



## Techno Science Africana Journal

Journal homepage: [www.technoscienceafricana.com](http://www.technoscienceafricana.com)



### SPATIAL ANALYSIS AND DISTRIBUTION OF SOLAR POWERED BOREHOLES IN RURAL COMMUNITIES OF NORTHERN BAUCHI STATE, NIGERIA

Ibrahim Danladi Sule

Department of Geography & Regional planning

Federal University Dutsin-ma, Katsina State, Nigeria

#### ARTICLE INFO

##### Keywords:

*Spatial Distribution,  
Solar Powered  
Boreholes, Rural  
Communities,  
Functionality,  
Northern Bauchi  
State.*

##### Correspondence

Author:

idanladi@fudutsinma.  
edu.ng

Phone No:  
08035285126

#### ABSTRACT

This research investigates spatial analysis and distribution of Solar Powered Boreholes in the Rural Communities of Northern Bauchi State, Nigeria. Field survey and documented records were used to generate data for this study. The field survey data were collected through questionnaire administration and with the use of Global Positioning System (GPS). The documented data were collected from Rural Water Supply Units of the Local Government Areas, State Millennium Development Goals Support Office and Rural Water Supply and Sanitation Agency (RUWASSA). Forty five communities were sampled for this study through a Multi stage sampling procedure. The data collected were presented in charts and maps. The study identified that 240 solar boreholes were constructed by thirteen institutions from 2007-2014 in the nine LGAs of the study area. Gamawa and Zaki Local Governments have the highest number of solar boreholes with 21% and 14% respectively. Jama'are, Katagum, Misau and Shira LGAs have 10% of the solar boreholes constructed each and Giade LGA recorded the lowest with only 8% of the boreholes constructed. From the records MDGs/CGS drilled 43% of the boreholes, Hadejia/Jama'are River Basin Development Authority (HJRBD) 17%, Federal Ministry of Water Resources (FMWR) drilled about 12%. The State Ministry of Water Resources (SMWR) and Rural Water Supply and Sanitation Agency (RUWASSA) constructed 5% and 7% respectively. The number functional boreholes (52%) nearly equal those of non functional boreholes (48%). The most common cause of non functionality was associated with submersible pumps, cable, switch, panel among others. The sampled boreholes have once experienced the failure of the components. The study concluded that the solar powered boreholes were generally distributed within LGAs and the innovation introducing solar powered boreholes is significantly improving access to safe and clean water supply especially to the rural communities of the study area. The study recommends that in the sparsely populated villages and access to safe water is very low, government should provide solar boreholes. Governments and development partners need to improve the monitoring and evaluation various solar powered boreholes projects executed.

**INTRODUCTION**

Growing global concern regarding climate change motivates technological studies to minimize environmental impacts (Akunai 2014). In this context, solar powered boreholes are notably prominent in Nigeria, primarily because of the abundance of solar energy in the country. In rural areas where there is no power grid and more water is needed than what hand or foot pumps can deliver, the choices for powering pumps are usually solar or a fuel driven engine, usually diesel. In terms of reliability, it is much easier (and cheaper) to keep a solar-powered system going than it is a diesel engine. This is evident in field where fossil fuel engines lie rusting and unused by the thousands and solar pumps sometimes run for years without anyone touching the systems (SELF 2008). Solar pumping has had clear advantages for a number of years but the differences are becoming more striking in a world of rapidly escalating fuel costs.

In Nigeria, more than 75% of the populations are rural dwellers. And less than 20% of Nigeria is connected to the National grid, and more than 70% of Nigeria’s population of about 140 million live in more than 80% of land mass of Nigeria which is not connected to the national grid (Akinboro, Adejumobi and Makinde undated). The energy production level of any community indicates her pace of development and hence her poverty level, it is possible to alleviate poverty of the large community of Nigerians by providing solar as an alternative energy.

Solar photo-voltaic is the conversion of solar radiation to electricity using solar cell. It is now on increase in Water pumping for drinking, domestic uses, irrigation, lightings and other purposes in the rural communities of the study area. Research into solar pumps has also made it possible to draw water to heads of 60-120 m, with relatively high discharges of up to 13,500 l/d and 44,700 l/d at depths of 120m and 40m respectively, (Mono pumps, 2004; Groundfus, 2012 in AKunai 2014).

The United Nation Commission on Sustainable development has called for much wider access to efficient and clean energy as a prerequisite for reducing poverty to about 50% by the year 2015 and to cut by half the proportion of people without clean and safe drinking (Bauchi State MDGs, 2012). Construction of solar powered boreholes is among the leading strategies adopted to address acute shortage of water especially in the rural areas of developing nations (Bauchi State MDGs, 2012).

**Location of the Study Area**

The area is approximately located within Latitudes 11°12’N and 12°31’N and Longitudes 9°37’E and 10°58’E. The area has nine Local Government Areas; the Local Governments are Katagum, Shira, Gamawa, Itas-Gadau, Giade, Zaki, Misau, Dambam and Jama’are Local Governments. The area has total land mass of about 12020 km<sup>2</sup>; and shares border with Yobe state to the north and north- east, Jigawa to the north-west part and Darazo Local Government of Bauchi State to the south (Encarta Premium 2009).

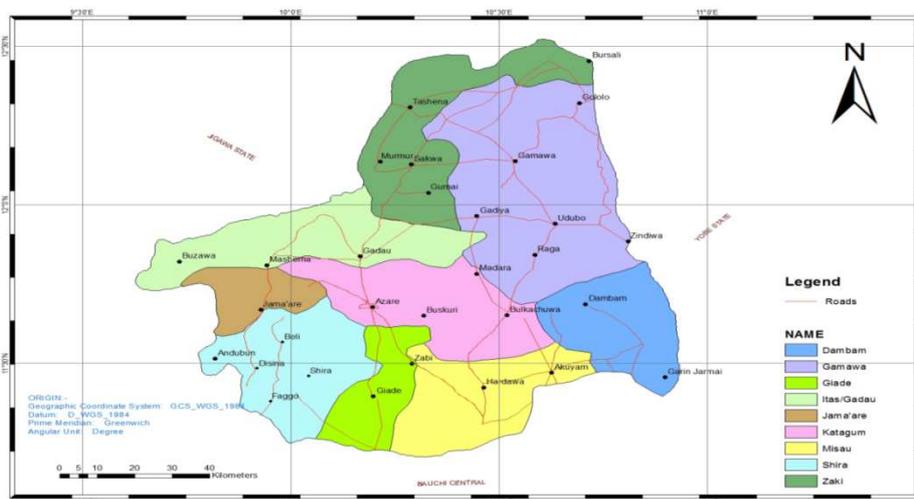


Figure 1: The study area

## RESEARCH METHODS

The list of the solar boreholes constructed from 2007-2014 was obtained from rural water supply units of Local Governments of the study area. The sampling frame was made up of the 240 communities with solar boreholes.

### DATA SAMPLING

A multi-stage sampling technique was adopted, classifying the nine LGAs as the first sampling unit. All the nine LGAs were selected at this stage. At the second stage, five communities were selected from each of the LGAs, irrespective of the number of boreholes to give a uniform geographic spread for the study area; at this stage balloting was used to select five communities installed with solar boreholes were drawn from each LGA to give every community an equal chance of being selected. Through this process, 45 communities representing about 20% of all communities with solar powered boreholes were selected for the study.

### DATA ACQUISITION

Both field survey and documentary data were acquired in this study. The field survey data were acquired through the questionnaire administration and field observation. While documentary data were acquired through the records from the rural water supply unit of the LGAs and some institutions involve in the development of the boreholes. Furthermore, GPS was used to take the coordinates of the Solar Powered Boreholes.

### Documented Data

The documented data was obtained from Local Government Areas, Bauchi State Office of the Millennium Development Goals (MDGs), Rural Water Supply and Sanitation Agency and State Ministry of Water Resources among others, pertaining to the previous boreholes projects, such as historical records, maintenance and expenditure incurred. The list of solar powered boreholes was obtained from the Rural Water Supply Units in the nine Local Government of the study area. From the records, 240 solar powered boreholes were installed by thirteen different governmental and nongovernmental organizations from 2007-2014 in the nine Local Governments. Other sources of secondary data are unpublished thesis, journals, internet sources, reports and conference papers.

### GPS Survey

Garmin Etrex Legend H model GPS was used to obtain the coordinates of each location of the solar boreholes. The coordinates were later entered in to ARCGIS 10.1 version to produce a map showing the distribution of the solar boreholes.

### Questionnaire Administration

The questionnaire targeted the solar borehole operators to obtain information relating to functionality, components affecting the functioning of the solar boreholes.

### DATA ANALYSIS

The data collected, was coded and analyzed with statistical package for social sciences (SPSS 16.0). The result was summarize and presented in descriptive form using various charts and map.

## RESULTS AND DISCUSSION

### Inventory of the Solar Powered Boreholes

An inventory of the solar powered boreholes from the study area indicates that there are two hundred and forty boreholes constructed in the nine Local Governments of the study area from 2007 to 2014. (Figure1). From the data collected the result indicates that Gamawa and Zaki Local Governments have the highest number of solar boreholes with 21% and 14% respectively. This can be attributed to the participation in Sanitation, hygiene and water in Nigeria (SHAWN project) and National livestock development projects by the L.G.As. Dambam and Itas-Gadau LGAs have 9% of the solar boreholes constructed each while Jama'are, Katagum, Misau and Shira LGAs have 10% of the solar boreholes constructed each and Giade LGA recorded the lowest with only 8% of the boreholes constructed. Generally there is equitable distribution of the solar boreholes among the LGAs. Most of them have about 10% of the total boreholes constructed. The exception of Gamawa LGA which has about 21% because it's benefitted from intervention of Sanitation, hygiene and water in Nigeria (SHAWN project) and National livestock development projects (NLDP) intervening in the development of grazing reserves. Moreover all these boreholes were provided with aim of cutting down by half proportion of people without safe drinking water by 2015 as contained in the agenda seventh of MDGs.

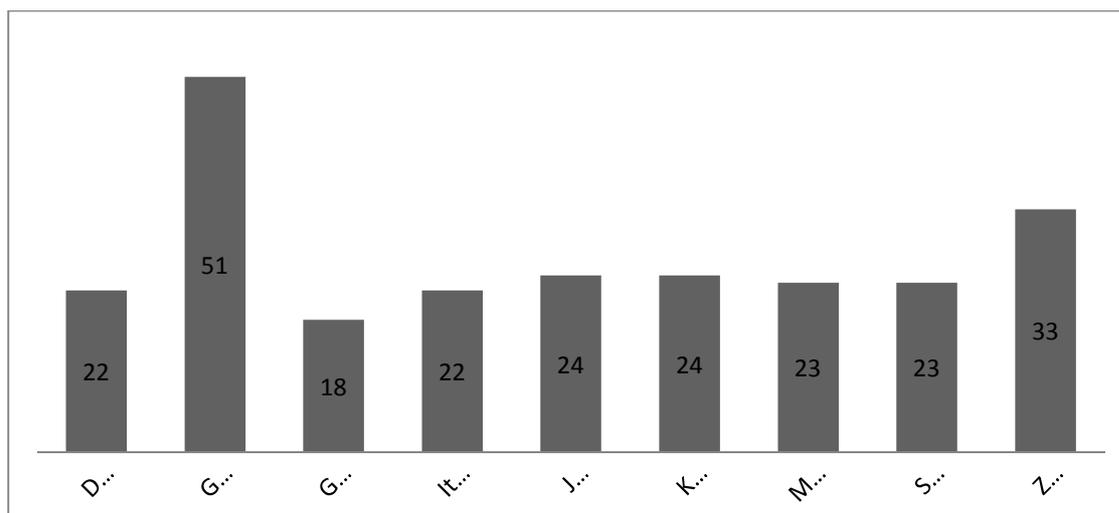


Figure 2: Number of the solar powered boreholes in the sampled LGAs

**Institutions Involved in Construction of Solar Powered Boreholes**

The two hundred and forty solar boreholes constructed in the LGAs were provided from 2007 to 2014, after the United Nations declarations of 2000, popularly known as Millennium Development Goals (MDGs). The boreholes were constructed by thirteen (13) different institutions (Figure 2). The rationale behind the provision of these solar powered boreholes was to cut down by half the proportion of people living without safe drinking water by using more efficient and cleaner energy sources such as solar energy as contained in the Agenda Seven (7a and b) of the Millennium Developments Goals (MDGs).

From the records MDGs/CGS drilled 43% of the boreholes, Hadejia/Jama’are River Basin Development Authority (HJRBDA) 17%, Federal Ministry of Water Resources (FMWR) drilled about 12%. The State Ministry of Water Resources (SMWR) and Rural Water Supply and Sanitation Agency (RUWASSA) constructed 5% and 7% respectively while National Livestock Development Project (NLDP), National Primary Health Care Development Agency (NPHCDA), Federal Ministry of Housing and Urban Development (FMUD), Great Green Wall Project (GGW), Federal Rural Development Board (FRDB), and T-Ship were involved in the development of boreholes as shown below.

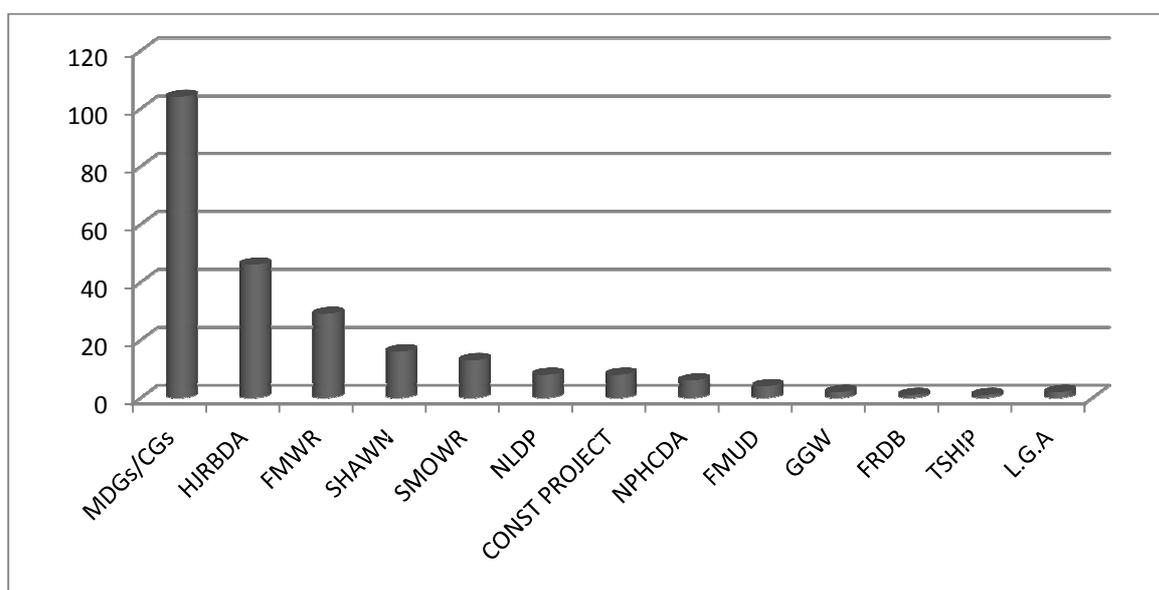


Figure 3: Institutions involved in the construction solar powered boreholes

### Spatial Distribution of Solar Powered Boreholes

Generally the solar boreholes are not concentrated in few settlements but widely distributed in all parts of the LGAs (Figure 4). Nonetheless, there were areas where a political issue influences the site selection of the projects resulting to the concentration of

solar boreholes in particular settlements. For example, Tarmasuwa village with a population of about 4500 people have three solar and hand pump boreholes. Even though achievement has been made in the study area in provision of improved water sources, more need to be done to have a wider coverage especially within the rural areas.

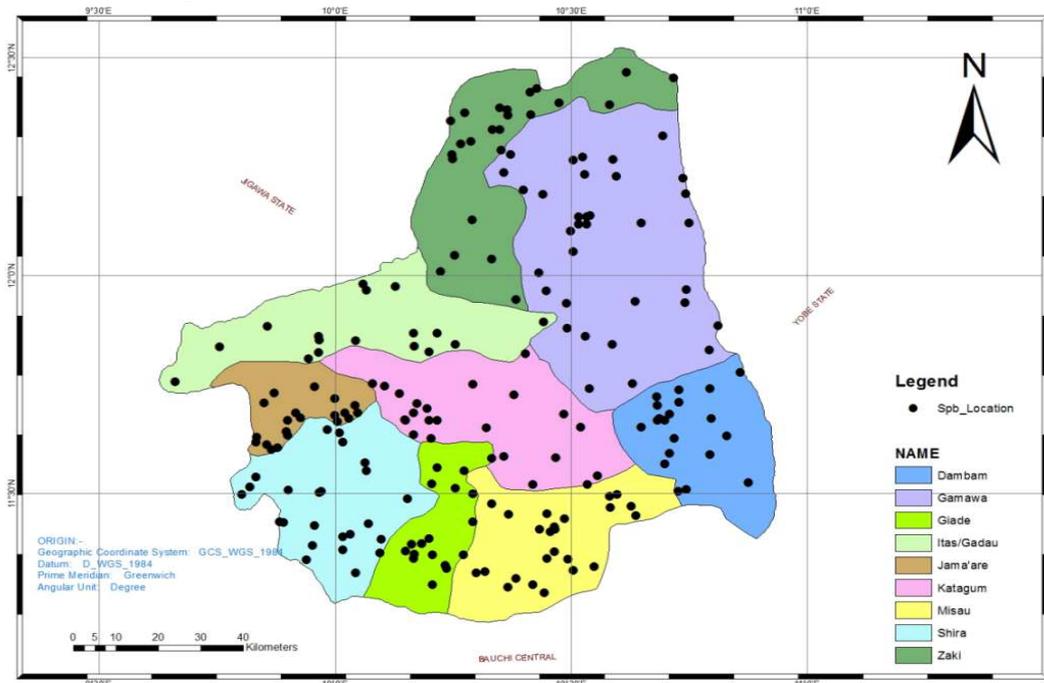


Figure 4: Spatial Distribution of Solar Boreholes in Northern Bauchi State

### Functionality of the Solar Powered Boreholes

Overall, the number functional boreholes (52%) nearly equal those of non functional boreholes (48%) refer to the appendix one for details. The non functionality was due to the following reasons and problems:-

- i. Failure of components such as submersible pump switch, cable, panel and pipe.
- ii. The theft and vandalization of the submersible pump was a major cause of borehole failure. Interview with LGA officials indicated that theft of submersible pump was common and responsible for non functionality of most of the boreholes.
- iii. Lack technical knowhow on the part of operators on the repairs and maintenance of photovoltaic systems.
- iv. Lack of water development committees to handle the general

repairs and maintenance of boreholes at community levels and failure LGAs to ask communities to establish such committees and hand over the projects to such committees.

- v. Improper completion and handing over of project to the executing agencies particularly after general election. According to community leaders of Zubo, Gadau and Kofar fada Itas pointed out that they witness no single drop of water from their boreholes since completion.

NAMREP (2006) reported that theft of submersible and other modules is not a problem exclusive to Nigeria for example in Namibia and Mexico the most common cause of the solar borehole failure was theft submersible pump and other modules.

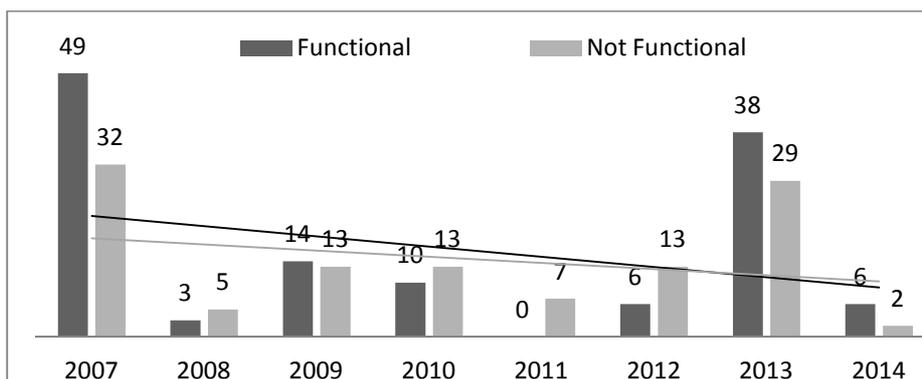


Figure 5: Year of construction and functionality of solar powered boreholes

**CONCLUSION**

Access to safe and clean water is a problem in rural communities of the study area, in line with United Nation declaration of 2000 that is MDGs 7a and b, which seek to cut down by half the proportion of people without safe drinking water through the use of clean and efficient energy sources, from 2007 to 2014 about two hundred and forty (240) solar powered boreholes were provided in nine Local Governments of the study area by thirteen (13) different sponsors. The distribution of boreholes revealed that all Local Government Areas have about 10% of the installed solar powered boreholes except of Giade Local Government Area with about 8%. Failure of components due to theft and vandalization were identified as the bottle neck facing the utilization of the boreholes. The study finally concluded that provision of solar powered boreholes in the rural communities will significantly help in addressing current issues of water supply.

**REFERENCES**

Akinboro F. G, Adejumbi L. A, Makinde, V. (Undated) SOLAR ENERGY INSTALLATION IN NIGERIA: OBSERVATIONS, PROSPECT, PROBLEMS AND SOLUTION. Transnational Journal of Science and Technology: May edition vol. 2, No.4

Akunai, A.A. (2014). Performance evaluation of solar powered boreholes and use of capped boreholes for irrigation in the Upper East region of Ghana: Unpublished M.Sc, thesis submitted to the Department of Agricultural Engineering, Kwame Nkrumah University of Science and Technology

Manzuma, B.M. Abdulsalam, D. Stanley, A.M. (2015). Performance of Motorized

**RECOMMENDATIONS**

- The recommendations of this study are:-
- i. Government should provide solar boreholes, in order to improved safe and clean water supply thereby reducing the outbreak of water borne diseases.
  - ii. Governments and development partners need to improve the monitoring and evaluation various solar powered boreholes projects executed.
  - iii. Local communities should be committed in safe guarding these installations from theft and vandalization.
  - iv. Operators should be trained on various repairs and maintenance strategies in order to improve performance of the boreholes and minimize theft as well.

Boreholes System for Residential Portable Water Supplies in Zaria, Nigeria. Microsoft Encarta Premium (2008)

Millennium Development Goals (CGS 2007-2011). Bauchi State: The Journey So far Mono Pumps Limited June 2011 Literature reference: ART29-11. Registered in England No 300721

NAMREP FINAL REPORT (2006): Feasibility Assessment for the Replacement of Diesel Water Pumps with Solar Water Pumps (MINISTRY OF MINES AND ENERGY NAMIBIA)

Solar electric light fund, (SELF 2008). Cost and Reliability of Comparison between Diesel and Solar Powered Pumps