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Assessing the Performance of Water Schemes in Alleviating Water Shortages in Isiala Ngwa, Nigeria

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Abstract
The work aimed at assessing the performance of water scheme in alleviating water shortages in Isiala Ngwa, Abia State. To achieve this, 500 copies of questionnaire were distributed, while 453 were returned. Frequency means and percentages were used to analyse data. Principal component analysis was used to justify performance ratings of the public water schemes. PCA returned an Eigen value of 1.94 with a cumulative percentage of 90.4%, while the remaining 9.5% unexplained variations were outside the scope of the work. Among other recommendations, community participation in project planning, execution and post execution was suggested as an ideal way of improving services delivered by public water schemes.

Keywords: *Performance, Water schemes, Water shortages, Community participation*

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Background to the Study

In specific terms the first objective of rural development is to improve the quality of live and standard of living of majority of people in rural areas can be translated to mean the provision of basic services to the people. The basic services must surely include: water, electricity, shelter, motorable roads and medical centres. However, Alozie, (2001), Chima and Alozie, (2005) and Alozie, (2012) singled out water as the most vital service to man and its availability has defined the economic development of many nations. Earlier on, Ayoade and Oyebande, (1983), and Ezedike, (1990) and more recently, Nwaugo, (2014) observed that adequate water supply is vital to the development of rural areas and pivotal to sustained rural industrialization. Already, various public water schemes are cited in the area, only few are operational; especially the recently constituency water projects, World Bank. Abia State Government Partnership Sponsored Water Projects and Private boreholes. Incidentally, these water projects are inadequate and will not satisfy the water needs of the people. It is obvious that, meaningful sustainable rural development is hinged on the effectiveness of a consistent water generation and distribution programme, having in mind the peculiarities and uniqueness of each rural area.

Nevertheless, in rural Abia State, sources of water include; rain water, surface streams, rivers, boreholes, water vendors and very few functional public water schemes. In Isiala Ngwa Local Government Area, reliance for water needs during the rainy season is the rainwater, while in the dry season; reliance is on boreholes (public and private) and surface water bodies. The fewer presence of surface water in the area demands that, boreholes both (private or public) should be operationally effective in order to satisfy the water needs of the people. Unfortunately, the boreholes are limited by numerous operational inadequacies for which this paper has highlighted.

Study Location

Abia State is one of the states in South-Eastern Nigeria occupying an area of about 6320 Square Kilometers. Abia State has the following coordinates Lat. 4°40' to 6°14'N and Long.7°10' to 8°E. On the other hand, Isiala Ngwa North is one of the 17 local government areas in Abia State. It covers a total area of about 420 Square Kilometer and lies between Long 7°20'E to 7°35'E and Lat.5°28'N to 5°20'N. Isiala Ngwa North falls within the wet tropical climate with clearly marked dry season and double maxima rainfall in June and September, with a short break in August. Dry season extends from November to early April, with January and March as the hottest months. Within this period of dry season, water generation in the area is very severe. For this reason, it is expected that the various water projects both public and private will be able to provide water needs of the people. Mean monthly temperature hovers around 20° to 22°C. Isiala Ngwa north falls within the margins of the extended coastal plains. The land surface is flat or gently rolling, slopes down smoothly down to the West towards the lower Imo River.

Methodology

The survey research design approach was adopted to retrieve data from the field. Five hundred respondents were selected and stratified purposively into four major communities of 100 respondents each. These are the communities with relative functional public and private boreholes. Structured questionnaire was used to collect data. Out of the five hundred copies of questionnaire distributed, 453 were retrieved. Principal component analysis was quickly applied to harmonize the various correlations existing between the variables, otherwise referred to as components. The variables after varimax rotations were later tested to derive the Eigen value. Delineations for the catchment zones for the boreholes, public or private was based on a 3km radius which is in agreement with Von Thunen's concentric zone model.

Results and Discussions

The general installed capacity of some of the public water projects which is signified by the capacities of the reservoirs as presented in Table 1, it will show vividly the need for private boreholes since in 2000 when the data was supplied. Alozie, (2001) projected Average Water Demand for the area was 10,767,150 litres.

Table 1: Installed Capacities of Some Selected Public Water Projects as at 2000

Borehole Location	**Capacities litres**	**Pop Size**	**Add (Pop X 113 Litres)**	**Margin of Deficiency**
AmapuNtigha	100,000	6068	685,684	-585,684
Nbawsi	65,000	5621	635,173	-570,173
Amaputa	70,000	1290	145,770	-75,770
Amaoji	60,000	3019	341,147	-281,147
Okpuala Ngwa	85,000	3572	403,636	-318,636
Total	**280,000**	**19,570**	**2211,410**	**-1,931,410**
Mean	**56,000**	**3914**	**442282**	**-386,282**

Sources: [1]Works Dept. Isiala Ngwa, North L.G.A, September, 2000.
[2]Pop size (Projection based on 3% from 996 base year).
[3]ADD: Pop Size x 113 litres (WHO) Daily water requirement

In table 1, margin of deficiency was derived by subtracting capacities of water projects from expected Average Daily demand for water by the people at 113 litres per person. Further in 2016, Alozie, (2016) revealed that population projection increased summarily to 194231 with 21,948,103 average daily demand for water. Nevertheless, both results increased the need for the emergence of private boreholes which generally increased from 6 to 14especially in Amapu Ntigha locations. Private boreholes do not sustain water generation, especially as operational costs is increasing exponentially, without guarantees of favourable returns on investment. In addition, the encumbrance of private boreholes only becomes lucrative in the dry season since reliance is largely on rainwater during the rainy season.

Table 2: Performance Rating of Public Water Projects in the Area

Borehole Location	Above Average	Average	Poor	Very Poor	Total
AmapuNtigha	8	19	30	39	96
Nbawsi	-	7	31	46	84
Amaputa	-	18	30	42	90
Amaoji	-	10	52	33	95
Okpuala Ngwa	-	21	45	22	88
Total	**8**	**75**	**188**	**182**	**453**
Mean Total	**1.6**	**15**	**37.6**	**36.4**	**90.6**
Mean%	**1.77**	**15.57**	**41.50**	**40.18**	**100**

From Table 2, over 80 mean percentage of the respondents rated the performance of public water projects as below average. It gives an indication that the water schemes have performed dismally. It has also encouraged the people to seek for alternative sources of water supply not minding its attendant consequences of material and human costs.

Operational Limitations

The water schemes were described by the consumers as performing relatively below average. Operational limitations include: lack of community participation, obsolete equipments, dwindling, government funding, poor management, vandalization, rising cost of energy supply and misappropriation/embezzlement of fund made available for running the water schemes. All these are captured in Table 3.

Table 3: Reasons for Poor Performance of the Water Schemes

Borehole location	Lack of community participation	Obsolete equipment	Dwindling Govt. Funding	Lack of Spare Parts	Poor Mgt	Vanda-lization	Rising Cost of Energy	Embezzle-ment	Total
Amapu Ntigha	25	20	25	21	1	-	3	1	96
Nbawsi	29	18	22	11	1	2	1	2	84
Amaputa	19	11	40	14	2	1	2	1	90
Amaoji	27	19	18	26	2	1	1	1	95
Okpuala Ngwa	19	16	24	23	1	1	1	1	88
Total	119	84	125	99	7	5	8	6	453
Mean	23.8	16.8	225	19.8	1.4	1	1.6	1.2	90.6
Mean (%)	26.27	18.54	27.59	21.85	1.55	1.10	1.77	1.33	100

From Table 3, reasons for poor performance of public water projects in the area accounted for the following responses; lack of community participation, 26.27%; obsolete equipment, 18.54%; dwindling government funding, 27.59%; lack of spare parts, 21.85%; poor management 1.55%, vandalization 1.10%; rising cost of energy supply, 1.77%; embezzlement and misappropriation of funds released from maintenance of the schemes, 1.33%.

Major household activities were affected by the low performance of these water schemes. It is very imperative given that sustainability of water supply is paramount to productive rural industrialization.

Table 4: Household activities affected by the low operational performance of the Water Scheme

Borehole location	Domestic	Garri processing	Oil palm extraction	Farming activities	Others	Total
Amapu Ntigha	42	10	21	18	5	96
Nbawsi	24	16	28	10	6	84
Amaputa	35	20	15	10	10	90
Amaoji	36	23	24	9	3	95
Okpuala Ngwa	36	21	18	9	4	88
Total	**173**	**90**	**106**	**56**	**28**	**453**
Mean	**34.6**	**18**	**21.2**	**11.2**	**5.6**	**90.6**
Mean percentage	**38.19**	**19.87**	**23.39**	**12.36**	**6.19**	**100**

As presented in Table 4, household activities affected by the low performance of the water schemes include; domestic activities, 38.79%; garri processing, 19.87%; Oil Palm extraction, 23.39%; farming, 12.36% and other activities, 6.19%. Other activities include; block moulding, construction of mud houses, other forms of construction activities and preparation of local medicines.

These activities have social and economic relevance to the communities and locational peculiarities such that the shortage water in these areas will produce services repercussions. Alozie, (2012) observed that tribal conflicts have been fought in Africa because of water scarcity. The World Business Council for Sustainable Development defined it as water stress and applied it to situations where there is not enough water for all users, whether agricultural, industrial or domestic. Although, Gleick, (2000) noted that defining thresholds for stress in terms of available water per capita is more complex, however, entailing assumptions about water use and its efficiency.

Nevertheless, it has been proposed that when annual per capita renewable freshwater availability is less than 1,700 cubic meters countries begin to experience periodic or regular water stress (FAO, 2009). Below 1,000 cubic meters, water scarcity begins to hamper economic development and human health and well-being. Further enumeration of factors that can increase water stress in the area especially as it is increasingly becoming urbanized include; expansion of business activities, rapid urbanization, climate change, depletion of aquifers, pollution, and water conflicts.

Locational Limitations

Choice of locations for the water schemes created both operational, technical and economic problems. Results from the surveys presented in Table 5 shows that some of the water schemes were cited where there had been reservoirs built in time past while political interest and distance relationships imposed measurable constraints.

Table 5: Reasons for Siting the Water Scheme at Amapu Ntigha

Communities in the zone	**Political interest**	**Population distribution**	**Distance function**	**Presence of existing resources**	**Total**
Amapu Ntigha	5	3	4	24	36
Eziama Ntigha	16	2	1	13	32
Aror Ntigha	10	1	3	14	28
Total	**31**	**6**	**8**	**51**	**96**
Percentage Rating	**32.29**	**6.25**	**8.33**	**53.13**	**100**

Overwhelmingly, more than 50% of the zone has submitted that the selection of AmapuNtigha as the site for the water project was as a result of the presence of a 100,000 litre concrete overhead reservoir, which was built in 1964.

Initially, the reservoir was intended to serve the then Northern Ngwa Country Council. However, the feelings of other communities besides Amapu Ntigha insisted that political interest was the prime factorsince the reservoir had receiving water from Amaoji water scheme. Technically, water filling of reservoirs and subsequent reticulation of water is best when boreholes are sited in close proximity with the reservoir.

Table 6: Reasons for sitting the Water Scheme at Nbawsi

Communities in the zone	**Political Interest**	**Population Distribution**	**Distance Function**	**Presence of Reservoir**	**Total**
Nbawsi	13	10	5	1	29
Agburike	14	3	1	2	20
Umuomaukwu	10	4	2	2	18
Umuzegu	13	1	1	2	17
Total	**50**	**18**	**9**	**7**	**84**
Percentage Rating	**59.52**	**21.43**	**10.72**	**8.33**	**100**

The location of the water scheme at Nbawsi was also for political reasons, 59.52%. Field investigation revealed further that Nbawsi was initially a regional administrative centre for the Northern Ngwa County Council and a major railway outpost. Thus population distribution also accounted for 21.43%.

Table 7: Reasons for siting the Boreholes at Amaputa

Communities in the Zone	Political Interest	Pop. Distribution	Distance Function	Presence of Reservoir	Total
Uratta	18	6	5	1	30
Amaputa	21	4	5	2	32
Amaekpu	14	3	7	4	28
Total	**53**	**13**	**17**	**7**	**90**
Percentage Rating	**58.89**	**14.44**	**18.89**	**7.78**	**100**

Just like other water schemes, Amaputa water scheme was also citedin the area for political reasons. Distance function also influenced the choice of location attracting a response rate of 18.89%.

Table 8: Reasons for Siting the Water Scheme at Amaoji

Communities in the zone	Political Interest	Population Distribution	Distance Function	Existing Reservoir	Total
Amaoji	14	12	6	3	35
Ihie	22	6	3	1	32
Abayi	18	7	1	2	28
Total	**54**	**25**	**10**	**6**	**95**
Percentage Rating	**56.84**	**26.32**	**10.53**	**6.32**	**100**

In the choice of Amaoji as a borehole site, political interest accounted for 56.84%. Greater concentration of people attracted 26.32% while the centrality of the area and presence of reservoir accounted for 10.52% and 6.32% respectively.

Table 9: Reasons for siting the Water Scheme at Okpuala Ngwa

Communities in the Zone	Political Interest	Population Distribution	Distance Function	Existing Reservoir	Total
Okpuala Ngwa	28	7	4	4	43
Osusu	12	4	2	4	22
Ngwaukwu	13	5	3	2	23
Total	53	16	9	10	88
Percentage Rating	60.23	18.18	10.23	11.36	100

From Table 9, more than 50% of the respondents agreed that Okpuala Ngwa was chosen as a site for the water scheme for political reasons. The score is high due to the fact that Okpuala Ngwa is the administrative headquarters of Isiala Ngwa North Local Government Area. Other reasons include; greater population concentration 18.81%, Centrality of the location in respect of other locations, 10.23% and presence of reservoir, 11.36%.

In general analysis, AmapuNtigha water scheme is sited at an existing reservoir offers which offers the best optimum technical results and economics of scale. The reservoir is well structured to enabling the reticulation of water to communities located 5km away from the supply point. On the other hand, the long distance covered by the water scheme increases the need for maintenance of the reticulation systems and total engineering costs. Other sites serve communities distributed unevenly within their respective catchment zones. Centrality was not a strong perquisite.

Sites were selected based on political interest other than technical requirement. None of the sites were selected after a seismicsurvey, terrain, geomorphic, or feasibility analysis had been carried out.

Testing Related Assumptions
The low performance of Public water schemes is due to human and material inadequacies.

To analyse this assumption, and because of the related nature of the premise, the Principal Component Analysis (PCA), was used. At the level at which the PCA operates, problems of multicorrolinaty, hidden externalities are eliminated and statistical conclusions reached without overlooking even the minutest of detail. In order to verify the reasons behind the low performance of some of the public water projects in the area, data presented in Table 3 was used.

In all, 8 variables were selected as the reasons, they include:

1. Lack of Community Participation (LCOPAT)
2. Lack of Spare Parts (LASPPAT)
3. Dwindling Government Funding (DWGTFND)
4. Obsolete Equipment (OBSEQUP)
5. Poor Management (POORMGT)
6. Vandalization (VANDAL)
7. Rising Cost of Energy Supply (RISENGY)
8. Embezzlement of Funds (EMBEZLMT)

The above variables incorporate human and material problems and values assigned to each variable were summed up from number of times they occurred in the area. These variables were harmonized and transformed into a matrix of inter-correlations between the variable to know the strength of their inter correlation. The correlation matrix indicated that some of the variables have high correlation with each other, (for instance variables 1 and 4 have high correlation). To remove this strong bias, and probable effect on the expected results we transform the 8 predictor variables into orthogonal (uncorrelated) values by Principal Component Analysis. (PCA).

Using an SPSS computer programme, (Nlie, Hull, Jerkins, Steinbrener, and Bent, 1975) principal component analysis then reduced the eight variables to 3 orthogonal (uncorrelated) factors that account for why public water projects in the area failed. These 3 factors together account for 90.5% of the basic reasons responsible for the failure of public water schemes in the area.

However, to improve interpretations of the result and achieve clarity of purpose, the varimax rotation was utilized to maximize variances and to place the Eigen value in a unique position such that each factor can be interpreted by its weight (loading). In addition, variables that at least 0.7 loading was selected. This was necessary to eliminate the possibility of selecting the variable twice.

In Table 12, the three under laying factors identified to be responsible for the low performance of public water projects in the area are as follows:

1. Lack of Community Participation and ineffective post execution monitoring.
2. Misappropriation of funds and lack of spare parts.
3. Increasing Overhead Costs and Lack of Security.

These factors are family names assigned to the variables that have more than 0.7 loading and fall within each other, of the selected rotated variables. (See Table 16, stage IV).These family names are interpreted as thus:

Factor I: Family Name: Lack of Community Participation and Ineffective Post Execution Monitoring. It includes:

a. Dwindling Government Funding
b. Lack of Community Participation
c. Obsolete Equipment

Factor II: Family Name: Misappropriation of Funds and Lack of Spare Parts, which include;

a. Embezzlement
b. Lack of Spare Parts

Factor III: Family Name: Increasing Overhead Costs and Security.
It includes:

a. Rising cost of energy supply.
b. Vandalization

Table 10: Variables with Highest Loading in the Factors

Factors	Variables	Loading
Factor I	DWGTFND LCOMPAT OBSEQUP	0.92 0.79 0.98
Factor II	EMBEZLMT LASPPAT	0.87 0.95
Factor III	RISENGY VANDAL	0.96 0.79

(Note DWGTFND-Represents Dwindling Government Funding as in the list presented on page 21) full text of the calculations are presented from Tables 13, 14,15,16,17 and 18.

Decision Rule

H0: That the low performance of the public water projects in the area is not due to human and material inadequacies.

HI: That the low performance of the public water projects in the area is due to human and material inadequacies.

We can then conclude from the analysis that the factors responsible for the low performance/abandonment of the public water projects in the area generally human and inadequate materials for work, since they account for 90.50%. The remaining 9.5% unexplained variations are outside the scope of this work. We therefore accept HI. Which says that human and material inadequacies are responsible for the low performance/abandonment of the public water project in the area since acceptance rate is as high as 90.50% with only 9.5% unaccounted for.

Alternative Sources of Water

The dismal performance of the Public water schemes prompted the emergency of alternate sources of water which include private boreholes, 30.90%; water vendors, 24.45%; Stream/rivers, 19.94%, Ponds, 4.09% and rainwater, 19.63%.

Table 11: Alternative Sources of Water Existing in the Area

Borehole Location	Private Borehole	Water Vendors	Stream/Rivers	Ponds	Rain Water	Total
Amapu Ntigha	22	28	17	7	22	96
Nbawsi	27	21	17	2	17	84
Amaputa	30	13	15	6	26	90
Amaoji	31	25	19	10	10	95
Okpuala Ngwa	30	16	13	15	14	88
Total	**140**	**103**	**81**	**40**	**89**	**453**
Mean	**28.0**	**20.6**	**16.2**	**8**	**17.8**	**90.6**
Mean (%)	**30.90**	**24.45**	**19.01**	**4.09**	**19.65**	**100**

Table 12: Measurement of Regularity Standard for Private Boreholes in a Week

Location	Every Day (Very Regular)	6-4 Times (Regular)	4-2 Times Fairly Regular	2-0 Times (Not Regular)	Total
Amapu Ntigha	8	2	8	2	20
Nbawsi	11	9	6	1	27
Amaoji	13	15	2	1	31
Okpuala Ngwa	12	9	3	6	30
Total	**54**	**47**	**22**	**15**	**138**
Percentage Rating	**39.13**	**34.06**	**15.94**	**10.87**	**100**

In Table 12, over 35% of the respondent scored the private boreholes as very regular since they function every day, while over 30% of the respondents rated them as regular. Other ratings include: fairly regular, 15.94% and not regular, 10.87%.

Performance rating for private boreholes is high especially for the communities investigated; (71.19%) it is very significant. Private boreholes readily filled the gap created by the non-performing public water schemes.

Recommendations

We have been able to identify the pitfalls in the existing public water supply system in the area. We therefore make our recommendations, though not completely an end in itself but an effective approach to a sustainable water supply programme in the area.

Better Management of Public Water Schemes through considerable Community Participation:

Community participation in rural development is not entirely a new phenomenon but have been severally adopted in most developing countries. It is an old phenomenon, though not well appreciated and effectively harmonized. Community participation is the involvement of the community in certain aspects of planning, execution, and post-execution stages of a project. Community participation can be achieved through three major approaches; Change in Attitude Method (CAM), Participatory Rural Appraisal (PRA) and Participatory Rural Method (PRP).

Onuoha, (1990). In rural Nepal, Chima,(2000) water boreholes sunk in the area could not last for more than two years since they were installed without the participatory consent of the communities. Infact the UNDP officials found that 80% of the boreholes had run dry due to sediment in tanks or broken pipes. The Nepalese considered the water supply system as a gift to compensate the several years of social neglect. The project was very dear to them and when it failed, they simply returned to their old system of water generation and collection, which was highly contaminated.

To redress this malady, UNDP through its Save the Children Foundation (SCF) introduced a village based maintenance system and instilled a genuine sense of ownership in the people, the water scheme became efficient. A village water committee was formed with clearly defined roles and responsibilities. The duties included the hiring of local plumbers and those who underwent technical training at the end of which, certificates were issued to them while on training they were paid a monthly stipend to enable them offset other personal costs.

Water Provision Transferred to the Local Government Councils

We recommend strongly that the ceding of the management of public water generation and distribution to the Local Government Councils.It is most ideal and will yield sustainable results. At the moment the state is responsible for providing water to her citizens, (as contained in the 1999, Federal Constitution of Nigeria), but most Local Government Councils out of total neglect by the state government have been involved in public water generation and distribution. Since this is a constitutional matter we recommend that the enabling constitution reviewing committee consider it for appropriate amendments. This suggestion is based on the peculiarities of the local government administration and its subsequent grass root enriched programmes.

Making ROHWAS More Effective – Rain Water Harvesting System (Igbozurike, 1991).

The problem of rainwater harvesting in the area is lack of adequate storage facilities. The other issue of thatched roofs is not prominent since in the few places where they exist, family members collect water from nearby buildings with zinc roof-tops. Storage facilities provided for storing rainwater in the area are; concrete containers, metal drains and 50-1000 plastic litre containers.

The cost of constructing underground water reservoirs has increased substantially, we therefore recommend that the local concrete reservoirs be adopted as an ideal storage unit for ROHWAS. The construction is relative to the size of reservoir in mind. For a 300litre-reservior, the following materials and costs are required.

i.	1 bag of cement at	N2600*
ii.	3 Wheel Barrows of Sand	N2100*
iii.	2-50 Litre Jerry can of Water	N100*
iv.	Labour	N3500*
		N8,300*

*Prices based on market prices for the area as at 2016.

Funds for this project can be generated through Government/Community partnership programme. The concrete surface reservoirs have a minimum life span of 10 years.

Water Schemes only for Manageable Units

This is a complete departure from the existing norm. It amounts to the decentralization of existing water projects and restricting it to communities. This method helps to reduce cost and technical complexities of distributing water over larger areas. It also makes community participation more meaningful hence each of the community will only respond to the needs of water project sited in their areas. Decentralization can be made possible by providing single unit boreholes in each community.

In addition the hand pumps like the Yaku in Bangladesh, (Safe water, 2000) can be modernized to serve local interest.

Yaku was adjudged by the UNDP as the best pumps (Safe water, 2000).

A localized version of Yaku, otherwise renamed, 'MmiriAko', will require the following resources

a. Drilling and Labour, (20,000 to 200,000 (depending on the depth of the well).
b. Rower, which allows water to spill lack into the well 22,000.

Total Cost, N142, 000.00-N222, 000.00

1. Based on September, 2000 assessment of N100 to $1

By UNDP standard, 'MmiriAko' supplies water to at least 400 persons. For a Community like AmapuNtigha with a projected population of 12,530 for the year 2016 at 3% growth rate, 31 "MmiriAko hand Pumps will be required at the cost of N6, 820,000. This amount though enormous especially on the rural populace can be phased, while relevant agencies, including NGOs could contribute, at least 80% of the total cost, while the remaining 20% is meet by the benefiting community. There are economics of scale to enjoy by all the parties especially at the long run, bearing in mind that a functional water scheme will inspire rural development. Other forms of hand pumps popular for low costs and efficiency include; Bucket Pumps, Blair pumps, Bush pumps, Mark II hand pumps and Vergnet pumps.

Rural Participatory Funding (RPF)

Participatory funding instills a genuine sense of ownership. It eliminates the spirit of "Nobody's Property". The people become maximally involved and propose several initiatives of safe guarding it. It is also necessary to obtain funds from the benefiting communities, since they are able and willing to pay for water in the right circumstances. For this purpose, the people must be involved at some level in the process from planning to post execution.

However, in the study area most of the communities view water supply as their primary concern and so will provide as much as it is possible, funds, materials and labour needed to run an efficient public water system.

Completion of PTF Sponsored Geological Study of the Area

Already the Petroleum Trust Fund has sponsored a geological study of the area. This was intended to record and map the nature of surface and underground water in the study area. We therefore recommend for the completion of that exercise. This will enable a more sustainable water supply system in the area.

Conclusion

Water generation and distribution is essential for rural development. An operationally effective water generation system will certainly enhance and further sustain economic and social development of the area.

Table 13: Stage I Correlation Matrix

	DWGTFND	EMBELMT	LASPAT	LOCOMPAT	OBSEQUP	POORMGT	RISENGY	VANDAL
DWGTEND	1.00							
EMBEZLMT	-0.254	1.00						
LASPPAT	-0.494	-0.712	1.00					
LCOMPAT	-0.682	0.631	-0.104	1.00				
OBSEQUP	-0.881	0.188	0.424	0.744	1.00			
POORMGT	0.349	-0.408	0.145	-0.159	-0.461	1.00		
RISENGY	0.420	-0.375	-0.445	-0.146	0.047	0.102	1.00	
VANDAL	-0.127	0.791	-0.563	0.307	-0.198	0.000	-0.791	1.00

Table 14: Stage II Factor Matrix

Note PCA Extracted, 3 factors. (Unrotated)

	Factor 1	Factor 2	Factor 3
DWGTFND	*-.75803	-.59270	.25891
EMBEZLMT	*.82205	-.50231	.26557
LASPPAT	-.18733	*.83733	-.49838
LCOMPAT	*.83362	.20505	.11467
OBSEQUP	.63540	*.75220	.15292
POORMGT	-.44688	-.18609	-.59574
RISENGY	-.51667	.31675	*.74876
VANDAL	.62129	*-.72089	-.30184

Table 15: Stage III Varimax Rotation

Rotated Factor Matrix

	Factor 1	**Factor 2**	**Factor 3**
DWGTFND	*-.92176	.21714	-31009
EMBEZLMT	.36860	*.86520	.33790
LASPPAT	.30259	*-.94500	-.00257
LCOMPAT	.79103*	.29682	.19046
OBSEQUP	*.97558	-.14713	-.13967
POORMGT	-.53821	-.41120	.36122
RISENGY	-.11519	-.02249	*-.95611
VANDAL	.00634	.60260	.79600

Table 16: Stage IV

	Factor 1	Factor 2	Factor 3
DWGTFND	-.92176* -0.922	.21714 0.217	-31009 -0.310
EMBEZLMT	.36860 0.369	.86520* 0.865	.33790 0.338
LASPPAT	.30259 0.303	-.94500 -945*	-.00257 -.003
LCOMPAT	.79103 0.791*	.29682 0.297	.19046 0.190
OBSEQUP	.97558 0.976*	-.14713 -0.147	-.13967 -0.140
POORMGT	-.53821 .538	-.41120 0.411	.36122 0.361
RISENGY	-.11519 -0.115	-.02249 -0.022	-.95611 -0.956*
VANDAL	.00634 0.006	.60260 0.603	.79600 0.796*
EIGEN VALUE	2.96	2.33	1.94
% OF VARIANCE	37	29.1	24.3
CUMMULATIVE %	37	66.1	90.4

The Eigen value for the unrotated and rotated was derived by summing the squares of each loading for the variables within the factors. Percentage of variance is the Eigen value in respect of the N value, which in this case is 8. While the cumulative percentage is adding up cumulatively the percentage of variance for each factor.

Table 17: Rotated

Factor 1	**Factor 2**	**Factor 3**
0.922	0.865	0.956
0.791	-0.945	0.796
0.976		
3 Variables	2 Variables	2 Variables

Note, we choose the rotated values to assign family names and make our final comments, since, the procedures allow for any of the two values, (Rotated and Unrotated) to be chosen.

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