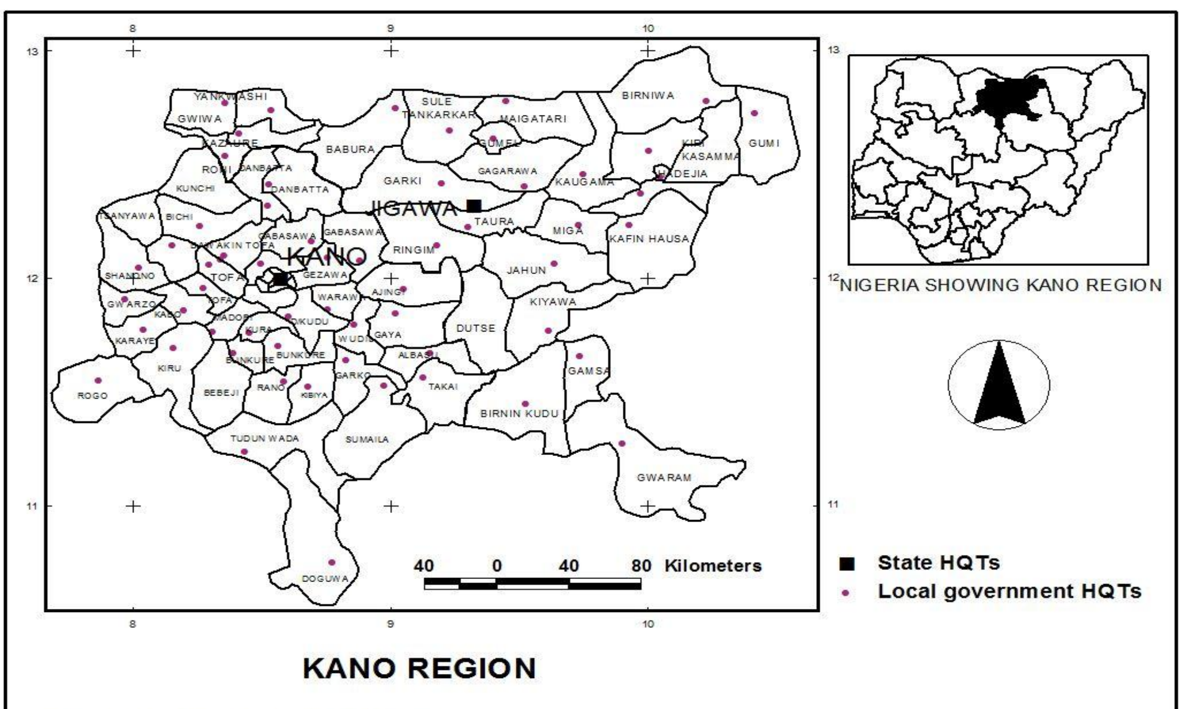
De Satge, et al. [7] defines vulnerability as "the characteristics that limit any individual, a household, a community, a city, a country or even an ecosystem's capacity to anticipate, manage, resist or recover from an impact of natural or other threat often called 'hazard' or natural 'trigger'. United Nations Development Programme (UNDP) [8] defines vulnerability as "the degree of loss (for example from 0 to 100 percent) resulting from a potentially damaging phenomenon".

Vulnerability to disasters is, to a large extent, a function of human action or inaction and behavior. It describes the degree to which a socio-economic system or physical assets are either susceptible or resilient to the impact of natural hazards. It is determined by a combination of several factors, including awareness of hazards, the condition of human settlements and infrastructure, the nature and application of public policy, the resources available to a given society, and organizational abilities in all fields of disaster and risk management. In this study, risk is conceptualized as relating to compound disasters, triggered by natural or human e.g. droughts, flood, famine, loss of lively hood due degradation etc and the vulnerability of the systems, [9, 10]. Therefore risk is viewed as a function of hazard and vulnerability.

The level of risk in relation to natural disasters in a society is determined by the level of vulnerability combined with the level of probability and intensity of the occurrence of a natural hazard. Risk reduction refers to activities taken to reduce both vulnerable conditions and, when possible, the source of the hazard especially addressing drought, floods and landslides. In order to tailor development policies that reduces vulnerability. In this study, four main parameters namely: hazard occurrence, effects of the last disaster that occurred, hazard manageability and coping strategies are calculated on the basis of agro-ecological zones identified on the basis of longitudinal location which affects the climate and socio-economic characteristics.

1.2. Study Area

Kano Region is combined Kano and Jigawa States, located at the eastern margin of the Northwest Geo-Political Zone of Nigeria as shown in Fig.1.



Source:GIS Lab. Dept. of Geography BUK (2010)

Figure-1. Location of Kano Region

It has a land area of 43,285 km2 - about 4.69 percent of Nigeria's total land area and is recognized as having a climate that is among the most variable in the world on intra-seasonal to decadal timescales [11]. The size of the region and its amplitude of climate variability make the region an important component of the climate system of surrounding regions. Kano region is characterized by a high population growth rate of 2.9% [12]. It has a total population of about 14 million and a population density of 649 people per hectares compared to a national average of 235 and world average of 442. In fact, within the Kano –closed settled zone population density is about 1000 per hectare [13, 14].

About half of the region's cultivable land is arid and semiarid, mostly with entisols which have low organic matter content. About 65 percent of the cropland and 30 percent of the pastureland are affected by degradation with consequent decline in crop yields and chronic food insecurity. It is also estimated that 14 percent of degraded soil result from vegetation removal, 13 percent from over-exploitation, 49 percent from overgrazing and 24 percent from agricultural activities [15]. Agriculture is the economic mainstay accounting for up to 70 percent of the source of livelihood of the population—and nearly 90 percent of the population work primarily in agriculture [16]. Urban Kano accounts for 37 percent of the total population of the region and the city is undergoing rapid population growth of more than 6.5 percent per year [12] accompanied by rapid development pressures with high demands for housing and infrastructure.

2. Methodology

Kano region was divided into three agro-ecological zones on the basis of isohyte limits as follows: Zone 1: within 500- 650 mm annual rainfall, Zone 2,+ 650 -800mm and Zone 3, +800 – 1000 mm located on 7^{o} 45' E and 09^{o} 35' E; Zone 2 Central: 7^{o} 45' E and 11^{o} 35' E and Zone 3 North: North of 12^{o} E respectively as shown in Figure 2. The identified zones that have different physiographic parameters, such as rainfall amount, duration and patterns; dependable and length of growing seasons and average water-holding capacity of soil characterize as shown in Table1. These differences indirectly reflect the socio-economic, conditions of the different communities in the zones.

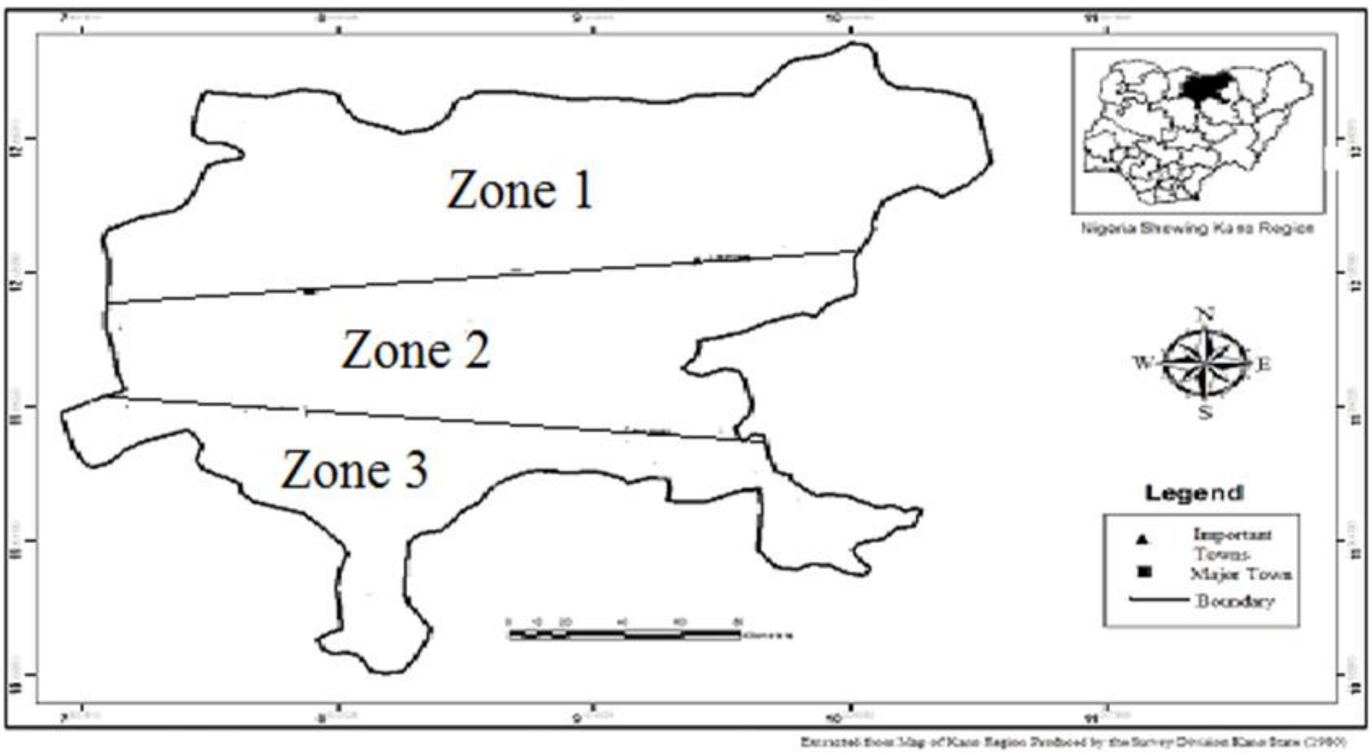


Figure-2. Delineation of the three Agro-ecological zones of Kano Region

Two sets of questionnaires were developed: one for the household and the other for Disaster management officers. Each set of questionnaires covered the key topics: hazard occurrence, effects of the most recent disaster, hazard manageability and coping strategies, including critical facilities.

Table-1. Physiographic Characteristics of Kano Region.

Zone	**Altitude m/sea level**	**Precipitation pattern**	**Dependable growing season in months**	**Physiographic**
1	300 to 400m	Bimodal and Monomodal	From 4 to 8	Hills uplands, undulating and rolling plains. Mainly younger granites of Jurassic age. Volcanic soils
2	+ 450 to 800 m	Predominantly mono modal	From <3 to 5	Many Physiographic types, ranging from flat areas, undulating and rolling plains, and scattered hills, Mainly Precambrian basement rocks. Sand- loam soils
3	+ 800 to 1200m	Monomodal	From 3 to 4	Composed of flat to undulating rolling plains made up of sandstone. Sandy soils

The analysis of the data was undertaken to determine hazard occurrence, effects and manageability at the two levels. Household data were used to obtain a broad picture of the spatial distribution of hazard occurrence in each agro-ecological zone. Subsequently, coping strategies for the three most commonly mentioned hazards were generated for each zone. The unit for rankings was the percentage of respondents at each level. A risk index was calculated (or each disaster by fitting the response variables of the household questionnaire linked to the impacts of the last disaster. The vulnerability index was determined by using the United Nations Development Programme (UNDP) [8] formula:

$$\text{Vulnerability} = \frac{\text{Hazard} * \text{Risk}}{\text{Manageability/copying strategies}}$$

3. Result and Discussions

3.1. Occurrences of Hazard at the Household and Institutional Levels

Fourteen different hazards were recognized by households with clear variation in terms of ranking between the zones. The ranking and the observed difference between the zones reflect the dominant impact of physiographic factors as clearly the highest level of ranking relate to flood, drought and desertification. These are issues that determine the day to day decisions of households in the three zones and all relate to land and climate. This area is one of the most fragile ecosystems due to the frequent drought and unreliable rainfall regimes. It is also an area affected by desertification and land degradation and the sustainability of the farming system is under serious debate due to such factors as overgrazing, fuel wood extraction, and nutrient deficiency aggravated by continuous cropping [11]. Also, modeled regional and continental simulation of climate change scenarios suggest that the temperature in the region will increase by 0.45° C per decade from the 1961 mean values, with a higher expected increase in hot season and increased frequency of heat waves. In addition precipitation is forecast to decrease and mean precipitation values may undergo a seasonal shift, with the start of the rainy season late and the duration much shorter than at present.

At the institutional level however, only four hazards were identified in all the zones, namely flood 50 %, windstorm 7 %, civil strife 10 %, and drought 33%. The difference in the ranking of hazards between the households and the disaster management officers is to be expected, because the household data are based on perceptions and the actual experience of the households while the institutional data emanate from records collected through the administrative processes that take place many weeks after the occurrence of the disaster. Another reason is that the focus of households is more on physiographic hazards, while at the institutional urban-related issues are as significant as physiographic.

3.2. Impact of Last Disaster

Damage to property appears to be a common feature in all three zones, attesting to the fact that housing in all areas cannot with stand flood. Damage to infrastructures is second especially electric poles were the most severely affected 60 %, followed by roads, 18% schools 13 % and hospitals 9 %. Factors such location of houses, patterns, building type, family assets, size of the household, family, community ties and community isolation have been observed to influence loss of property and displacement [17-20].

It has been shown that the resilience of a community can be defined as the vulnerability of a society before disaster strikes and its resilience after i.e., its coping capacity [21] and that the coping capacity is not “exogenous”, but related to its level of development - socio-economic and physiographic. Unfavourable conditions such as extreme poverty, poor urban infrastructures and services and weak regulatory practices including poor enforcement of building standards and corruption can render a society much more vulnerable and less resilient to hazards. Weak infrastructure, poverty, weak enforcement of planning regulations due to corruption, has meant households have limited scope for diversifying against risks, consequently any hazard turns easily into a deadly disaster.

With respect to loss of income, drought and flood are the dominant causative factors. Zone 3, which is poorer in terms of agricultural potentials, shows the greatest loss. Elsewhere, it has been shown that where the standard of living is broadly similar in an area as is the case in this study indicators like the illiteracy rate or the GDP/income are not useful [22, 23], instead, Tapsell, et al. [6], argued that measure reflecting social vulnerability that consist of an index of the elderly (aged 75+), lone parents, and those with pre-existing health problems provide a better basis for explanation. It has also been observed that vulnerability is dynamic because changes in social and economic conditions may bring about increase, or decrease, in vulnerability, even where the context of recurrent natural hazards remains constant [24]. Nonetheless, it has been recognized that vulnerable conditions are far more prevalent in developing countries, because the level of resilience is low and typically areas like Kano state lack and do not have appropriate level of preparedness such as insurance and social security. Consequently, loss of a home is a major livelihood set-back, because of the burden on limited finances in providing replacement. This cost may not be in terms of cash outlay only, but also in loss of time which would otherwise be used in other livelihood activities. For poorer families, agricultural loss and loss of domestic animals are the most serious aspect of flooding. As observed by Blaikie, et al. [25], in many areas of the world, as indeed in Kano region, there is an unhappy coincidence because the season in which floods are more likely to occur is also the one in which the crops ripen for harvest.

With regards to death and injury, the demographic characteristics of the household are as important as the hazard type in explaining the phenomena. Analysis of the data from three zones indicates that those most vulnerable to the effects of flooding include the elderly, women, children, and individuals with disabilities and those with low incomes similar to what was reported in South East Asia Hidajat [22]. The data on the absolute number of the dead indicate that the young age group shows the most fatalities. However, the relative number of dead of specific age groups showed that elderly people were especially vulnerable. For example, the fatality rate among people aged 70-80 years was around 40 % and in the 50-60 years age group, 13 %. In contrast the fatality rate among those in their thirties was only 2 %. The World Health Organization [26], recognized culture, economy, infrastructure and the environment and such other indicators like the vaccination coverage rate or disease pattern after an emergency as factors that could provide explanations for variation in fatalities among households demographic aspects.

Gender showed a direct relationship to death and injury as the results showed that nearly twice as many females 72 % as males 28 % per cent were dead. This shows clearly that females were and presumably still are more vulnerable than men. Women have more difficulties in getting to safety quickly. Female household members might also be more exposed due to their traditional role of carrying out activities around the house [27].

The enormous gender gap between the revealed vulnerability of females and males regarding the likelihood of being killed was also observed in other studies, for example in the Aceh province in Indonesia [28, 29] and in the Tamil Nadu province in India [30] In terms of loss of assets, hazards such as flood contributed significantly and again those with limited access to resources, lacking appropriate skills are more vulnerable. Others factors that show direct relationship include, literacy level in the household and income of the household and in general the overall economy of the communities.

3.3. Coping Strategy in the Three Zones

It has been shown that although, poor households in developing countries whether in the rural or urban informal sectors live in a perpetual state of poverty, natural disaster can disrupt their livelihood and plunge them deeper into poverty. The loss of livelihood leads to hardships with long-term consequences that compel households to make many decisions, such as to withdraw a child from school, send women to work as domestic servants, sell assets etc.

Though these decisions might reduce exposure to the shock, they could often also disrupt long-term livelihood which has been referred to as "consumption smoothing by income smoothing". What is remarkable is this study is the fairly large numbers of children sent as "*Almajiri"* and as domestic workers. Female children in the age bracket 5- 15 years and women 45 -60 years are sent as domestic workers to earn income for the household. The same applies to same segment who hawk such goods as fruits, sugar cane, and cola nuts etc. Most Non Governmental Organizations (NGO's) and international organizations and indeed governments in Nigeria consider these practices as illegal.

To obtain a cross-level value for each zone, the coping strategy with the highest score at the household level were summed up and then divided by the total number of the indicated coping measure to obtain an index showing the relative strength of coping measure in each zone. The coping strength in each zone for a particular hazard is then used to determine and compare the strengths of coping measures across the zones.

The coping strength for drought in the three zones ranges from 37.6-50.6, with zone 2 having the highest value and zone 3 the lowest. With respect to flood it ranges between 24.4 - 69.5% with zone 1 having the lowest and 2 the highest. Droughts and floods both have major impacts on the socio-economic well-being of countries. In some cases, it is possible to experience both extremes simultaneously.

3.4. Vulnerability Index

Table 6 shows the vulnerability index for three major hazards recorded and shows that incase of flood, Zone 1 has the highest coping capacity followed by zone 3 and zone 2 has the least, but , Zone 3 is the most vulnerable to flood (0.38), and closely followed Zone 2 (0.31) and the least is Zone 1 (0.16). However, though flood occurrence is highest in Zone 2 (38.94), this zone's vulnerability is only second highest because it has a relatively low coping capacity 66.37 compared to Zone 3,75.99 which implies higher drought manageability capacities. The other zones have essentially low drought vulnerability because they have low drought occurrence and high manageability capacities.

The vulnerability index identifies the social and economic vulnerabilities as well as the hazards caused by natural conditions that contribute to the risk in the locality and has been used successfully in the last few years due to the growing evidence that prevailing top-down approaches in disaster risk management may lead to inequitable and unsustainable results. Many such programmes fail to address the specific local needs of vulnerable communities, ignore the potential of local resources and capacities, and in some cases even increase people's social and economic vulnerability.

4. Conclusion

This study revealed that there are great deal of variation in the occurrences, type and perception of disaster in Kano region. More significant is the observed variation in the level of vulnerability to different disasters in the region. These variations are significant and need to be factored in planning and mitigation measures. It is proposed that there should be a risk transfer mechanisms whereby those in hazard-prone areas are protected against potentially large losses from disasters by undertaking ex ante measures to reduce the ex post financial consequences. In addition there should be in place other risk reducing mechanisms that could reduce future losses from disasters. These include assuring that proper building codes and land-use regulations are implemented in hazard prone areas coupled with mitigation grants to reduce both economic losses and fatalities/injuries from future natural disasters.

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