

Water, Land and People in Climate Change



S. L. Tilakasiri

WATER, LAND AND PEOPLE IN CLIMATE CHANGE

Issues, Challenges and Perspectives

Editor

S L Tilakasiri



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Chapter 17

CLIMATE CHANGE ADAPTATION IN THE SAHEL:

UNDERSTANDING THE ROLE OF PUSH CART VENDORS IN WATER PROVISION IN SOKOTO METROPOLIS

I.P. Ifabiyi and D. S. Adekeye

Introduction

All sectors of Nigeria's socio-economic development, including the natural ecosystems, are vulnerable to climate change (Oladipo, 2010). In the same vein Heinrich Böll Stiftung (HBS) Foundation Nigeria (2009) documented evidences of Nigeria's vulnerability to climate change. Unfortunately, unlike some West Africa nations, Nigeria is yet to develop a clear cut document on climate change adaptation.

The emergence of push cart water vendors or small water entrepreneurs (SWE) in cities is a symptom of the failure of piped water systems (Kjellén, and McGranahan, 2006; McGranahan *et al.*, 2006a; McGranahan *et al.*, 2006b). It could also be a major way of adapting to climate change. Inefficiencies of the water sector is a common sight in many urban settlements in the Less Developed Countries (LDCs) of the world. Water supply system in the LDCs is characterized by low coverage, whereby water fetching is done mainly by woman and children. There is widespread of water related communicable diseases in many urban centers due to widespread poverty, rapid urbanization, poor governance and a host of other factors. The poor suffers this problem more as they mainly reside in places without piped water networks, such as swampy areas, rocky and mountainous neighborhood and other marginal areas where for reasons of poor terrain conveyance of water may be difficult. The rich on the other hand, do have fair share of clean water as they could afford accommodation in the better parts of cities (Mc Granahan *et al.*, 2001).

In Africa, only 34 per cent of the inhabitants have in-house water connection (WHO and UNICEF, 2000). Hence, the huge percentage of individuals without in-house connection is left with no option than to collect water from water vendors and sometimes other unwholesome sources. This development has continuously sustained alternative water sources; and has encouraged the emergence of small scale private water providers in many parts of the world (Conan and Paniagua, 2003).

Water vending is an old art, dating back to years in the past. Whittington *et al.* (1989) classified water vendors into three. First, is the wholesale vendor, which is a category of vendors that obtain water from a source and sell to distributing vendors. Second, are the distributing vendors which comprise those vendors who obtain water from a source and sell to consumers door to door and third, is the direct vendor, which are those vendors selling water to consumers who come to the source to purchase water. In the same vein, Kjellen and McGranahar (2006) have also classified water vendors into five, namely: vendors who resell water to those who sell to households with piped water; second, distributing SWE who are water carriers. Others include: third, distributing SWEs who are concerned with tankers supplying water to high income earners; fourth, private water suppliers who obtain water from groundwater sources and other alternative sources (Solo, 1998). Lastly, the bottled or sachet pre-packed water; which is a recent development in many parts of Africa (Conan and Paniagua, 2003; Khan and Siddique, 2000).

Water vendors otherwise called small water enterprise (SWE) have a lot of relevances in community water supply systems. These include: affording the poor urban households the opportunities to purchase small quantities of daily water need which is commensurate to what they could afford (Wanjalla, 2011); allowing poor urban household to make choices pertaining sources of water; delivering water to households and saving people of the effort of drawing water and saving time, as the time used could be used to do other economic activity. Others are: helping to extend water coverage by serving areas that were not served to urban sources; ensuring relatively hygienic water as most times the vendors collect from public treated water which is regarded as safe; and finally, push cart water vending is a major source of employment generation. There are about 2000 SWEs in Dakar, Senegal for example (Kjellen and McGranahan, 2006).

The characteristics of water vendors are still less understood. This is because of the complexities of SWE as their characteristics differ from place to place. For example, water vendors employ some forms of transport; they are private payers and driven of profit or income-generation. In poorly serviced areas, many paid employees employ water carriers in order to keep them from queuing or carrying their own water. Paid water carriers are typically male, with some form of equipment to carry the heavy load of water. Plastic or metallic cans are loaded onto bicycles or tricycles or hand pushed carts. It is heavy and demanding. The prices of water are based on the efforts. Water vendors are typically poor they mostly supply water to low income people. Earnings are usually low (Kjellen, 2000). They operate outside any legal framework. In most cases water is resold or stolen. They are difficult to tax or regulate, due to their great mobility and low earnings. Studies

by Oyemade *et al.* (1998) in Nigeria and Benneh *et al.* (1993) in Ghana showed that, the quality of water supplied by vendors could be of poor quality. For example, Thompson *et al.* (2001) and Tumwine *et al.* (2002) have reported high incidences of diarrhea in water collected by vendors. This suggests a need for caution.

Furthermore, high level of competition is reported as vendors entice buyers (Collignon and Vozina 2000). The carts and water containers which are the major equipment required could be rented; as little or no capital is required before starting the business. The water vendors are skeptical about changing their prices in order to keep customers. Resellers and itinerant vendors seem to make more money. Evidences have shown that many poor families depend on urban water vendors for water provision. Meanwhile, in some cities the buyers are mainly those with relatively higher income. This is because in many developing nations, the very poor are normally excluded from reliable water sources since poor families could only afford to live in marginal areas (Komives *et al.*, 2000).

Wanjalu (2011) reported the disadvantages of SWE to include: higher prices which are normally higher than public utility and not regulated; as the poorest may not be able to afford it; services are not guaranteed because they are largely unregulated and the fact that water vendors draw attention to the deficiencies of public utilities in service provision. Also, water vendors usually steal water as they resell treated public/ government water to their various unsuspecting buyers, they are not legally recognized or licensed. Also, water vending encourages unregulated use of groundwater. Despite this, push cart vendors have been playing significant roles in urban water supply particularly in the phase of climate change. These roles need to be identified and recognized and regulated for sustainable urban water management.

This study becomes imperative in view of the vulnerability of Nigeria and indeed, the Sudano-Sahelian Zone to climate change, which according to IPCC (2007) is evidenced by: warmer and more frequent hot days and nights over most land areas. Also, frequent cases of warm spells and heat waves and incidences of heavy precipitation events are increasing; likewise the areas affected by droughts are also expanding.

Study Area

Sokoto state is located in the North-Western part of Nigeria between latitudes 10° 20' and 14° 00'N and longitudes 3° 30' and 6° 58'E, occupying about 64,000km² of land area. It falls within a region where rainfall distribution is irregular in time and space and characterized by a prolonged dry season and a short rainy season lasting from June to September. The climate is semi-arid. Rainfall in Sokoto shows a marked variation with annual mean precipitation varying from 350 mm (at Kalamalo in the extreme North) to 670 mm (at Sokoto Airport). Rainfall is concentrated in a short wet season which extends from middle of May to middle of September, whilst the dry season (with no single rain) lasts more than seven (7) months. Mean annual rainfall varied from year to year. Daily

temperature, in the harmattan season, is about 17°C, with large diurnal range; March and April usually are very hot, when daily temperature may sometimes be greater than 40°C. The Sudano-Sahelian Zone where Sokoto is located is one of the few parts of Nigeria where the effects of climate change are most felt.

Sokoto is underlain by sedimentary materials. The sediments of the Sokoto basin were deposited during three (3) main phases of deposition: continental Mezoic and Tertiary phases, with an intervening marine Mastrichian to Palaeocene phase. The principal water bearing beds in the Sokoto sediments are the surface laterites, sandstones, and grits in the Gwandu formations, limestone beds in Kalambaina formation, sandstones in the Wurno and Taloka formations as well as grits and sandstones in the Gundumi and Illo formations. Groundwater occurs under water table conditions throughout the area. Moreover, the association of inclined impervious beds alternating with water bearing horizons gives rise to pressure water conditions in some parts of Sokoto basin. Perched bodies of groundwater also exist in the area. In the valley depression along the water courses, alluvial aquifers up to 20m thick can be found consisting of intercalations of gravels, sand, silt and clay causing locally confined conditions. The depth of groundwater in the alluvium, of Wurno area is about 1-3m but reaches several tens of meters under topographic highs. Some of the tube wells provided for irrigation purposes in the study area are relatively rich in groundwater. The fluctuation of the water table in the *fadama* area may be about 2-3m throughout the year.

The Sokoto sedimentary basin in North-Western Nigeria consists of predominantly gentle undulating plain with an average elevation varying from 250-400 m above. This monotonous plain is occasionally interrupted by steep-sided, flat-topped hills with a low escarpment called the Denge escarpment as the most prominent feature. The escarpment itself is closely related to the geology of the area and has undergone intensive erosion to the extent that the Denge Scarp is no longer recognizable today (Udoh, 1970). Sokoto is drained by river Rima and its tributaries, which rises from Kaduna state and empties its water into river Niger.

Water is supplied to the metropolis from the Rima dam, owned and managed by the Sokoto State's Water Board. In addition, numerous privately owned bore holes and hand dug wells are available from where people fetch water for domestic use. The water vendors (*mai kura*) also play a major role in water supply in the city

There is also a history of long distance trading involving goods such as kola nuts, dates, salt, cloth, leather, rice, onions, garlic, pepper and spices, fishes, etc, up to the North Africa countries of Libya, Morocco, etc and to the southern parts of Nigeria. Dry season migration to south western Nigeria occasioned by drought is an important phenomenon in Sokoto and becoming popular by the phenomenon of climate change. This explains the presence of many Nigeriens in many parts Sokoto States.

Methodology

The data required in this study are mainly information on water vendor's characteristics, such as their socio-economic characteristics, sources of water, price of water, nationality, associations, distance covered, etc. These information were solicited with the use of structured questionnaire. A total of 40 variables were generated from the administered questionnaire. Questionnaire administration was done through systematic random sampling. The metropolis was sectioned into 10 areas based on the congregation of water vendors. These are: (1) Gwiwa Low Cost (2) Angwan Rogo (3) Old Airport (3) Eastern bye pass (4) Arkilla (5) Nakasare (6) Kofar Marike (7) Rungi Sambo (8) Mabera Waterworks (9) University Road and (10) Hajiya Halima Areas. These locations were mapped out after a pilot survey exercise was concluded.

In each of these areas 15 copies of questionnaire were administered to water vendors, these make a total of 150 copies of the questionnaire in the metropolis. All copies of questionnaire were recovered as they were administered by the author and a few research assistants. The relatively few copies of questionnaire are rather due to the homogenous nature of respondents, who are largely from the same cultural background, same economic base and almost same educational status. This homogenous nature was noticed during the pilot survey.

Both descriptive and inferential statistical methods were used for data analysis. The inferential methods employed were mainly multiple correlation and principal component analytical procedures. The multiple correlation method was used to establish relationships between the various water indices and social economic characteristics of the vendors. Principal component analytical method was used as a reduce model to bring out the factors underlying the characteristics of water vendors in the city. The component defining method was used in this analysis, whereby component with the dominant variable was used in interpreting the data.

Results and Discussion

Economic Characteristics of Water Vendors

The results of the descriptive methods showed in Table 1 that 48.4 per cent of the water vendors are less than 18 years, 25.8 per cent between the ages 26-30 years, while the respondents are less than 30 years. This clearly indicates that those involved in the business are mainly youths. Also, all the push cart water vendors are of male sex. This is expected in the study area, where women hardly participate in outdoor employment. Also, 77.4 per cent of the respondents are married, 16.1 per cent are single, while 6.5 per cent is divorced. About 87.1 per cent of them earn less than 18,000.00 naira per month, only 12.9 per cent earn above 18,000 suggesting that majority of the respondents are low income earners. About, 48 per cent of the respondents have family sizes between 6-10 people,

while only 3.2 per cent are single. About 71 per cent of them are from Republic of Niger (foreign national) and only 6.5 per cent have primary school education. The above show that water vendors in Sokoto are mainly young, illiterates, and unemployed youths of very low income and with relatively large family size eking out their living for survival.

The Water vendors have no personal source of water; they collect water from various sources namely: Sokoto State Water Board, private boreholes, water tankers, and public taps. They all source water from the nearest available water points that is free (Table 1). Only 9.7 per cent who sometimes buy water from tankers pay for water; all others collect water free. About, 35 per cent collect directly from the Sokoto State Water Board (at no cost). Also, 90 per cent of the respondents have no form of relationship with the Water Board; they are not by any means registered with the Board as 80.6 per cent of the respondents do not belong to any association. Only 16.1 per cent of the respondents belong to some form of associations (Table 1), while 54 per cent showed that meetings rarely come up except when there are issues. About, 51.6 per cent do not treat water, 80.6 per cent have no license 51.6 per cent do not repair their pipes, 61.3 per cent do not pump water, 48.4 per cent are ready to partner with government and do not want to be driven out of business. Also, in the future, 45.2 per cent want water to be free, while, 96.8 per cent enticed their customers by giving them discount.

The problems facing water vendors include low water pressures, illegal connection, irregular power outages and long queue among others. External problems facing vendors are mainly financial and power supply problems. About 71 per cent have no formal agreement with the water board (Table 1). Water is expensive in dry season compared to wet season.

A Jerri-can of water goes for 15 Naira to 30 Naira, 45.2 per cent of the respondents sell a Jerri-can for 20 Naira. About 54 per cent of the respondents service between 2 to 10 people. Sales are generally higher in dry season. In dry season sales goes up to 20,000 liters in wet season highest sale is 5000 litres. About 64.5 per cent of the respondents collect up to 40-60 Jerri-cans daily. All vendors determine prices arbitrarily (Table 1).

Table 1: Primary Characteristics of Respondents.

| Variables | Options | Percent of water vendors (%) | Cumulative Percent |
|---------------------------------------|---------------------------|------------------------------|--------------------|
| 1. Age | Less Than 18 Years | 48.4 | 48.4 |
| | 19 – 25 Years | 25.8 | 74.2 |
| | 26-30 Years | 25.8 | 100.0 |
| 2. Male | Male | 100.0 | 100.0 |
| 3. Marital Status | Singe | 16.1 | 16.1 |
| | Married | 77.4 | 93.5 |
| | Divorced | 6.5 | 100.0 |
| 4. Income | Less Than 18,000 Naira | 87.1 | 87.1 |
| | Greater Than 18,000 Naira | 12.9 | 100.0 |
| 5. Family Size | Less Than 5 | 3.2 | 3.2 |
| | 6-10 | 48.4 | 51.6 |
| | 11-15 | 41.9 | 93.5 |
| | Greater Than 15 | 3.2 | 96.8 |
| 6. Nationality | Nigeria | 29.0 | 29.0 |
| | Republic Of Niger | 71.0 | 100.0 |
| 7. Bike Ownership | Cart Owners | 29.0 | 29.0 |
| | Care Renters | 71.0 | 100.0 |
| 8. Level Of Education | Koranic Education | 71.0 | 71.0 |
| | Primary School Holders | 6.5 | 77.4 |
| | No Form Of Education | 22.6 | 100.0 |
| 9. Distance covered by vendors | Less Than 500 Meters | 22.6 | 22.6 |
| | 501 -800m | 19.4 | 41.9 |
| | 800- 1km | 3.2 | 45.2 |
| | Greater Than 1km | 54.8 | 100 |
| 10. Source of Water | Water Board | 35.5 | 35.5 |
| | Borehole | 32.3 | 67.7 |
| | Tanker | 9.7 | 77.4 |
| | Others | | |
| 11. Relationship with water board | Indifference | 3.2 | 3.2 |
| | No Licensed | 96.8 | 100.0 |
| 12. Water Treatment Efforts | % Treating Water | 48.4 | 48.4 |
| | % Not Treating Water | 51.6 | 100.0 |
| 13. Memebership of Vendor Association | % Indifference | 3.2 | 3.2 |
| | Non Memebership | 16.1 | 19.4 |
| | | 80.6 | 100.0 |
| 14. Vendor Meetings | .Indifference | 25.8 | 25.8 |
| | Very Rare | 54.8 | 80.6 |
| | Weekly | 3.2 | 83.9 |
| | Whenever There Is Problem | 16.1 | 100 |

| | | | |
|-----------------------------|----------------------------------|-------|-------|
| | No Issues | 29.0 | 29.0 |
| 15. Issues Discussed | General Issues | 35.5 | 64.5 |
| | Operational Issues | 32.3 | 96.8 |
| | Problems | 3.2 | 100.0 |
| | | | |
| 16. Water Rates Determinant | Arbitrarily | 93.5 | 93.5 |
| | By Consensus | 6.5 | 100.0 |
| 17. Monthly Earning | 3,500-4000 | 25.8 | 25.8 |
| | 4,500-5000 | 58.1 | 83.9 |
| | 5500-6000 | 9.7 | 93.5 |
| | 6500-7000 | 3.2 | 96.8 |
| | >7,500 | 3.2 | 100.0 |
| 18. Other Income | With Other Source Of Income | 35.5 | 35.5 |
| | No Other Source Of Income | 64.5 | 100.0 |
| 19. Water License | Indifference | 16.1 | 16.1 |
| | With Some Form Of Permit | 3.2 | 19.4 |
| | Without Permit | 80.6 | 100.0 |
| 20. Charges | Indifference | 6.5 | 6.5 |
| | Yes | 6.5 | 12.9 |
| | No | 87.1 | 100.0 |
| 21. Repairs | No Repairs | 93.6 | 93.6 |
| | Vendors Who Repaired Broken Pipe | 6.5 | 100.0 |
| | | | |
| 22. Pumping | Vendors Who Pump Water | 38.7 | 38.7 |
| | Who Does Not Pump Water | 61.3 | 100.0 |
| 23. Cash Mode Of Payment | Vendors Who Collect Cash | 100.0 | 100.0 |
| 24. Future Plan | Ready To Partner With Government | 3.2 | 3.2 |
| | Not To Be Driven Out Of Business | 48.4 | 51.6 |
| | Water Supply Should Be Made Free | 45.2 | 96.8 |
| | Government Should Intervene | 3.2 | 100.0 |
| | | | |
| 25. Problems Encountered | Low Pressure | 25.8 | 25.8 |
| | Illegal Connection | 16.1 | 41.9 |
| | Irregular Power Supply | 9.7 | 51.6 |
| | Long Queue | 16.1 | 67.7 |
| | Others | 32.3 | 100.0 |
| Perceived solution | Breakdown Of Water Works | 32.3 | 32.3 |
| | Low Water Pressure | 29.0 | 61.3 |
| | Legal Connection | 22.6 | 83.9 |
| | Power Supply | 6.5 | 90.3 |
| | Provide More Boreholes | 9.7 | 100.0 |
| 26. Government Support | By Recognizing Their Roles | 41.9 | 41.9 |
| | By Running Mains To New Areas | 41.9 | 83.9 |
| | Others | 16.1 | 100.0 |

| | | | |
|---------------------------------------|------------------------------|------|-------|
| 27. Customer Inducement | We Entice Customers | 96.8 | 96.8 |
| | We Do Not Entice Customers | 3.2 | 100.0 |
| 28. Externalities | Indifference | 9.7 | 9.7 |
| | Finance | 51.6 | 61.3 |
| | Power Supply | 19.4 | 80.6 |
| | Long Queues At Water Sources | 16.1 | 96.8 |
| | Others | 3.2 | 100.0 |
| 29. Wet Season Sales | Tanker | 45.2 | 45.2 |
| | Shallow Water Sources | 9.7 | 54.8 |
| | Water Board | 41.9 | 96.8 |
| | Others | 3.2 | 100.0 |
| 30. Dry Season Sales | Tanker | 12.9 | 12.9 |
| | Shallow Wells | 6.5 | 19.4 |
| | Water Board | 74.2 | 93.5 |
| | Borehole | 6.5 | 100.0 |
| 31. Cost price of jerricans | <15naira | 38.7 | |
| | 20.00 | 45.2 | |
| | 25.00 | 9.7 | |
| | 30.00 | 6.5 | |
| 32. Market Size | .<10 | 54.9 | |
| | 14-20 | 25.8 | |
| | 28-50 | 12.9 | |
| 33. Quantity Of Water Bought Per Head | 0-50 | 6.5 | 6.7 |
| | 52-100 | 22.6 | 30.0 |
| | 150-200 | 3.2 | 33.3 |
| | >150 | 9.7 | 43.3 |
| 34. Sales In Dry Season | 70.00 | 16.1 | 16.1 |
| | 98.00 | 3.2 | 19.4 |
| | 252.00 | 3.2 | 22.6 |
| 35. Sizes of jerrican Container | Indifference | 3.2 | .2 |
| | 25.00 | 90.3 | 93.5 |
| | 30.00 | 6.5 | 100.0 |
| 36. Jerri cans sold per day | 20-40 | 19.3 | |
| | 40-60 | 16.4 | |
| | 60-100 | 13 | |
| | >100 | 3.2 | |

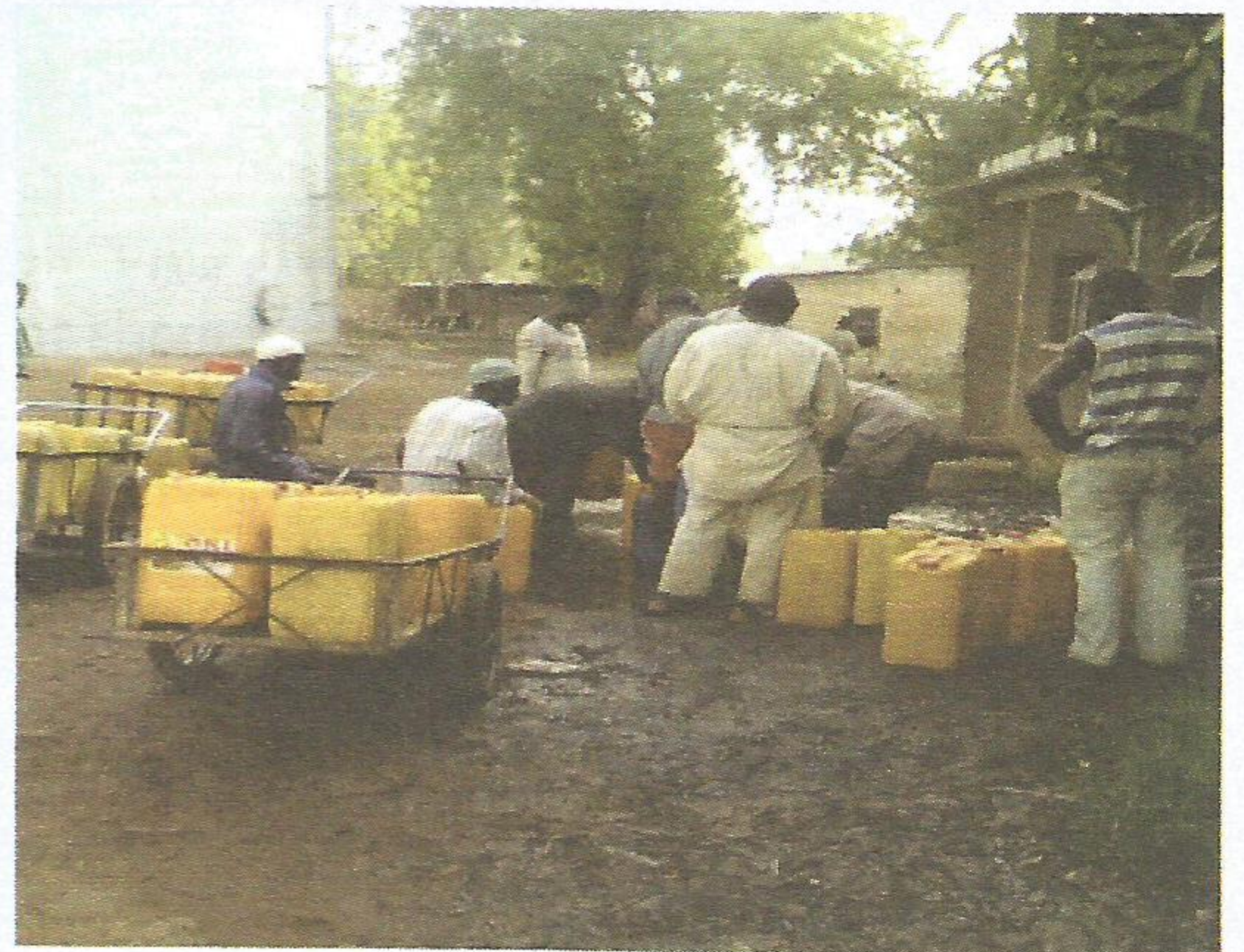
Source: Authors' Field Survey, 2016.

Correlates of Water Vendors in Sokoto

Correlative relationships exist among the selected water supply and water vendors' characteristics. For example, marital status of vendors has strong relationship with income of vendors. Income also inversely relate with membership of water association (-0.412), suggesting that members who do not belong to any vendor association have higher income. Vendor's nationalities also have strong positive relationship with prices of water (0.807) as Nigerian vendors sell at higher prices compared to their Nigerien counterparts. Bike ownership and external problems have inverse relationship (-0.534), whereby vendors without bikes are exposed to lots of problems. Vendors with higher income have other sources of income (0.366). Vendors who sourced water from the Sokoto State Water Board charges higher rates (0.607).

Factors Underlying the Characteristics of Water Vendor

About 38 variables were extracted from the questionnaire . The result of PCA showed that 13 underlying components explained water vendors' characteristics in Sokoto metropolis (Table 2). These components are : water cart carriage capacity (17.9%), Jerri-cans (11.1%), quantity of water bought (10.11%), price of water (8.05%), marital status (6.50%), distance covered per day (6.40%), dry season sales of water (5.94%), water board collection point (4.86%). Others are: monthly income (4.40%), ownership of bike (3.63%), government support (3.63%), nationality (3.02%), and level of education (2.77%). All these give a cumulative explanation of 87.9 per cent to the variance in the equation (Table 2).



Plates Showing the Major Equipment and Push Cart Water Vendors Waiting to Collect Water at Different Points; Particularly at the Sokoto Waterworks.

Table 2 : Component Loadings and Factors Underlying the Characteristics of Water Vendors in Sokoto.

| Variables | Components | | | | | | | | | | | | |
|-------------------------|------------------------------|------------|--------------------------|----------------|----------------|--------------------------|---------------------------|------------------------------|----------------|-------------------|--------------------|--------------|--------------------|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 |
| 1. Age | -.175 | .083 | -.025 | -.068 | -.141 | .016 | -.710 | .172 | .057 | .345 | .133 | .056 | -.057 |
| 2. Marital Status | -.104 | -.021 | -.051 | .148 | -.816 | -.070 | -.081 | .049 | .055 | -.058 | .100 | -.101 | .137 |
| 3. Income | .008 | -.106 | -.067 | -.112 | -.048 | -.191 | .042 | -.323 | .720 | -.279 | .205 | -.177 | -.005 |
| 4. Family Size | -.099 | .079 | -.091 | .914 | -.071 | .090 | -.043 | .191 | -.047 | -.052 | .040 | .001 | .052 |
| 5. Nationality | -.089 | -.051 | .088 | .120 | .019 | .107 | .028 | -.087 | -.050 | .065 | .041 | .898 | -.008 |
| 6. Bike Ownership | .131 | .104 | -.007 | .074 | -.104 | -.007 | .063 | .026 | .113 | -.880 | .119 | .035 | -.099 |
| 7. Education | .218 | .176 | .060 | .113 | .006 | -.164 | -.111 | .009 | .069 | .044 | -.027 | -.034 | .802 |
| 8. Distance | -.016 | .027 | -.108 | .137 | .039 | .867 | -.026 | .099 | .000 | -.032 | -.028 | .171 | -.202 |
| 9. Water Source | .122 | -.170 | .424 | .468 | .406 | -.380 | -.253 | .108 | .020 | .191 | .153 | .115 | -.167 |
| 10. Water Board | -.003 | .116 | .032 | .091 | -.043 | .102 | .022 | .905 | -.013 | -.086 | -.023 | -.151 | -.087 |
| 11. Treatment | .229 | -.177 | .422 | -.003 | .241 | -.295 | .425 | -.092 | .246 | .231 | .374 | .180 | .032 |
| 12. Association Member | -.051 | -.152 | .101 | .198 | .263 | -.038 | -.095 | .644 | -.224 | .169 | .375 | .137 | .391 |
| 13. Meetings by assoc. | .217 | .471 | -.144 | .572 | -.295 | .206 | .057 | .005 | .078 | .009 | .071 | -.334 | -.013 |
| 14. Issues at Meetings | .171 | .443 | -.246 | .286 | -.126 | .289 | .133 | -.076 | -.263 | -.169 | -.025 | -.531 | .039 |
| 15. Water Rates | .011 | .162 | .017 | .890 | .052 | .117 | .198 | .000 | .043 | -.106 | -.086 | .129 | .093 |
| 16. Monthly Income | .152 | .018 | -.032 | -.032 | -.708 | .134 | -.158 | -.177 | -.064 | -.087 | .093 | .026 | -.445 |
| 17. Other Income | .268 | .394 | .294 | .103 | .103 | .480 | .018 | .088 | -.080 | .046 | .089 | -.084 | -.485 |
| 18. License permit | -.035 | .639 | .063 | .101 | .097 | .144 | -.267 | .217 | -.362 | .139 | .035 | -.290 | .269 |
| 19. Charges | .007 | .576 | -.049 | .078 | .000 | -.025 | -.121 | .629 | -.129 | -.163 | .280 | -.016 | .068 |
| 20. Repairs of pipes | .381 | .362 | .189 | .098 | -.214 | .104 | .105 | .326 | -.107 | .004 | .558 | .127 | .214 |
| 21. Pumping of water | .358 | -.022 | .292 | .142 | .323 | .060 | .189 | -.068 | .607 | .212 | .081 | .338 | .072 |
| 22. Future plans | -.189 | .471 | -.193 | .119 | .446 | .343 | -.020 | .095 | -.092 | -.382 | -.083 | -.158 | -.205 |
| 23. Problem encountered | -.161 | -.070 | .213 | -.180 | .027 | -.664 | .046 | .066 | .423 | .131 | -.280 | .196 | .011 |
| 24. Constraints | -.390 | -.220 | .101 | .301 | -.083 | -.098 | -.101 | .135 | .591 | .153 | -.070 | -.003 | .409 |
| 25. Govt. Support | .215 | -.118 | .061 | .028 | .069 | -.103 | .229 | -.121 | -.220 | .149 | -.814 | .028 | .103 |
| 26. Entice customers | -.944 | .075 | -.026 | -.011 | .051 | -.045 | -.101 | .043 | .031 | .166 | -.003 | .068 | -.023 |
| 27. Externalities | -.360 | -.156 | -.195 | -.074 | -.026 | -.172 | -.018 | -.107 | .136 | .691 | .069 | .295 | -.080 |
| 28. Agreement | .435 | .508 | -.314 | -.005 | .083 | .333 | .135 | .122 | -.327 | .041 | -.073 | -.338 | -.050 |
| 29. Wet Season sale | .063 | -.136 | .837 | -.280 | .128 | -.061 | .017 | .056 | .259 | .083 | .113 | .129 | .066 |
| 30. Dry season Sale | -.072 | -.004 | .778 | .229 | -.053 | -.088 | .379 | -.040 | -.155 | .034 | .065 | -.057 | -.153 |
| 31. Water Source | -.006 | -.489 | -.158 | .064 | .529 | .103 | .178 | -.378 | .195 | -.075 | .175 | -.087 | -.052 |
| 32. Water Rates | .565 | .035 | .003 | -.308 | .165 | -.216 | .447 | .239 | .233 | .021 | -.269 | .005 | -.033 |
| 33. Customer Size | .277 | -.060 | -.284 | .326 | .000 | -.374 | -.572 | -.020 | -.305 | -.187 | -.118 | .071 | -.141 |
| 34. Quantity Bought | -.008 | -.004 | .897 | -.076 | -.067 | -.050 | -.136 | .067 | -.004 | -.222 | -.155 | .106 | .120 |
| 35. DrySeason Sales | .166 | .122 | -.014 | .256 | .117 | -.031 | .741 | .078 | .020 | .085 | -.158 | .076 | -.375 |
| 36. Storage facility | .294 | -.398 | .090 | -.246 | -.388 | -.108 | -.110 | -.112 | -.143 | .193 | .497 | .271 | -.114 |
| 37. Container size | .954 | -.055 | -.012 | .017 | -.004 | .027 | .016 | -.029 | -.001 | -.124 | .005 | -.067 | .077 |
| 38. Jerri-Can | .161 | -.899 | .105 | -.167 | .054 | .009 | -.119 | -.011 | -.056 | .228 | -.076 | -.026 | .005 |
| Eigen value | 3.56 | 3.46 | 3.17 | 3.09 | 2.49 | 2.45 | 2.39 | 2.34 | 2.28 | 2.17 | 2.01 | 2.00 | 1.93 |
| % Variance | 9.37 | 9.11 | 8.35 | 8.13 | 6.57 | 6.45 | 6.30 | 6.17 | 6.01 | 5.73 | 5.31 | 5.26 | 5.09 |
| Cumulative Variance % | 9.37 | 18.4 | 26.8 | 34.9 | 41.5 | 48.0 | 54.3 | 60.4 | 66.5 | 72.2 | 77.5 | 82.8 | 87.9 |
| Component Description | Water Cart Carriage Capacity | Jerri-Cans | Quantity Of Water Bought | Price Of Water | Marital Status | Distance Covered Per Day | Dry Season Sales Of Water | Water Board Collection Point | Monthly Income | Ownership Of Bike | Government Support | Nation-ality | Level Of Education |

Source: Authors' Computation (2016).

i. **Customers Enticement**

Most of the vendors entice their customers in order to stay in market, this is imperative because of the saturated market of water vendors in the city sometimes. The arrangement is that most households tend to have permanent vendors who regularly service them. Therefore, in order to be in service the customers are normally enticed to buy water. This has brought competition among the vendors; it has also encouraged loyalty in the form of patronage. This agrees with the findings of Kjellen (2000) in Tanzania. The forms of enticement are the forms of rebates, buying on credit, punctuality, regularity and integrity on the part of vendors. This factor has 9.37 per cent contribution to the explanations (Table 2).

ii. **Size of Jerri can**

This component explains 9.11 per cent of the variation in the explanations of vendor's characteristics (Table 2). All water vendors in the city use plastic Jerri cans, which are either 25 or 30 liters in size. These Jerri can are usually yellow in colour, they were originally vegetable oil can, but being re-used for the purpose of collecting water. The plastic Jerri cans are unbreakable and their shapes allow for easy transportation. They are durable and cannot rust.

iii. **The Quantity of Water Bought**

The amount of water sold is an indication of whether the vendor will remain in business or not. However, the inefficiencies recorded in public water supply coupled with the Sahelian weather have put pressure on the demand for water in the metropolis. In addition, the fact that public water pipe network did not go round the metropolis has also encouraged the operation of water vendors in the city. This component contributes 8.13 per cent of the variance in the explanation.

iv. **Price of Water**

The prices charged by water vendors are arbitrary and range from 15 to 25 Naira per can. Prices are fixed arbitrarily. As a strategy, price of water are sometimes sold at lower prices in order to entice customers. Also, for regular customers 15 Naira or 20 Naira are mostly accepted as unit price. Price can also reduce where more customers are buying more Jerri-cans. Price of water explains 6.57 per cent of the variance (Table 2).

v. **Marital Status**

Marital status of the respondents explains 8.45 per cent of the explanations. It is a significant characteristic of push carts water vendors. About 77 per cent of them are married. This implies that vendors have high level of family responsibilities. Most times these vendors are migrant workers from Niger Republic who were in pursuit of better life. Since water carting does not require any serious capital outlay, it is possible to rent carts. In Sokoto 70 per cent of water vendors hired their water carts.

Water vending therefore is easily embraced by these illegal migrants who are mostly respondents.

vi. Distance Covered Per Day

This component has 6.30 per cent contribution to the variance (Table 2). The distance covered per day is crucial to the amount of water sold and also the income of vendors. It is a product of distance to water point and distance to residences of buyers. These will affect the time spent and quantity of water sold. It will also affect fatigue on the part of vendors. When a longer distance is covered it implied higher physical energy and stress.

vii. Quantity of Water Sold during the Dry Season

This component explains 6.17 per cent of the explanation (Table 2). Dry season in Sokoto starts in September and end in June, a period of about nine months. In the dry season rainwater harvesting will not be possible and it is a period when shallow groundwater dries up. Also, the physiological climate becomes unbearable because of the heat; with temperature hovering around 40°C. The environment becomes dry and thirsty and at water deficit. This will shoot up water demand. Meanwhile, government water supply network is limited and erratic leading to dependence on water vendors for water supply. This goes for nine months in a year, suggesting that the greatest challenge of water supply in Sokoto metropolis is the phenomenon of dry season water supply. Sales are generally higher in dry seasons. This is a season of peak activity of vendors; it coincides with the massive influx of labour migrants from Niger republic who dominates the push cart water vendor business.

viii. Water Board Water Point

It contributes 6.03 per cent to the explanation. Most of the vendors collect their water from the service point in the premises of the Sokoto State Water Board. This point is meant to serve members of the public. The water points are directly connected to the rising main; hence, water runs all the time at these points. The points are the last points of call whenever there is breakdown in supply due to power outage or some other problems in the city. In view of the reliability of this source, most water vendors are found queuing up in this place for water (see plate). The water point remains the only source of good quality water. All vendors collect (or steal) treated water free of charge and resell to their customers.

ix. Vendors Monthly Income

The monthly income of vendors is an index of their level of economic well being. It is a guide to the sustainability of vendors. Most vendors are attracted to the business due to unemployment and poverty (Kjellen, 2000). For example, to be a vendor no formal education or training is required; almost no capital outlay is needed as carts can be leased on daily basis. It is a fantastic source of employment for the low and

unemployable people without any trade or skills. Over 70 per cent of respondents earn below 18,000 Naira monthly income. Vendors' income contributes 6.01 per cent to the variance.

x. **Cart Ownership**

Cart ownership explains 5.73 per cent explanation in the variance (Table 2). Cart is locally fabricated, it has a pair of motor cycle tire, it can carry between 6 to 14 Jerrycans. Cart is the major capital that is required for business. Majority of the Nigerien vendors do not have water cart but do hire. This has several implications, first, it will affect the profit margin and it exposes vendors to unemployment among others.

xi. **Government Support**

Little is known and documented about push carts water vendors in Sokoto. Government policy and financial intervention will not only improve the well being of vendors, but also improve water delivery among the numerous poor urban dwellers that relied on cart pusher's services. Up to now, there is no physical government support for push cart vendors. They are still not mobilized and organized. There is no registered vendor in Sokoto. Vendors' activities are yet to be officially recognized or appreciated in the metropolis. They have been accused of stealing treated water. Water vendors sometimes vandalize water reticulations in order to fetch water from sources close to their destinations. The profit made is repatriated unofficially. With government support, water vending could be a source of employment and a vibrant domestic water delivery outlet. Government support explains 5.31 per cent of the variance.

xii. **Nationality**

Majority of the practitioners are illegal aliens from Niger Republic. They are seasonal migrants who migrate due to the effect of the seasonal drought in the Sahara in dry season. This business is dominated by Nigeriens; during the rainy season, when they return home through their various illegal routes in the Sahel, the business suffers as most of their customers whose homes are not connected to government are have difficulties in accessing water. Nationality explains 5.26 per cent of the variance (Table 2).

xiii. **Level Education**

The vendor's level of education contributes 5.09 per cent to the variance (Table 2). Finally, level of education is important; most vendors have no formal education. The bulk of them are illiterates having only Quranic education. They can only communicate in the local language; they cannot read and write in English language. They hardly can understand government policies. It portends vendors' hygiene level as many do not understand basic hygiene. This affects the rate of patronage as the quality of water will affect its use, this will affect sales.

Conclusion

Nigeria is endemic to climate change. The sudano sahelian zone and the Niger delta belt of Nigeria are already bearing the brunt more than any other part of the country. Unfortunately, there are no serious documentation by concerned public agencies on adaptation methods.

Push cart water vendors is an old art in different part of the world. The Sokoto caliphate has a long contact with the neighboring country of Niger; this explains why many Nigeriens are seasonally found in Sokoto. The push cart water vendors are found in all nooks and crannies of Sokoto, particularly in dry seasons which is about nine months. SWE have been known to play fantastic role in water supply in many urban centers in the poor nations of the world, including Sokoto. Sokoto is a fast growing city with limited pipeline network, it is Sahelian city where physiological comfort index is high. The city is mostly under water deficit in view of about 7-9 months of rainless dry season. Sokoto metropolis is already battling with the consequences of climate change. Hence, the SWEs are playing tremendous role in water provision in Sokoto and by extension, in many parts of the Sahel. Indeed during the long dry season the entire city virtually depend on their supply. They are found all parts of the city. Only little official information are available on them. They are not regulated, not registered, nor integrated into the water supply chain of the state.

Conclusively, despite the role of SWE, they are yet to be integrated into water supply systems in the state. Sokoto, like many Sahelian cities, might not be able to survive without the SWE in view of the increasing effects of climate change, coupled with the inefficiencies in public water supply. However, reasons for the non official recognition and inclusion of SWE in the water supply chains stems from the little understanding of the characteristics of these vendors. This has been attempted in this study. This paper calls for more studies on SWE in Nigeria, particularly concerning the roles of SWE in water supply, poverty alleviation, employment generation. Efforts should be made at integrating push carts water vendors into the water supply network of Sokoto state and the larger Nigeria, as it is the case in Kenya and other parts of the world. Also, government should see water vending as an integral part of the water supply system which may help in the design and implementation of more comprehensive policies that will better serve the poor end-users. Indeed, the recognition of push cart water vendors might build official partners for government water supply, which is the dominant water provision strategy in Nigeria. Also, new laws should be enacted to encourage water vending; the constraints on water supply should also be removed. Also, when integrated, water vendors should be given a tax window and they should be encouraged to form vendor associations.

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