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Causes of Water Borehole Failure in Sedimentary Terrain: Case of Rural Water Supplies to Communities in Enugu State, Southeastern Nigeria

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Abstract

Many water boreholes sunk under past Government Administrations in Enugu State have failed in performing their desired functions. Analysis of data from government records, personal visits and investigations, interviews of water borehole owners and drillers showed that all the twenty-four (24) new water boreholes sunk and four (4) rehabilitated water boreholes totaling twenty-eight (28) across seven Local Government Areas of Enugu State under Local Empowerment and Environmental Projects (LEEMP) have failed. Diagnosis and analyses of the failures indicated that the causes are numerous and varied. Though some of the causes are partly due to hydrogeological and lack of well-organized and structured operations and maintenance programmes related problems, most of the failures are caused by poor and inadequate planning and use of unqualified and corrupt service providers (contractors) execution of water borehole projects. These frequent failures and breakdowns of water boreholes result in communities reverting to the traditional polluted water supplies and children and women trek several kilometers daily in search of waters of even questionable qualities and quantities.

Keywords: Causes, water, failure, sedimentary, rural communities.
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Introduction

Water as a natural and renewable resource is essential for national economic growth and promotion of standard of living in every community it serves. Readily availability of adequate and safe water close to the users at least cost is indispensable for the promotion of health and dignified life. Because of its economic and reliable advantages over other water sources, potable water supply through boreholes or ground water abstraction supplemented by rain water during wet season is the major source of potable water for domestic purposes in rural communities of Enugu State.

The importance of water boreholes in rural communities of Enugu State suggests the need for serious attention to existing water borehole schemes. Under Local Empowerment and Environmental Management Projects (LEEMP) Programme in Enugu State (2004-2009), total of twenty-eight (28) water boreholes were put in place across Local Government Areas in Enugu State to improve the wellbeing and health conditions of the people in rural communities. Enugu State LEEMP was quoted to be the best in Nigeria in terms of quality of projects executed (Enugu LEEMP News, 2008).

Available statistical records indicate that all the water boreholes put in place under LEEMP programme in rural areas of Enugu State are not currently functioning as desired. Some have totally broken down and overgrown by bush while some are still rendering skeletal services to the users. Unavailability of adequate and potable water supply through boreholes due to frequent breakdown and failures of water boreholes leads to rural communities' dwellers reverting to traditional old contaminated if not polluted water sources; trekking of several kilometers daily by women and children to fetch

waters and in some cases waters of questionable quantities and qualities. This does not only expose them to unexpected road accidents and kidnapping but increase the rate of water born diseases and affects their socio-economic activities.

The main aim of this study is to ensure greater access to reliable, adequate and safe water at least cost through identification of the factors causing water borehole failures from which possible solutions may be proffered. The objective is to review the status of water boreholes, analyze data collected through interviews and available government documents and field practical experience to some of the major factors causing water borehole failures.

The methods of investigations involved gathering of relevant information on the construction and performance history of the water boreholes from drilling companies, operators and some stakeholders. Personal visits to the localities of the water boreholes were made to see their current status, interviews were granted to some users of the boreholes and data from the 28 water boreholes were analyzed.

According to Agunwamba (1994), for sustainable remedial measures to be effective, the first step is identification of factors responsible for the failures. Without proper understanding and identification of the factors responsible for failures in water boreholes and proffer solutions to the factors causing water borehole failures, construction of new boreholes and rehabilitations cannot be meaningful (Dan-Hassan, 2017). Inadequate feasibility studies lead to sitting of water boreholes in unproductive areas and even when the problem does not stem from wrong sitting, unplanned maintenance programme has crippled the good efforts made for sustainable water supply development. It is noted that like any other capital project that enthusiasm and availability of funds tend to be limited to construction stage with minimum interest and plans for operations and maintenance programmes. While the expected life of a water boreholes for supply of water depends on its design, quality of construction, development and operations, proper maintenance assures the expected yield, improves its performance, and extends the life of the water borehole even beyond what is envisaged at the planning and design stages (Jemilugba and Oguntuase, 1994).

For effective operation and maintenance, communities should be responsible and continuity in government ‘s policies and priorities will be vital ingredient for a successful water supply to communities (Babatola, 1997). Lack of community ownership of rural water supply schemes has been a major threat to operation and maintenance with the non-involvement of women in planning and implementation of rural water supply schemes has been a major threat to operation and maintenance (Dan Hassan, 2017). Proper maintenance of boreholes and associated infrastructures prevent unnecessary failures and reduce the quest for new boreholes (Jemilugba and Oguntuase, 1994). Where exploration is carried out and was not properly monitored or supervised to ensure reliable results, and pumping tests that should lead to efficient pumping schemes and installation was not properly or not carried out, and proper well completion and adequate borehole development were not carried out may lead to poor or low yield or even water borehole screen collapsing (Abibo, 1988).

Study Area

Enugu State lies between longitudes 007º 00‘and 007º 42‘E, of the Greenwich Meridian and between latitudes 06º 00‘and 07º 06‘N of the Equator. Enugu State has a population of about 4.6 million people as at 2016 with an annual growth of 3% and covers about 7,161square kilometer Enugu State has seventeen Local Government Areas.

2.0 Geology and Hydrogeology of the Study Area

Geologically, Enugu State lies within the Southeastern Nigeria Sedimentary Basin and is underlain by nine (9) important geologic formations (figure. 1)

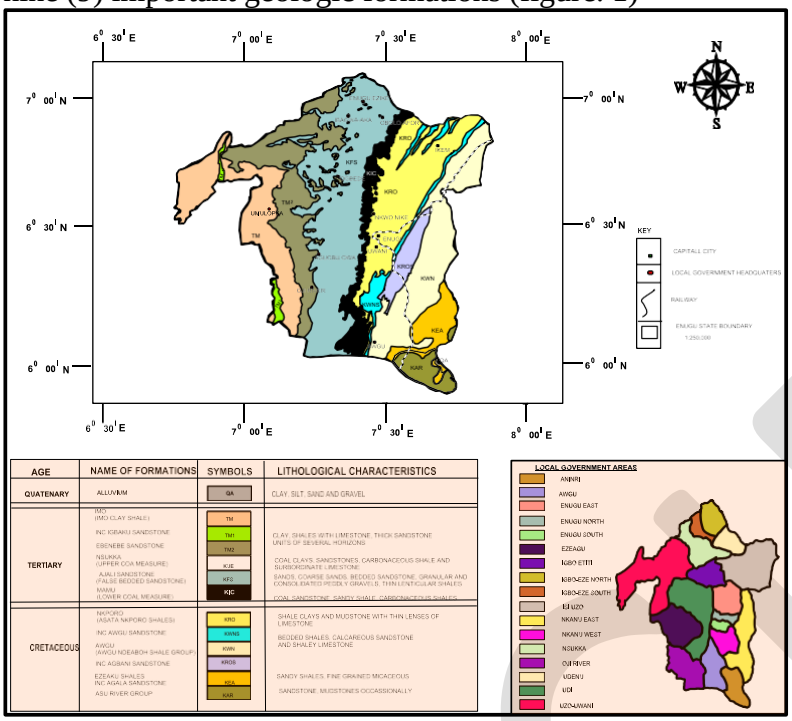

Fig.1: Geologic map of Enugu State (Cranfied University in collaboration with DFID, 2008)

Enugu State is well endowed with water resources with an average annual rainfall of about 1800mm. The hydrogeology of the area is strongly influenced by the geology of the area and in terms of hydrogeology, the state is rich in aquifers and most of potable water schemes are based on groundwater development. According to Okagbue (1988), the most important geologic unit that bears aquifers of regional distribution within this study area is the Ajali Formation. It is one of the most prolific aquifers in Nigeria. Other auriferous layers of local importance within the area of study include the sandstone units of Nsukka and Mamu Formations, sandstone member units of Imo Shale Group. From hydrogeological point of view, Imo Shale, Nsukka and Mamu Formation aquifer units are limited in area extent but are useful when local problems of water supply are considered. Fractured/Fissured shale units of above formations may also be of local important. Most ground waters are derived from precipitation through infiltration and percolation into the ground and all groundwater in southern Nigeria are mildly acidic (Ezeigbo, 1990). Based on their yielding capacities the study area can be grouped into: high yielding aquifers (Ajali Sandstone aquifer units), moderate yielding aquifers (Mamu Formation, Nsukka Formation, Alluvium deposits, sandy members of Imo Shale Group and Awgu Shale Group) and low yielding zones (fractured and fissured shale units of Awgu, Eze-Aku, Asu-River, and Nkporo Groups).

3.0. Causes of Water Borehole Failures

Water borehole is said to fail when at any time of the year; it cannot perform or fulfill any of the desired functions efficiently and effectively**.** Water borehole consists of several parts working together to make it function effectively and efficiently. A fault in any part of the borehole will affect the performance of the whole system, ultimately leading to failure. Failure can be in form of the borehole being dry or reduction in quantity and/or water quality produced from the borehole after few months of operations. Generally, factors causing water borehole failure are numerous and varied. They include but not limited to planning related factors, groundwater potential and hydrogeology related factors, design, construction and development factors and operation and maintenance related factors.

3.1 Planning Related Factors

Inadequate and inappropriate feasibility studies (financing structures and inadequate water demand and supply analysis), improper water borehole sitting and lack of well- articulated, organized and structured operations and maintenance programmes, little or non-involvement of benefiting community in all stages of the project, negligence of local political and legal structures, lack of cohesiveness, lack of transparency and attitudes of some stakeholders, instability in governance, policies and priorities, practice of top-bottom approach, inadequate and non-provisions for proper monitoring and supervisions of projects and lack of requisite of technicians, and other minor factor are the planning related factors. In many instances, there may be poor or lack of well planned financing structure, finance misappropriations and untimely release of the allocated funds. Frequently, not enough money is available to cover operational costs and carrying out running repairs let alone necessary preventive maintenance programmes. These may lead to water borehole failure.

Some of the water borehole failures are aggravated by population pressure caused by inadequate water demand and supply analysis (poor population projections). When there is wide margin between the rate of population‘s growth and rate of water supply from water borehole, there may be stress on the parts of the water borehole scheme which may result in pumping equipment failure, hence, reduction in efficiency of the water borehole and or shorten the meaningful life of the water borehole. Many water boreholes fail because they were wrongly sited probably because of poor and/or inadequate pre-drilling investigations and/or are influenced and pre-determined by some selfish stakeholders whether it will be productive or not.

Rarely will people remember that operations and maintenances programmes sustain the projects even beyond desired life span. Their enthusiasm over the new project is limited to the initial construction of the project. In such cases, the question of who oversees or finances the operations and maintenances is never in their mind. Even when enough money for operations and maintenances is available, the question on whether they have capable technicians to operate the scheme or viable institutions to carry and organize and maintenance of the scheme will never occur to their mind. Thus, negligence or inadequate attention to how operations and preventive maintenances will be taken care of during early planning stage may contribute greatly in the failure of water boreholes.

Sometimes little or non-involvements of benefiting community in the early planning of the project and this may lead to inadequate enlightenment, education, sensitization, mobilization and motivation of the people. Even when they are fully involved, their participations and contributions in decision taking are low and they are not properly guided This may lead to poor selection of need and awarding of the water borehole contracts to unqualified and corrupt service provider which may hamper the success of the water borehole project.

Facilitators may indirectly impose service provider of their own choice on the community because facilitators are seen to be more knowledgeable than the benefitting community members. Again, when some of the community members are not adequately convinced about the worth of the utility derivable from the project, they may likely be unwilling to contribute to the success of the project. Moreover, clans that are not favoured by the geographical location of the project or are not well represented in the constituted water committee may not be willing to contribute in any form for the success of the project. In some communities, there may be deep-seated attitudes such as apathy, rift, lack of self-confidence and distrust that may stand in the way of development and these if not well handled by giving them sense of ownership and their responsibilities fully instilled in them through adequate sensitization, enlightenment and the likes may lead to failure of water borehole projects. Negligence of local political and legal structures who are there to make the realization of projects facts because they command general support among the population may cause water borehole to fail. In some communities lack of cohesiveness because where there is real class divisions, deep tussle for political and/or chieftaincy interest and much income differences may hamper developmental projects. Lack of transparency and unnecessary interferences of some stakeholders who may collaborate with some greedy and corrupt members of the facilitators, water committee to select unqualified and corrupt service provider may jeopardize the success of water borehole programmes.

Instability in governance, policies and priorities are factors causing failures in rural water supply through water borehole. These may lead in stepping down of projects already started by predecessor without completion of some projects as previously planned. Every new government have new plans and wants to start its own project, thereby abandoning already started projects no matter the stage of the project completion.

Practice of top-bottom approach affects the quality of job done. The decision of which project, location of project and the selection of contractor may have been pre-determined during planning stage without consulting the benefiting community. The community in government mind is a mere passive recipient of developmental projects. Hence, they are not consulted and even when they are consulted it is just to inform them. They are not adequately consulted or involved in the planning and execution of the project. Instructions and directives are simply parceled down to the rural people. There is no room for collaboration and cooperation. In this case poor need assessment may result, hence, embarking on project that does not suit or solve the rural dwellers problem or priority need. This may result in the rural dwellers not being in support of the project. They will be less concern about the project and not willing to contribute/ participate in any form.

Inadequate and lack of provisions for proper monitoring and supervisions of projects, and training of technicians on operations and maintenance of the water boreholes during project planning contribute to water borehole failures. Unclear clarifications and definitions of responsibilities at the early stage of planning contribute to water borehole failures. Negligence of how the project shall be secured may give room for theft and vandalization of water borehole parts which may result in failures of water borehole schemes.

3.2 Groundwater Potential and Hydrogeology Related Factors

Tapping of water from geologic material of low or no water yield and decline in water level of aquifer is the most common cause of water borehole failure. Sitting of water borehole in such terrain may be due to poor pre-drilling groundwater investigations by incompetent technicians, political interference or poor design. At times, the screens may be placed or positioned opposite non-aquiferous horizons/zones with little or no water and even of poor water quality. This may lead to water borehole failure.

Next highest hydrogeology related factors cause to water borehole failure is variations or decline in water level especially in unconfined aquifer systems. The variations or decline of water level affects the quantity and quality of water being produced and the efficiency of the water borehole at a particular time of the season. Decline in water level which may subsequently result in low aquifer yield can be caused by lack of adequate aquifer recharge to the aquifer unit or over pumping. Aquifer mining leads to reduction in the yield and quality of water borehole. Incrustation, bio-fouling as well as corrosion of metal surfaces are common causes of reduction in water borehole yield and water quality. Again, clustering of water boreholes, presence of dissolved gases and other contaminants, un-coordinated and unregulated mining may affect the performance, yield and water quality of water borehole.

3.3 Design, Construction and Development Factors

Water borehole may fail because of poor and inadequate design (selection of size, length, type, inadequate physical specifications and placement of any water borehole component). Use of inappropriate method in drilling and or partial aquifer penetration may lead to failure in performance, yield and water quality of water borehole. Moreover, improper and/or inadequate development of the water borehole especially in an unconsolidated aquifer may result in sand-pumping and reduction in the specific capacity of the borehole.

3.4 Operations and Maintenance Related Factors

Negligence of operations and maintenance, lack of operations recording keeping may result in water borehole failure. At times water borehole fails because no proper arrangement was put in place for operations and preventive maintenance programmes during early planning stage. In such situation there may be un-organized operations and maintenance of the project that may lead to failure.

3.5 Negligence of other human activities

Frequent vandalization and high theft of borehole components, and erratic power failures and epileptic power supply also contribute to water borehole failure. Failure can occur also due to over-pumping of the water borehole probably to meet up with water demand. Generally, normal appropriate rate of pumping of water out of some water boreholes reduces pressure and temperature of aquifers within the immediate vicinity of the borehole and this may result in the release of dissolved gases in the water which may in turn contaminate water pumped out of the well.

4.0. Results and Discussions

Table one below shows boreholes sited in parts of rural areas of Enugu State and their present status.

Table.1: Results of water borehole status – Enugu LEEMP (2004-2009)

S/NO	NEW BOREHOLES Local Government Area	Communities	Number of Boreholes	Borehole status
1	Nkanu West	Ndiagu-Uwani Akpugo	2	Failed
		Obe Ugwu Ogbeke Nukurata	1 1	Failed Failed
2	Ezeagu	Akama Oghe Ezema Olo Iwollo	1 1 1	Failed Failed Failed
3	Uzo-Uwani	Akpugo-Ezedike	1	Failed
4	Igbo-Eze North	Abba Igogoro Okata Uda Umuida Ugwuike Aguibeje	1 1 1 1 1	Failed Failed Failed Failed Failed
5	Nsukka	Ogbozalla Opi Idi Opi Obige Obukpa Alor Uno Agbamere	1 1 1 1 1	Failed Failed Failed Failed Failed
6	Awgu	Akawu Agbojugu Amabo Obodonasa	3 1	Failed Failed
7	Oji River	Umuagu Inyi	1	Failed
		TOTAL	**24**	
	REHABILITATION BOREHOLES			
1	Nkanu West	Obinagu Ndino Ogbeke Nukureta	1 1	Failed Failed
2	Oji River	Akpugo Eze Umuogbuagu Ugwuoba	1 1	Failed Failed
		TOTAL	**4**	

Findings from the investigations indicated that most of the boreholes are not functional and some overgrown by grasses and bushes had been abandoned while very few are still rendering very skeletal services. The yields and water qualities of those rendering skeletal services vary widely in different locations. The study shows that 100 per cent of the 28 water boreholes put in place in Enugu State under Local Empowerment and Environmental Programme (LEEMP)- 2004- 2009 have failed to perform their desired functions effectively and efficiently. Though very few of the boreholes were seen providing inadequate services, eighty per cent of the boreholes failed at the point of commissioning. Fifteen of the boreholes were reported to stop functioning few days after commissioning indicating that they failed due to improper sitting, hydrogeological related problems or design and construction problems. Some of the overhead tanks were filled with imported water for the project to be commissioned by any means. About three of the ones rendering skeletal services failed because of high cost of operations and preventive maintenance.

5.0. Conclusions

Tough very few numbers of the water boreholes failed because of unorganized and unstructured operation and maintenance programmes, this investigation shows that, most common factors identified as causing water borehole failures in Enugu State are; poor and inadequate planning before embarking on water borehole projects, use of unqualified and corrupt service providers to design and/or construct water boreholes.

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