©Adamawa State University Journal of Scientific Research 04(2): August, 2016
ISSN: 2251-0702

Application of Remote Sensing and Geographic Information System Techniques for Investigation of Groundwater Sources for Possible Drilling of Borehole Hong Local Government Area of Adamawa State, Nigeria

Timothy Sabo[1] Alfred Dika Mshelia[2]

[1]Unity Bank of Nigeria Plc, Mubi, Nigeria.
[2]Department of Geography Adamawa State University Mubi, Nigeria.
Contact: *timothysabo@yahoo.com*

ABSTRACT

The persistent nature of water problem for drinking and other domestic uses in Hong Local government has caused a lot of water borne diseases such as cholera, typhoid, dysentery, and malaria parasites which has consequently caused a lot of premature deaths in the area. Most of the inhabitants depend on water vendors for their drinking water irrespective of the sources and the container which the vendors used. Hong is geological underlain with basement complex rock which does not support deposition of groundwater, therefore requires a more concise and technique for adequate water supply in the area. It is upon this background that this research was carried out to investigate groundwater sources using remote sensing and Geographic information system technique so has to enhance adequate water supply in the area. Spatial location of the existing boreholes in the area was determined using hand held G PS. A comprehensive database was also created with all the attributes of the existing boreholes. Information ranging from topographic, geologic, population land sat images of the Hong local Government was equally obtained. Different maps were extracted such as geologic map, DEM map, flow accumulation and NDVI analysis map. These maps were overlay to determine areas of possible groundwater for boreholes drilling. However, 36 out of 57 boreholes in the area were functional while 19 boreholes were not functional.23 new boreholes were proposed in the areas where groundwater is most available and accessible by the inhabitants. The research therefore shows Remote Sensing and Geographic Information System is a necessary tool for groundwater sources detection for adequate water supply.

KEYWORDS: Remote Sensing, GIS, Groundwater, Borehole Drilling

Introduction

Water is a precious natural resource, vital for life, development and the environment. It can be a matter of life and death, depending on how it occurs and how it is managed. When it is too much or too little, it can bring destruction, misery, or death. Irrespective of how it occurs, if properly managed, it can be an instrument for economic survival and growth. It can be an instrument for poverty alleviation lifting people out of the degradation of having to live without access to safe water and sanitation, while at the same time bringing prosperity to all (Water Front, 2003). However, when it is inadequate in either quantity or quality, it can be a limiting factor in poverty alleviation and economic recovery, resulting in poor health and low productivity, food insecurity and constrained economic development (WHO, 2004).

According to UNICEF/WHO reports (2004), more than 2.6 Billion people (over forty per cent of the world population) do not have access to basic water and sanitation. Around 2.2 Million children die of basic water related diseases every year and majority of which are in developing countries. More so, large fraction of the world population (about 1.1 billion people) do not have access to clean sources of water for drinking and essential purpose which present a significant health risk.

Groundwater is generally safer than surface water for drinking simply because of natural filtration and purification process which take place in the ground. It refers to any sub surface water that occurs beneath water table in the soil and other geologic forms. Scientists have estimated that groundwater constitutes 95% of all fresh water for drinking (Rosen and Vincent, 2001). It is a significant source of water for drinking in any united municipal water system.

Though underground and surface water are interdependent parts of hydraulic cycle and as a result of their interconnectedness, they can easily share their contaminants. Surface water is easily and mostly polluted because it is directly exposed to all kind of human activity that post serious contamination to water such as agricultural, household, commercial and industrial wastes. Except where contaminants are directly injected into aquifer, underground water does not easily get polluted, thereby making it safer for drinking (Rosen and Vincent 2001).

Remote sensing data often comprise a majority of existing and spited information available for extensive area. Establishing relationship between remote sensing data and hydrologic phenomena can maximize the efficiency of a water development project.

On the other hand, Geographical Information System (GIS) is an important and appropriate tool for unifying elements to develop an integrated strategy to characterize ground water resource for identification of borehole locations in an area. It provides the facility to analyze spatial data objectively using logical condition and is widely used for spatial modeling of hydro geological prospect of large area with more reliability (Shahid and Nath, 2002)

In Nigeria, the government, non-governmental organizations, and international bodies have over the years expended a lot funds to provide portable water to the populace but there is still acute shortage of the commodity, more so in the study area, Hong Local government. The inhabitants often draw polluted water from hand dug wells, or streams which are several kilometres away from their homes and collect rain water for drinking during the raining season.

Water borne diseases, such as cholera, diarrhoea and typhoid, among others constitute a major health concern to the people in developing countries and the study area (USAID, 1990, Lawal, 2006). It has not only cause sickness and death, but also resulting to low commodity production, hence affecting the economy of the people and Adamawa State at large.

A lot of man hour is lost particularly by women and children scouting for water for daily use. This precious time could be better utilised in productive ventures or learning in schools. The situation is so acute that most of the inhabitants depend on water vendors and sachet water outfits for domestic supplies regardless of the sources and the containers used in fetching and packaging of the water.

It is at this background that this study is embarked upon so as to identify potential location for underground water are sources for possible borehole drilling in the area using Remote Sensing and GIS.

Hong Local Government Area is the study area, which is geographically located between latitudes $9^0$50'N and $10^0$35'N of the equator and between Longitude$12^0$40'E and $13^0$15'E of Greenwich Meridian. It is situated at the foot of Adamawa hill sand spans and covers an estimated area of 24,850km2 (Adebayo and Tukur, 1999)

Materials and Methods

The sources of data for this study were based on the following parameters; topography, drainage pattern and geology of the study area. Land-sat image was also acquired and analysed for this work. Consequently, data types were classified into primary Source where the researcher collected field data on boreholes data through reconnaissance survey and Global Positioning System (GPS), while secondary sources include maps, images and review of related materials from published and unpublished sources.

Different computer softwares were used for processing and integrating both spatial and attributes data. Packages such as Arcview2.A was used for converting analogue maps into digital maps, ArcGIS 9.3 was used for detail analysis and creation of database for both attribute and spatial data.

Data Collection Procedures

Reconnaissance Survey was conducted to make the researcher more familiar with the study area. During this time the researcher noted areas of problems and potentials for the location of boreholes. Also, base map of the study area was obtained in line with existing satellite images of the area through internet, which helped to ascertain the physical problems and the need to improve portable water supply in the area

Land-sat image, Geologic map, DEM map, and Drainage map were obtained from the Global Land Cover Facility (GLCF), analyzed to investigate groundwater sources for possible borehole drilling. These were done by classifying the various images/ digital elevation of the study area based on suitability classes, and later being overlaid to generate potential sites for ground water.

Results and Discussions

The variables used in assessing the presence of good ground water in Hong L.G.A. of Adamawa state so as to meet the water demand of people in the study area are: DEM Classification Analysis, Flow Accumulation Analysis, Geological analysis and NDVI Analysis.

DEM Classification Analysis.

The DEM map of the study area was analyzed to generate areas of different altitudes in order to determine areas of possible ground water. This is in the sense that water tends to flow from areas of high altitudes and accumulate in areas of low altitudes. However, from figure 1, extraction from the field value indicated that the area was classified into high medium and low altitudes, where the low terrain (495-

540 metres) are areas considered to possibly yields good source of groundwater for boreholes. This area covers Kudja, Dabna, Sabongari, Hadaku, Zugumi, Njama, Mbilinyi, Kesure, Dafura, and Tuboha.

The analysis also shows that there is a relationship between relief and drainage pattern of the area. The direction of the flow of rivers in the area is radial which is drastically influenced by the relief.

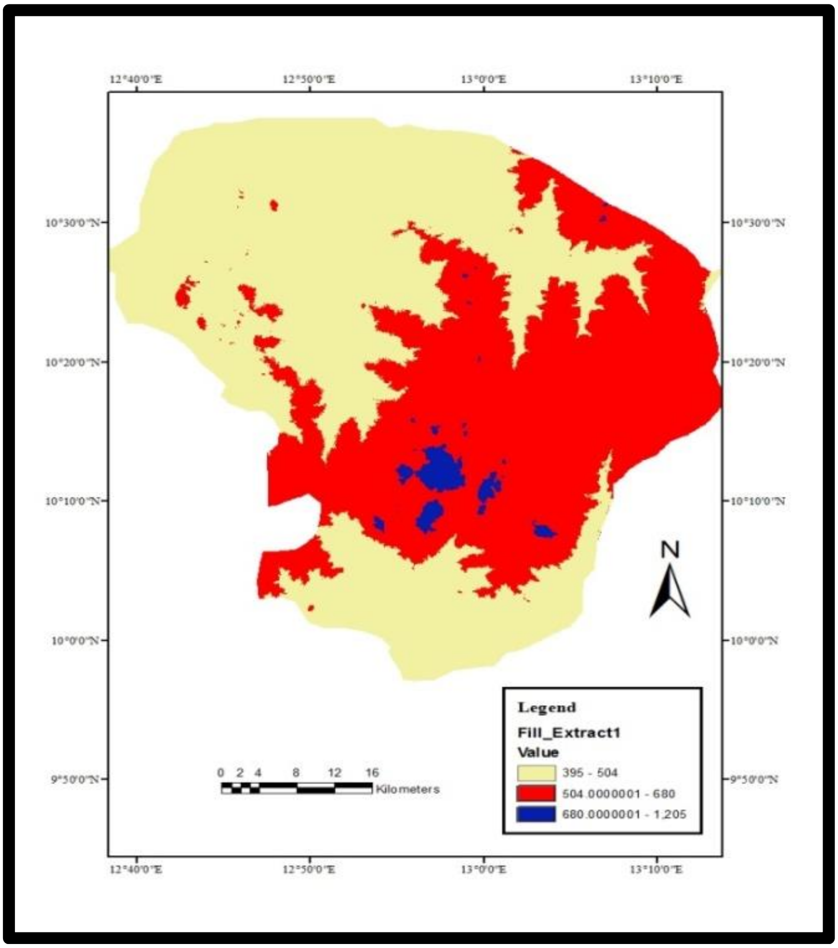

Figure 1: DEM Classification Map

Geologic Analysis

Generally, basement complex rocks form poor source of groundwater. Groundwater occurs in this type of rock only in the weathered mantle or in the joints and fracture system of the un-weathered rocks (Odusanya and Amadi 1999; Olorunfemi 1998). The presence of water therefore depends on whether the mantle is sufficiently thick and extensive to provide a reservoir or weathered joints and fracture present in the fresh rock.

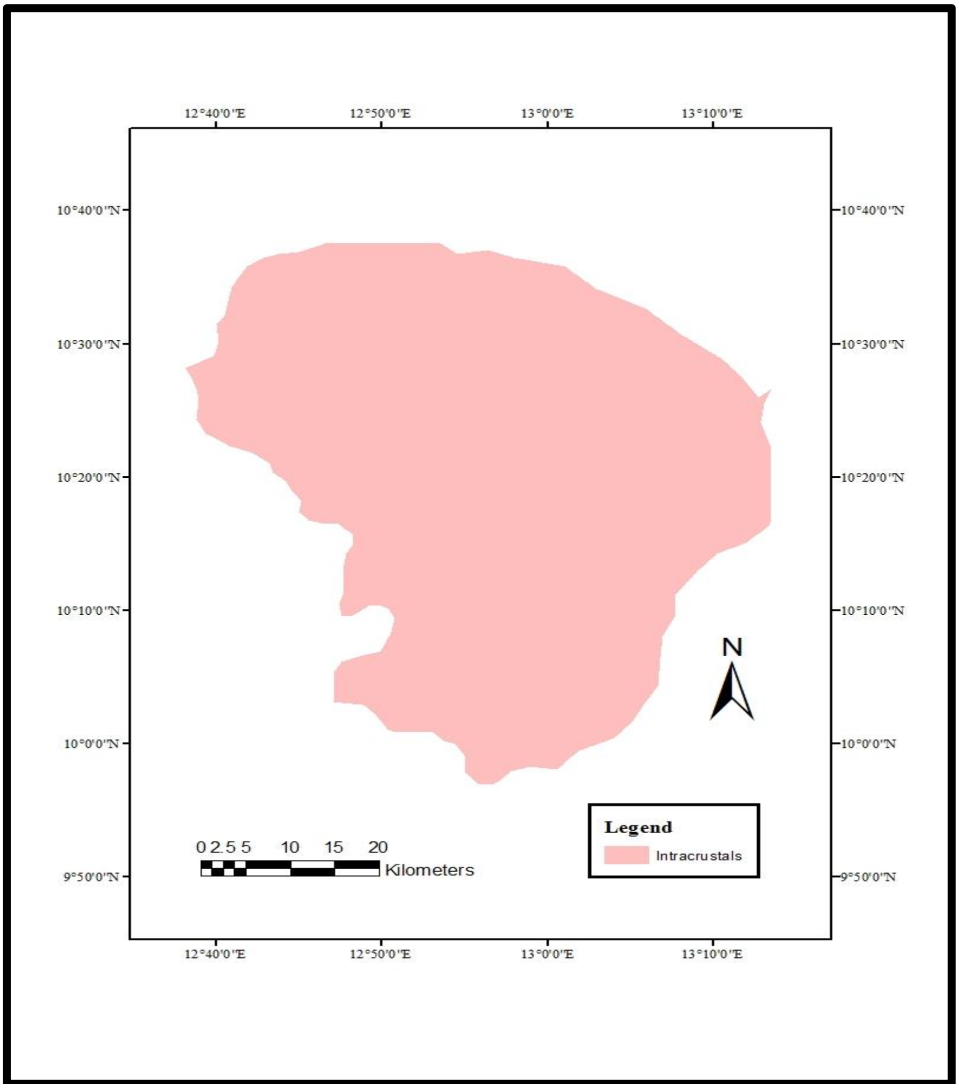

Figure 2: Geologic map of Hong Local Government

However, the analysis of the geology of Hong Local Government Area revealed that, the area is completely underlain by basement complex rocks called intra-crustals which are very unpredictable in terms of water yields (figure 2). Therefore, good sources of water could be located only in-between the cracks and fault lines.

Flow Accumulation

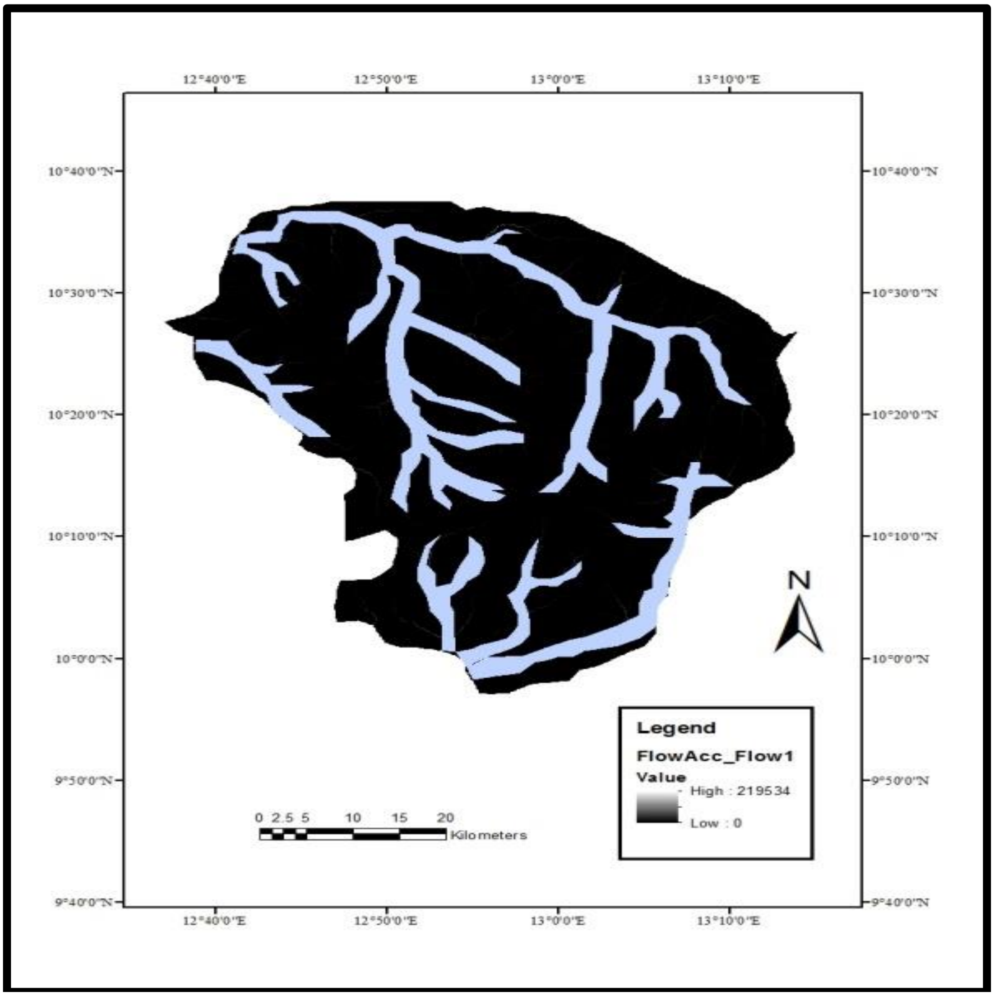

Figure3: Flow Accumulation Map with buffering

The DEM map of the study area was also used to carry out flow accumulation analysis. The map was analyzed to determine areas of fault lines and lineaments. Figure 3 and 4 shows areas with positive values as areas of lineaments and all areas with zero as areas without any lineament. However, 30 metres radius was used uniformly to buffer all areas of faults and lineaments to clearly indicate areas with potential groundwater.

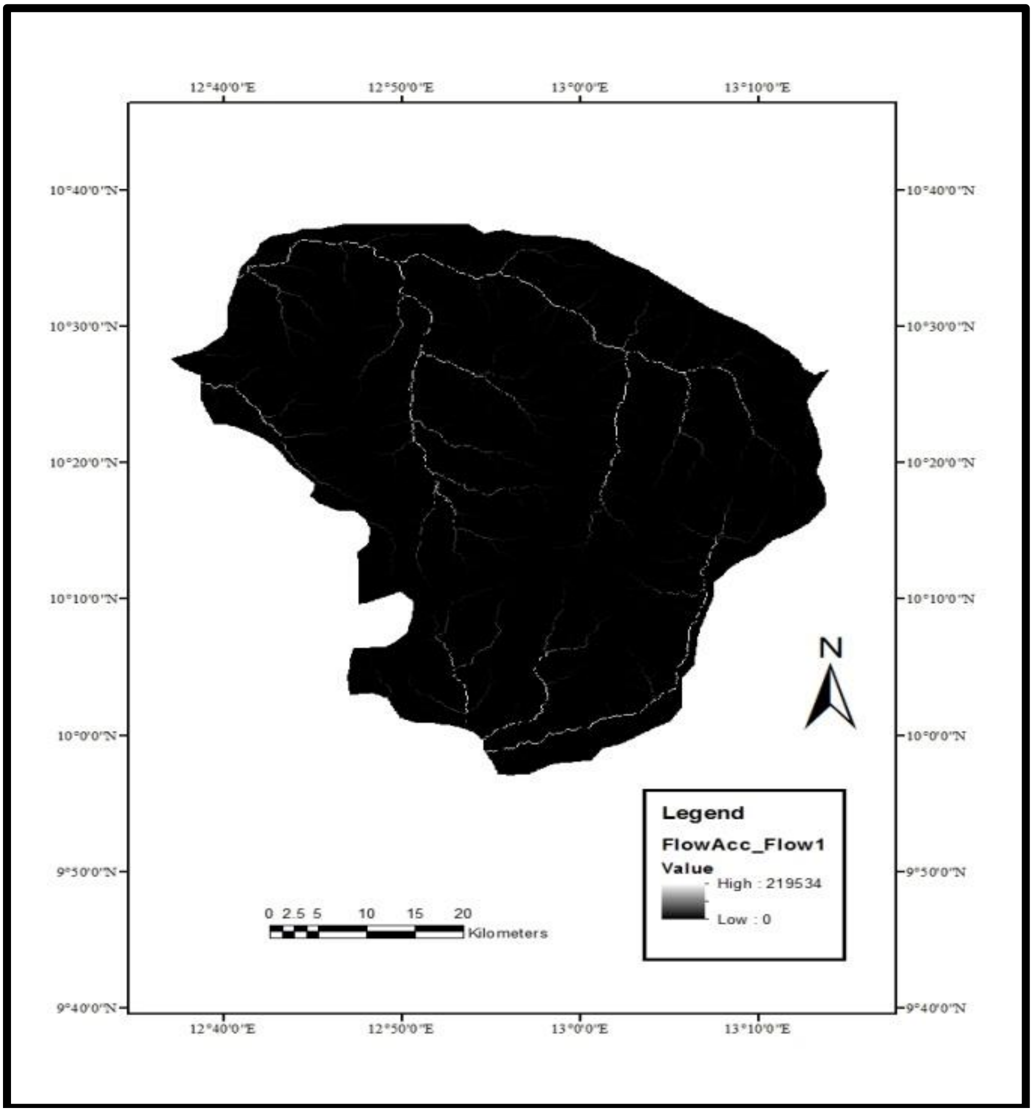

Figure 4: Flow Accumulation map.

Normalized Difference Vegetation Index (NDVI)

Normalized Difference Vegetation Index values are a measure for the presence and condition of green vegetation. Vegetated areas generally yield high values because of their relatively high near-infrared reflectance (0.2-0.3 are shrubs and grassland and ≥ 0.3 are temperate and grass forest) and low visible reflectance, in contrast, water, clouds, and snow have larger visible reflectance than near-infrared reflectance (Jensen 2007). Thus, these features yield negative index values. Rock and bare soil areas have similar reflectance in the two bands and result in vegetation indices near zero as shown in figure 5.

The Normalized Difference Vegetation Index (NDVI) was carried out to determine areas of vegetation cover. NDVI are a measure of the presence and condition green vegetation. Vegetated areas are areas which have high NDVI values. High vegetated areas are usually characterized by the presence of groundwater with high a yield.

Overlay

Idrisi software, which is capable of performing complex GIS analysis, was used for the overlay. Individual maps that is; flow accumulation map, geologic map, DEM classification map, NDVI map were overlay to produce a single map.

The criteria for the overlay include; low altitudes areas, areas with high NDVI values (vegetal cover), faults lines and lineaments.

A bullion type of overlay was chosen, where all the maps were overlay in a single sheet and the result obtained showed areas with most available, available, moderately available and less available (figure 6). The result served as the basis for planning and decision making.

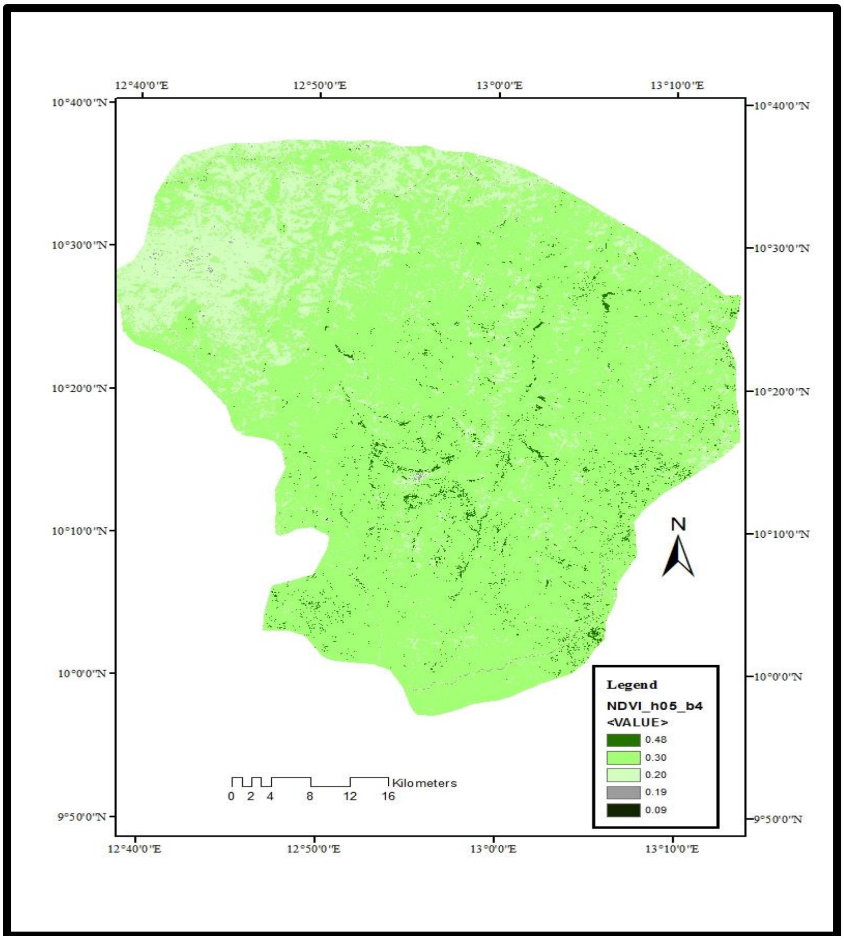

Figure 5: Normalized Difference Vegetation Index (NDVI) Map

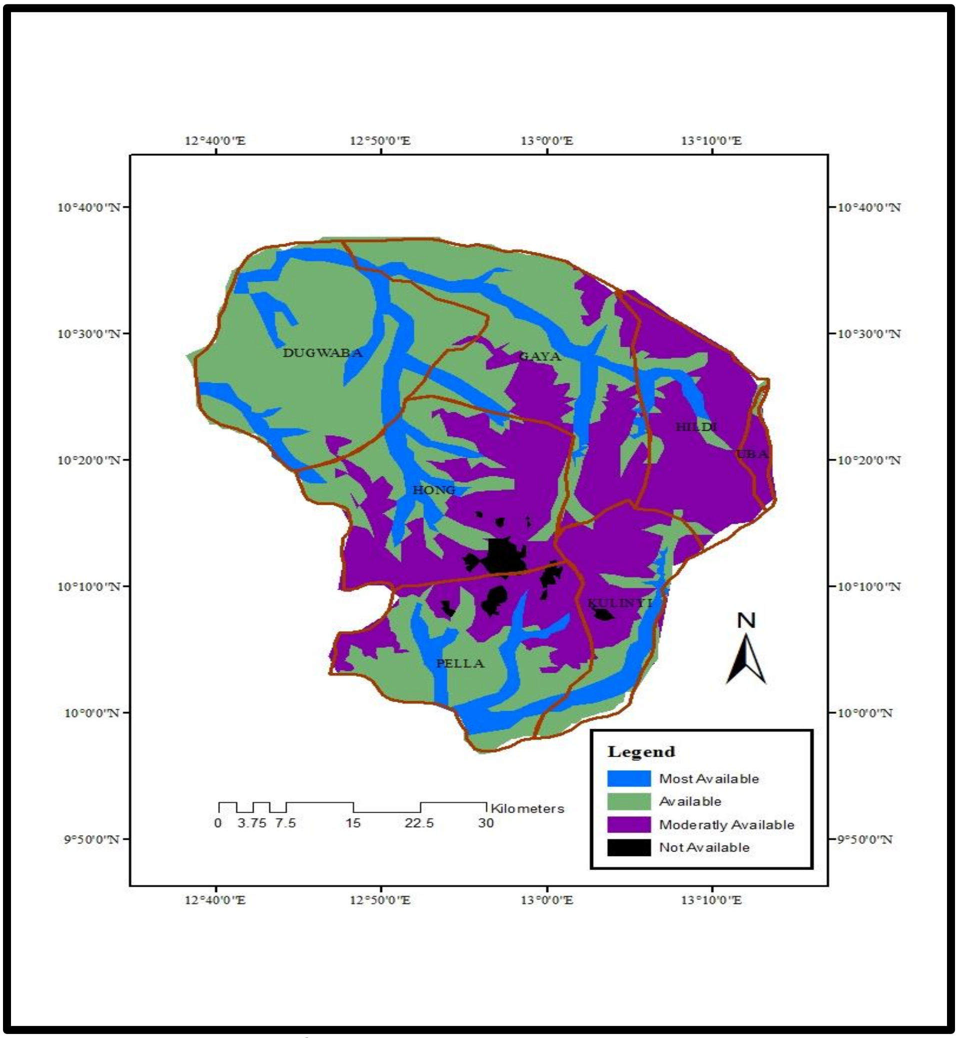

Figure 6: Overlay Map of the Study Area

Conclusion

Acute shortage of water, partly as a result of inappropriate techniques for determining suitable areas for bore hole drilling has led to negative impacts on the socio economic livelihoods of residents of Hong and its environs. Remote Sensing and GIS techniques used for the purpose of determining suitable sites of groundwater for possible borehole drilling demonstrates in this study veritable and powerful tool for investigating underground water sources through its ability to handle large volume of both attribute and spatial data, which was integrated to identify and propose potential sites of groundwater for possible borehole drilling in the area. The identified potential underground water sites when properly explored will help to bolster potable and safe water supply for the area, and consequently enhance the socio economic well-being of residents.

References

Adebayo, A. A and Tukur A.L. (1999).Adamawa *State in Maps.* Department of Geography, Federal University of Technology Yola, Adamawa State, Nigeria, Yola. Paraclete, Nigeria.

Lawal. U. (2006). Assesment of the Impact of United Nations Children Education Fund (UNICEF) Water Sanitation Programs in Some Selected Communities of Adamawa State. An Un Published MSc Thesis, Federal University of Technology Yola.

Rosen, S. and Vincent J.R. (2001). Household Water Resources and Rural Productivity in Sub-Sahara Africa: A review of the evidence of African Economic Policy 69 Washington D.C, USAID.

USAID (1990). Domestic Water and Sanitation. USAUD Policy Papers. Washington D.C.

Water Front, (2003). Portable Water Supply and Economic Development in Nigeria. Water Front Magazine. A Publication of Nigerian Water and Sanitation Association (NWASSA). Issue4. Lagos, Nigeria.

WHO, (2003) Looking ahead. Five decades of challenge in Environmental Sanitation and Health, World health Organisation, Geneva.

WHO/UNICEF (2004). Global Water Supply Aid Sanitation Assessment Report. United Nations ChildrenFunds and World Health Organization, New York.