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More People Less Water: Assessing Vulnerability To Water Scarcity Among Rural Households In Katsina State, Nigeria

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ABSTRACT

In Sub-Saharan Africa, domestic water use accounts for only 9% of consumptive water demands (WRI, 1994), but limited water availability to satisfy this need is a major concern in rural areas of the semi-arid zones even though such areas support large human population. This study examined this paradox by assessing the socio-economic, political and biophysical factors in vulnerability to water scarcity among rural households in Katsina State. The data used in the study were mostly primary data on household characteristics, household water demand and water availability which were collected through field survey. Field data collection procedure involved multi-stage sampling procedure guided by the three differentiated rainfall Zones of Katsina State while secondary data was collected purposefully. A total of 400 households were sampled from each of the three rainfall zones of the state totaling 1200 households plus 12 focus group discussions and 12 key informants. The results of data analysis established that across the three rainfall zones of the rural areas of Katsina State. Water availability per capita in the state was 26 litres per day as compared to the UNDP, (2006) recommendation for Nigeria of 38 litres per day indicating general water scarcity condition. There was significant difference in per capita water availability and this difference was due to rainfall variability thus reflecting the general geography of water availability in Africa with a tendency to have water scarcity increase with the distance away from the equator especially to the north. The indicators of vulnerability to water scarcity in the study area included low levels in formal education, inappropriate training in managing water scarcity, high poverty levels, over reliance on nature for water supply, sharing of water sources with livestock and wild life, long distances to water sources and minimal government involvement in water supply.

INTRODUCTION

Water is predominantly a limiting factor for most activities globally and is an issue that cannot be ignored as recurrences of droughts and climate variability continue to affect many communities especially in sub-Saharan Africa from where the world is frequently greeted with ugly pictures of human beings, animals and pathogens competing from the same heavily-contaminated water to meet their consumptive demands (see Appendix I).

Water supply is one of the world's most pressing issues of the 21st century and its scarcity and consequent stress is now the single greatest threat to human health, the environment, global food supply as well as economic and social development (IDRC, 2002). At the global level, the overall water cover gives the impression of abundance with about three quarters of the earth covered with water. But this is not true since 97.5% of the earth's water is contained in oceans with only 2.5% being fresh water in rivers and lakes (0.3%), ground water (1.7%) and the rest,(0.5%), frozen in icecaps, glaciers and atmosphere (IUCN, 2007). The fundamental question is whether or not that water is within reasonable proximity, reliable, safe for consumption and sufficient to meet human needs (UN-HABITAT, 2003).

In Sub-Saharan Africa, domestic water use accounts for only 9% of consumptive water demands (WRI, 1994), but limited water availability to satisfy this need is a major concern in rural areas of especially the semi-arid zones in northern Nigeria. According to the World Health Organization and the United Nations Children's Fund rural water coverage in Africa was 45% in 2000, compared to 40% in 1990, still leaving 237 million people unserved (WHO, 2000). People expected to be mostly affected by water scarcity are those living in the remote rural areas in Africa among the nearly 1 billion rural inhabitants worldwide still lacking access to water (Ravenga & Cassar, 2002). Hence rural households are likely to be highly vulnerable to water scarcity related problems. The extent of such vulnerability however remains to be documented due to absence of household level data for many areas. This is despite the fact that studies on community vulnerability and adaptation to environmental stress have been conducted globally and specifically in Africa (See for instance: Ribot, 1996; Downing, 1992; Nyong, 2003; Babugura, 2005; Zakieldeen, 2009; Ford, 2011), as most of the works on it were conducted on climate change and climate variability.

In the literature, a number of indices have been developed to assess water scarcity but almost all were not designed for use at household level as the component data they require are mostly regional and country level types. Such indices include Access to drinking water and sanitation services developed for country level assessment by WHO (2000), Falkenmark Water Stress Indicator developed by Falkenamrk (1989) also for country level assessment, Dry Season Flow by River Basin Model developed by WRI (2000) for river basis assessment, Basic Human Needs Index developed by Gleick (1993) for country level assessment, Indicator of Water Scarcity Index developed by Heap et al. (1998) and modified by OECD (2002) also for country level assessment, Water Availability Index of Meigh et al. (1999) for regional level assessment, Vulnerability of Water Systems Index developed by Gleick (1993) for watershed level assessment, Water Resources Vulnerability Index developed for country level assessment by Raskin (1997), Indicator of Relative Water Scarcity developed for country level assessment by Seckler *et al.* (1998), Index of Watershed Indicators developed by EPA (2002) for watershed level assessment and Water Poverty Index developed by Sullivan (2002) for regional and country level assessment Water Poverty Index. Because domestic water scarcity occurs principally at household level, models that utilise household level data are therefore required in its assessment.

This paper contributes in this direction by assessing household vulnerability to water scarcity in rural areas of Katsina state, Nigeria. In Nigeria, more than 90% of rural areas and 60% of urban areas face water related problems (ADF, 2007) but data on extent of vulnerability of households to the problem is lacking.

STUDY AREA

Katsina state is located at the northernmost margin of Nigeria (latitudes 11°08'N and 13°22'N and longitudes 6°52'E and 9°20'E, covering an area of 23,938 sq km), within a region that has variously been described as Sudano-Sahelian, semi-arid, arid and the Sahel (Gadzama, 1990; Sawa, 2010; Abdulkadir, 2011). The Sudano-Sahelian region is one of the most delicately balanced ecosystems in the world and faces several social and ecological crises including drought, desertification, pest invasion, high poverty rate and high population pressure on the land that make water supply issues very challenging. In addition, low development of water supply infrastructure has made clean and safe water supply unavailable in the region.

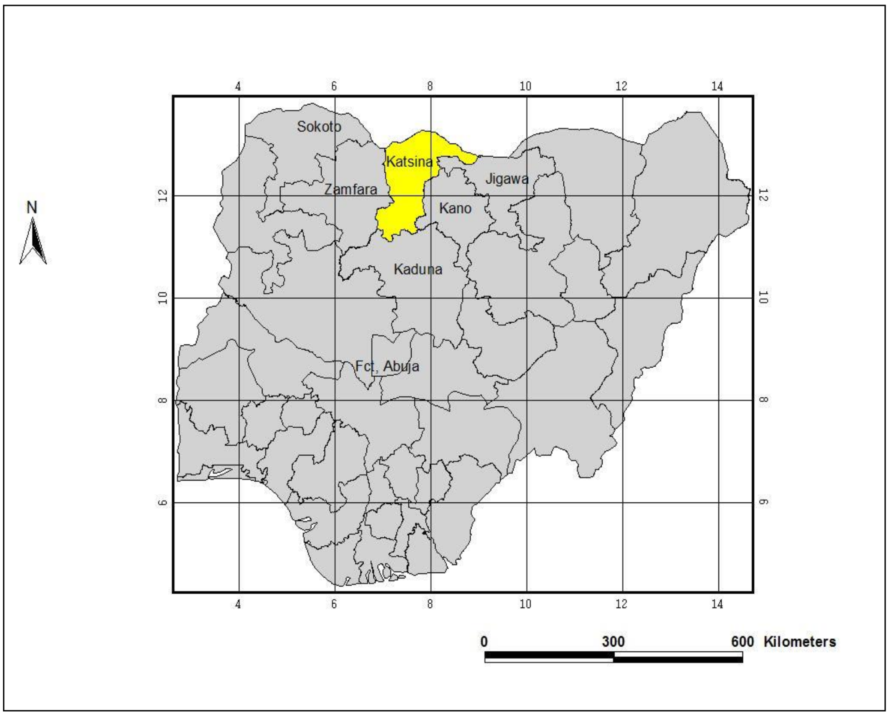

Figure 1: Location of Katsina State within Nigeria

Katsina state has a type of climate that can be identified as 'AW' using Koppen's climatic classification. It is a tropical climate type with a clear wet and a dry season. The coolest month is normally experienced between December/January with temperature of less than 18^{0}C. The state has three distinct rainfall zones as shown in Figure 2. The rainfall figures in the southern zone are above 900mm, they vary between 700mm and 900mm in the central zone and are less than 700mm in the northern zone. As rainfall significantly influences water budget of a catchment, this marked decreasing variation is to be associated with reduction in runoff and groundwater recharge as one move from southern to northern zones of the study area. Similarly, the seriousness of water scarcity crisis will increase as one move from south to northern margins of the study area. However the extent to which this is really so remains largely unknown due to inadequate research investigations on it.

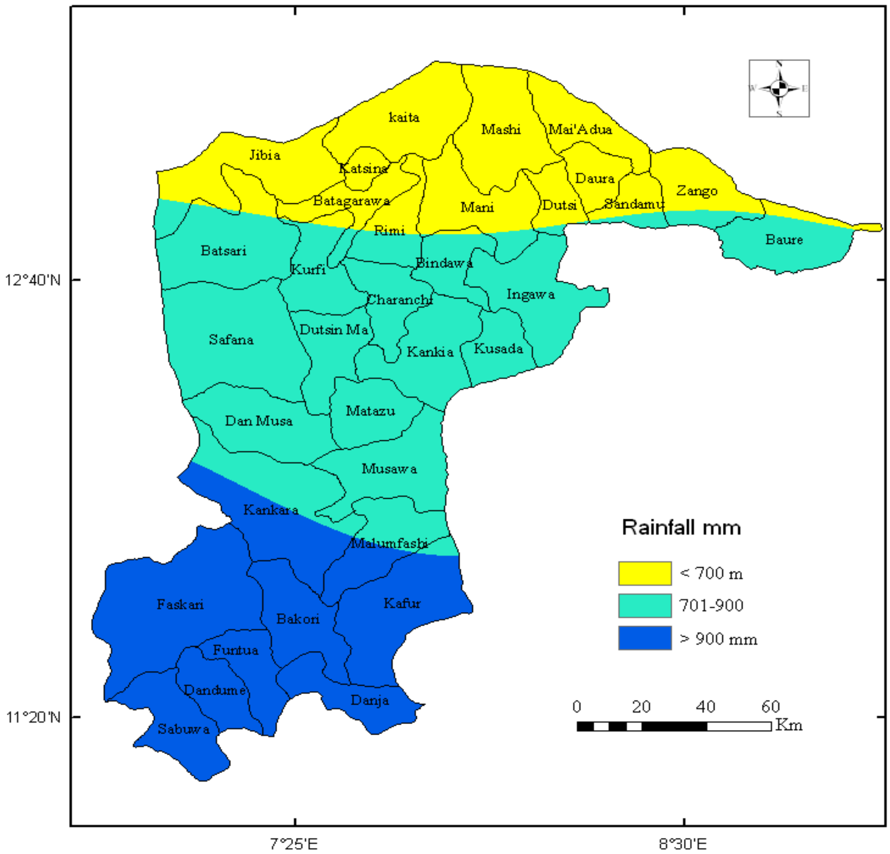

Figure 2: Major Rainfall Zones in Katsina State within Nigeria (After El-Tantawi, 2012)

The state is drained by a number of streams many of which have been dammed (Figure 3). However, the bulk of river flow in the area is conveyed by relatively smaller streams that tend to dry up almost after rains stop. The discharges of the rivers are generally low with water flowing mainly in months of June to October every year. The difference between minimum and maximum discharge could typically be very wide averaging 1:13 per year (Martins and Probst, 1991). The rivers depict bi-modal hydrograph and peak discharges which occur in July and September (Martins and Awokola, 1996). The generally low annual streamflow regimes of the rivers in the state are further compounded by high rate of siltation due to high erodibility of soils of the area and high rainfall erosivity (Mallo and Mgbanyi, 2013). All the river systems in the State, however, contain little or no water in the dry season, an indication of magnitude of water scarcity problem in the area.

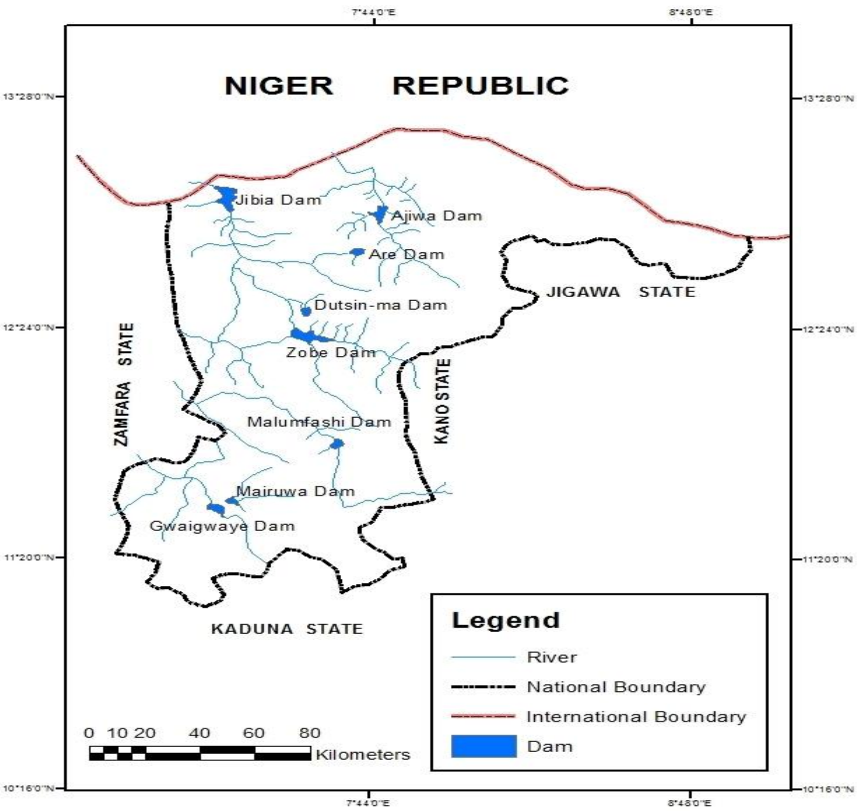

Figure 3: Major Drainage and Surface Water Resources of Katsina State

METHODOLOGY

In February 2012, a reconnaissance survey was conducted across the 34 Local Government Areas (LGAs) in the state. The essence of the survey was to familiarize the researchers with the study area (especially in terms of size and number of households) and identify background information relevant to the study. Between 21/11/2012 and 2/12/12, another reconnaissance survey was carried out across the LGAs selected for the study in order to identify the suitable communities (sampling frame) for primary data collection exercises. It was also used to test the capability of the instrument to provide the required data, and to identify communities that would be included in the study. From the reconnaissance survey, it was established that there were total communities of 5,363 and the household (HH) number of 1,130,733 spread across the 34 LGAS in the 3 rainfall zones of the state (north, central and south). This HH number represented the sampling frame in the study was based. A sample size of 1200 households, 400 HH from each rainfall zone and 4 communities per zone, was drawn using the Yamane (1967) formula of sample size determination. In total 12 communities in each of the 12 LGAs selected (Daura, Maiadua, Mashi, Kaita, Matazu, Kusada, Charanchi, Safana, Danja, Faskari, Funtua and Sabuwa) were selected across the 3 zones in the state. Copies of a questionnaire that elicits information on water demand and availability issues was administered to the 1200 HHs.

Field data from the HH questionnaire survey was first assembled into a single sample data in the form of a data coding sheet. For the open-ended questions, all the responses per question were first compiled, and then assigned meaning in the context of rural water supply management before including in the coding sheet. The coding sheet and associated data was then used to design a data entry interface in Excel and SPSS. Data entry was approached from the basis of quality assurance protocol where each case was entered twice by different data entry assistants and at the end of data entry exercise a comparative analysis of the two database files was done to limit data entry errors. A frequency distribution analysis on all variables was used as a tool for identifying outliers and missing responses which were confirmed with the results in the questionnaires. The clean data files were used to create the study database file which were used in the computation of the Water Scarcity Vulnerability Index (WSVI) as a ratio of Household water availability (HHWA) to Household water demand (HHWD) for each rainfall zone to get the spatial extent of household vulnerability to water scarcity.

Vulnerability to water scarcity in this study was determined using the data obtained from individual HHs on actual water availability and water demand from which water scarcity vulnerability index in the study area was generated as.

$$WSVI = 1 - \left(\frac{HHWA}{HHWD} \right) \times 100 \quad \text{.....................Eq(1)}$$

Where:

- WSVI is Water scarcity vulnerability index
- HHWA is Household water availability
- HHWD is Household water demand
- 1 was the value of water sufficiency a household should have if all its water demands are met

The vulnerability index calculation involved a number of data mining procedures that required small computation programs to be written both in excel and SPSS to generate new variables in the sample database. This then was followed by running frequency analysis and crosstabulation analysis procedures in the descriptive statistics menu of SPSS.

The ratio between water demand and availability of a household was used to define the water sufficiency of the household. This was expressed using a simple index:

$$\text{Water Sufficiency} = \left(\frac{\text{HHWA}}{\text{HHWD}} \right) \times 100 \quad \text{................Eq(2)}$$

Depending upon the ratio between what was demanded and what was made available to it, the water scarcity vulnerability index values were obtained using the above formula and this could be as low as 0% and as high as 100%.This means that practically, the lower the values the lower the vulnerability index of a household and the higher the value the greater the vulnerability. Further analyses of the above scenario and in comparison with the classifications developed by other research workers (e.g Birkman, 2006; Heap *et .al*, 1998) enabled the study to develop a vulnerability classification system that was used in the interpretation of the results obtained from the conduct of household survey (Table 1). This resulted into five categories of vulnerability to water scarcity and these were acute, high, moderate, low and no scarcity.

Table 1: Interpretation Table for Classifying Vulnerability to Water Scarcity

Vulnerability Class	Range of Values of Household Water Scarcity Vulnerability Index	Class Definition
I	0%	No scarcity
II	>0 - 5%	Low Scarcity
III	6 – 15%	Moderate Scarcity
IV	16 – 35%	High scarcity
V	Above 35%	Acute Scarcity

The results of vulnerability computation were subjected to descriptive and inferential statistical analyses as well as spatial analyses to provide measures of distribution tendencies, dispersions, differences and associations. The statistical techniques used included frequency analyses (tabulation and graphing), cross-tabulation analyses, one-way ANOVA, chi-squares test and Kruskal-Wallis H-test. All the statistical tests were conducted at α 0.05 (i.e. 95% level of confidence).

RESULTS AND DISCUSSION

Vulnerability to water scarcity assessment in the study area was approached from two view points. The first view point computed vulnerability to water scarcity on the basis of total water availability while the second view point computed vulnerability on the basis of sufficiency. Tables 2 and 3 summarised the results of background data of water sufficiency index and water scarcity vulnerability index thus, Table 3 presents the results of the computations made for each of the 12 communities studied across the three rainfall zones while figure 4 presents summary of mean values of the two indices over the three rainfall zones. As each of the two indices was expressed as percentages, the values were expected to vary between 1 and 100 where a higher water sufficiency index value reflects higher extent of satisfaction of water supply availability of a household while higher water scarcity vulnerability index values reflect higher degree of risk of a household to facing the problem of water scarcity.

Table 2: Household Water Sufficiency Index across the Three Rainfall Zones of Rural Katsina State

Water Sufficiency Index	Rainfall zone		
	North	Central	South
0-0.29	22(5.5%)	5(1.3%)	15 (3.8%)
0.3-0.49	88(22%)	33(8.3%)	52(13%)
0.5-0.69	185(46.3%)	248(62%)	141 (35.3%)

0.7-0.89	101(25.3%)	114(28.5%)	149 (37.3%)
0.9+	4(1%)	0(0%)	43(10.8%)

Table 3: Household Water Scarcity Vulnerability Index across the Three Rainfall Zones of Rural Katsina State

Water Scarcity Vulnerability Index	Rainfall zone		
	North	**Central**	**South**
No scarcity	0(0%)	0(0%)	0 (0%)
Low scarcity	0(0%)	0(0%)	8(2%)
Moderate scarcity	16(4%)	3(.8%)	80(20%)
High scarcity	133(33.3%)	176(44%)	152 (38%)
Acute scarcity	251(62.8%)	221(53.3%)	160(40%)

In the northern rainfall zone of rural Katsina State, the values of WSI varied between 20% and 92% with a mean of 57.4%; in the central zone, the values were between 25% and 86% with mean of 60.3% and; in the southern zone, the values varied between 06% and 97% with a mean of 67%. This incremental water sufficiency index condition tended to reflect the condition of water availability as already discussed and it was some measure of extent of satisfaction of water demand. The emerging pattern of water sufficiency index tended to decrease from south to north of Katsina State which tended to reflect the spatial distribution of rainfall amounts over the entire northwestern region of Nigeria within which Katsina State is located (Figure 4).

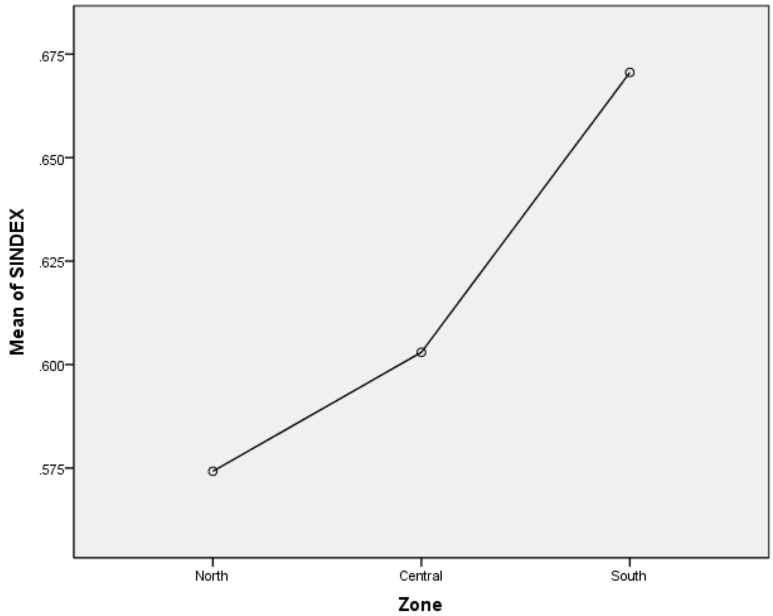

Figure 4: Patterns of Water Sufficiency Index in the Communities across the Three Rainfall Zones of Rural Katsina State

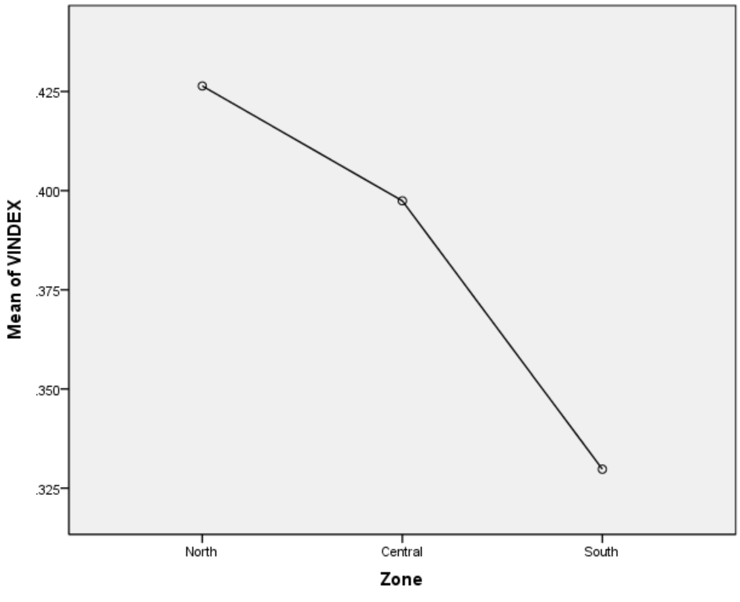

Figure 5: Patterns of Water Scarcity Vulnerability Index in the Communities across the Three Rainfall Zones of Rural Katsina State

The patterns of WSI values (Figure 4) were exactly opposite those of the WSVI (Figure 5), being highest in the northern and lowest in the southern rainfall zone implying that areas of lower rainfall amounts in the study area had higher vulnerabilities to water scarcity. The ANOVA test results used in assessing the significance of the observed variations (Table 5) indicated that the differences in both the WSI and WSVI over the three rainfall zones were statistically significant at 95% confidence limit.

In the northern zone, the mean WSVI values varied between 08% and 80% with a mean of 42.6%; central zone, 14% to 75% with a mean of 39.7% and; the southern zone, 03% to 94% with a mean of 32.9%. These WSVI scores implied increase in vulnerability from south to the northern rainfall zones and stress in water scarcity mitigations measures need to take this pattern in to account. This tends to conform to the general geography of water availability in Africa where there is a tendency to have water scarcity increase with the distance away to the equator especially to the north. Descriptive statistics of Water Sufficiency Index (WSI) and Water Scarcity Vulnerability Index (WSVI) values for the various communities in rural Katsina State are shown in Table 4 while Table 5 shows Summary of ANOVA results testing for significance of differences in Mean Values of Water Sufficiency Index (WSI) and Water Scarcity Vulnerability Index (WSVI) values for the three rainfall zones in rural Katsina State.

Table 4: Summary Results for the various Communities in the Study Area on Water Sufficiency Index and Water Scarcity Vulnerability Index

Community Studied		Min	Max	Mean	SD	Variance	COV %
Walawa	WSI	25	92	67.8	15.2	2.3	22.4
	WSVI	08	75	32	15.2	0.2	47.5
Gyarta	WSI	22	88	57.7	16.0	2.6	27.7
	WSVI	13	78	42	15.9	0.3	37.9
Gurjiya	WSI	20	75	44.7	12.6	0.2	28.6
	WSVI	25	80	55	12.5	0.2	22.7
Gwajo-Gwajo	WSI	29	85	59.3	13.2	0.2	29.5
	WSVI	15	71	41	13.2	0.2	32.1
Summary for the Northern Zone	WSI	***20***	***92***	***57.4***	***16.5***	***0.3***	***28.7***
	WSVI	***08***	***80***	***42.6***	***16.5***	***0.3***	***38.7***
Malamawa	WSI	25	83	61.3	12.6	0.2	20.7
	WSVI	17	75	39	12.6	0.2	32.3
Kofa	WSI	25	80	59.7	11.6	0.1	19.4
	WSVI	20	75	40	11.6	0.1	29.0
Kuraye	WSI	30	86	64.9	13.8	0.2	21.4
	WSVI	14	70	35	13.8	0.6	39.4
Yarsanta	WSI	25	83	55.2	12.4	0.2	22.5
	WSVI	17	75	45	12.5	0.1	27.8
Summary for the Central Zone	WSI	***25***	***86***	***60.3***	***13.0***	***0.2***	***21.6***
	WSVI	***14***	***75***	***39.7***	***13.1***	***0.2***	***32.9***
Ashraha	WSI	06	90	51.6	19.6	3.8	38.0
	WSVI	10	94	48	19.6	0.4	40.8
Tudun-Jae	WSI	41	93	71.4	12.5	0.2	17.6
	WSVI	07	59	28	12.5	0.2	44.6
Damari	WSI	34	97	74.4	17.4	0.3	23.5
	WSVI	03	66	26	17.4	0.2	66.9
Maigora	WSI	34	94	70.7	15.6	0.2	22.1
	WSVI	06	66	29	15.6	0.2	53.8
Summary for the Southern Zone	WSI	***06***	***97***	***67.1***	***18.8***	***0.4***	***28.0***
	WSVI	***03***	***94***	***32.9***	***18.7***	***0.4***	***56.8***

Note: WSI = (Water Availability ÷ Water Demand) x 100 ;

WSVI = (1 – Water Availability ÷ Water Demand) x 100

SD = Standard Deviation;

CV% = SD ÷ Mean X 100

In the literature review, the study could not identify an index based on household level data and this made it extremely difficult to compare the values obtained in this study with those of other research workers. The index developed in this study was, therefore, unique and the closest approximation was found in the work of Heap et al (1998) and Birkman (2006) which were used for comparative analysis. Heap et al (1998) provided the following classification based on water stress:

RWS < 0.1	no water stress
0.1 < RWS < 0.2	Low water stress
0.2 < RWS < 0.4	moderate water stress
0.4 < RWS	high water stress

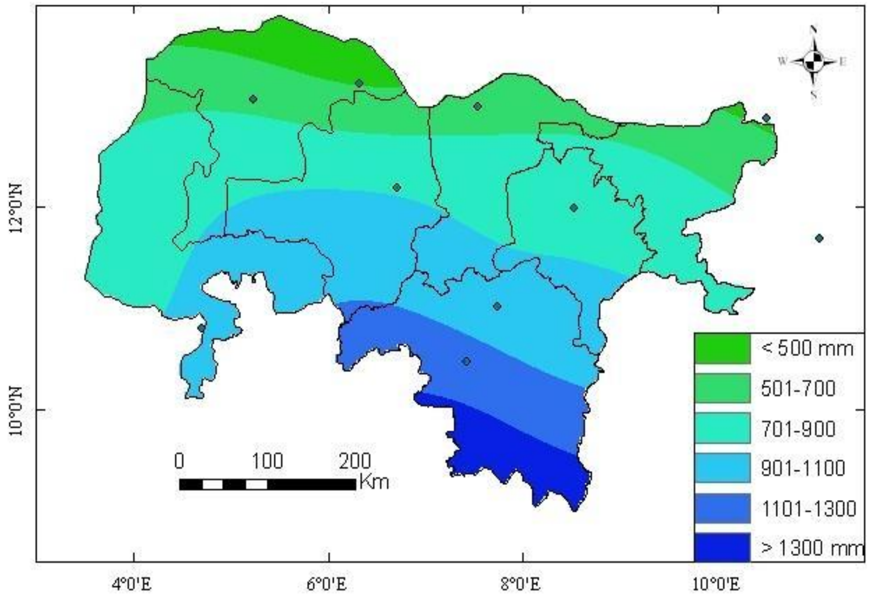

Figure 5: South-North Pattern Decrease in Annual Rainfall Amounts over Northwestern Nigeria

Source: El-Tantawi, (2012)

Table 5: Summary of ANOVA Results for the Three Rainfall Zones in the Study Area on Water Sufficiency and Water Scarcity Vulnerability Indices

ANOVA					
SINDEX (Sufficiency Index)					
	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	1.9	2	.9	36.9	.000
Within Groups	31.6	1197	.02		
Total	33.6	1199			
VINDEX (Vulnerability Index)					
Between Groups	1.9	2	.9	37.1	.000
Within Groups	31.7	1197	.02		
Total	33.6	1199			

Birkman (2006) on the other hand provided the following classification of vulnerability using a ranking scale of 0 (no damage) to 1 (total damage) based on number of people:

0.3- people up to 100 affected (low vulnerability)

0.6-from 101-1000 people affected (medium vulnerability)

0.7-0.9- more than 10000 people affected (high vulnerability)

The study computed WSVI values of 1.2% to 62.1% (Table 5.13) from which the the following classification was derived given the classifications of Birkman (2006) and Heap et al. (1998):

0	No Scarcity
<5%	Low Scarcity
6% - 15%	Moderate Scarcity
16% - 35%	High Scarcity
Above 35%	Acute Scarcity

The study used the above classification to compute WSVI values for communities in the 12 LGAs included in the sample data and it was the WSVI value that was used to identify the proportions of the communities belonging to specific category of water scarcity vulnerability. The results obtained are summarised in Table 6 and Figure 7 and indications were that none of the communities studied belonged to the 'No Scarcity' category implying that the problem of water scarcity affected all the communities in the study area.

Table 6: Proportion of Communities under Different Forms of Vulnerability to Water Scarcity in Each Community across the Three Rainfall Zones of Rural Katsina State

Zone	Community Studied	% of Households Under Various Forms of Vulnerability to Water Scarcity				
		No Scarcity	Low Scarcit y	Moderat e Scarcity	High Scarcit y	Acute Scarcit y
North	Walawa	0	0	1	40	59
	Gyarta	0	0	2	33	65
	Gurjiya	0	0	2	24	74
	Gwajo-Gwajo	0	0	1	31	69
Mean for the Zone		***0***	***0***	***4***	***33.3***	***62.8***
Central	Malamawa	0	0	1	43	56
	Kofa	0	0	.3	40.8	59
	Kuraye	0	0	1	48	51
	Yarsanta	0	0	.3	44.3	55
Mean for the Zone		***0***	***0***	***.8***	***44***	***53.3***
South	Ashraha	0	2	13	35	50
	Tudun-Jae	0	1	24	36	39
	Damari	0	1	16	40	43
	Maigora	0	1	19	40	40
Mean for the Zone		***0***	***2***	***20***	***38***	***40***

In the northern and central zone, no community belonged to the low scarcity category, but in the southern zone, 2% included in this category. In the moderate scarcity category, the scores were 4%, .8% and 20% for the North, Central and South zones respectively. In the case of High Scarcity category, 33.3%, 44% and 38% respectively for the North, Central and South Zones belong to it. In the northern zone, 62.8% of the households were in the acute scarcity category while in central and southern zones, 53.3% and40% respectively were in this category. The general picture was that Katsina State was a water scarce region but the scarcity vulnerability varied by rainfall zones.

The results were as in Table 5 indicating that all variations between the rainfall zones were not chance event and were, therefore, related to rainfall zoning which in turn affected water availability. The available water could affect vulnerability in terms of quantity available but also in terms of households' size and its associated water uses. Since the study established that rural Katsina State was largely vulnerable to water scarcity, it was important to have some measures of vulnerability that could be used in designing appropriate mitigation measures. The vulnerability measures were, therefore, considered as indicators to be used in decision making on water scarcity.

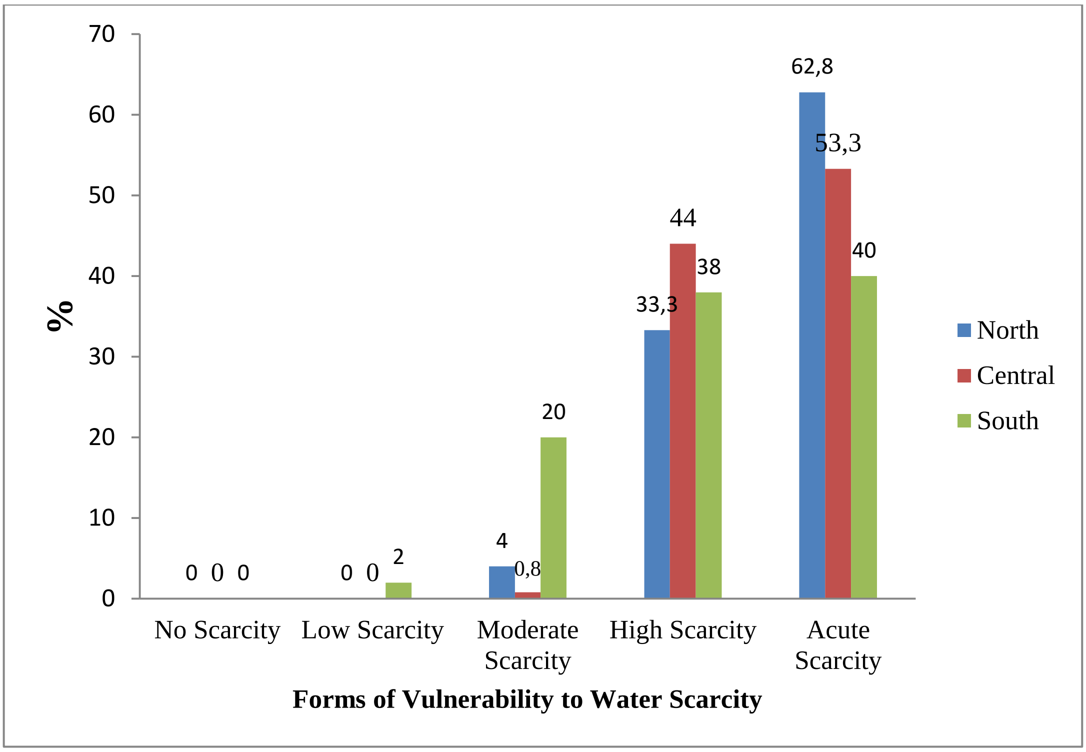

Figure 7: Proportions of Households under Different forms of Vulnerability to Water Scarcity across the Three Rainfall Zones of Rural Katsina State

The indicators of vulnerability to water scarcity in rural areas of Katsina State were found in this study to be multi dimensional (political, social, economic, institutional and biophysical). First, there is the issue of general low levels of formal education leading to over reliance on traditional knowledge and resulting low uptake of modern or scientific means of limiting vulnerability to water scarcity. Where formal training in managing vulnerability to water scarcity was present, the training was usually inappropriate. The general low income level indicated that most households in the study area were leaving below the poverty line as defined by the UN benchmark with over 80% of the households indicating income below the benchmark. Expenditure on water was found to be relatively low mainly due to low income level and sourcing water from natural reservoirs which could be a health risk in terms of water- borne diseases. The sources of water were generally shared with other domestic demands such as livestock watering and general laundry, a situation that further exposes households to risk of water-borne diseases. The acquisition of water generally tended to involve long distance travel and time resulting in less water available to households' thus increasing vulnerability to water scarcity. Government support in limiting vulnerability to water scarcity was generally peripheral and the households relied on water supply without much water quality monitoring, management, funding and leadership from either the federal or the state government. Where government institutions supporting water supply existed, in most cases, their roles overlapped due to ill defined mandate and their roles tended not to exist in the field.

CONCLUSION

It is clear from the results obtained that the pattern of water sufficiency index in rural Katsina State tend to decrease from south to north and this reflects the spatial distribution of rainfall amounts over the entire northwestern region of Nigeria. These implied increase in vulnerability from south to the northern rainfall zones and, therefore, stress in water scarcity mitigations measures need to take this pattern into account. This conforms to the general geography of water availability in Africa where there is a tendency to have water scarcity increase with the distance away from the equator especially to the north. None of the communities studied belong to the 'No Scarcity' implying that the problem of water scarcity generally affected all the communities in the study area. Besides the water scarcity conditions chiefly due to differences in rainfall distribution and amount, the vulnerability indices based on water availability and demand in the households showed that there is a relationship between rainfall and degree of vulnerability to water scarcity. The vulnerability to water scarcity in rural Katsina State is mainly a crisis of governance since many official intervening factors are usually unclear and overlapping leading to inefficient institutions, insufficient funding, none-grassroot decision-making, limited public awareness and ineffective regulations and enforcement. To address water scarcity problem in the state therefore, there is the need to ensure that the activities of the many institutions involved in provision of rural water supply facilities across the State are synergised to eliminate duplication and enhance service delivery. There is need for improved governance in water supply situation in rural Katsina State to avoid the current lack of government presence in meeting households or communities water demands.

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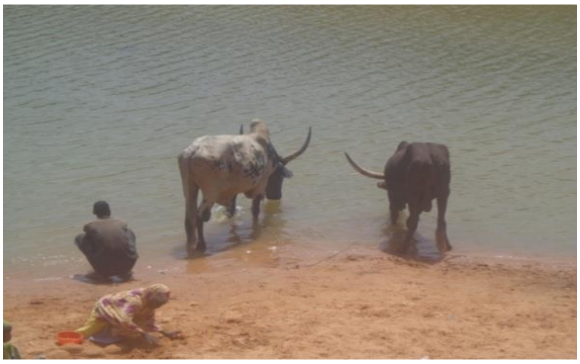
APPENDIX I: EVIDENCES OF WATER SCARCITY CHALLENGE IN AFRICA


Mwamanongu, Tanzania

Mashi, Nigeria




Kuraye, Nigeria

Kuraye, Nigeria

Takoradi, Ghana

Amhara, Ethiopia

Bombadi, Togo

Ponachot, Benin Republic