The Application of Geographic Information Systems (GIS) In the Sitting Water Reservoirs/Tanks to Enhance Water Distribution and Networking in Lokoja, Kogi State, Nigeria.

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ABSTRACT

The challenge of portable water and water distribution in Africa and the world at large in which Lokoja, Kogi State in Nigeria is no exception, is on the increase. The situation in Lokoja where both the River Benue and Niger met is even more pathetic as both the young and old have to source their drinking water from the mud in what used to be the famous confluence - the meeting point of Nigeria's two renowned rivers. This research project investigated means of taking the advantage of the topography of the area, to enhance portable water distribution and networking systems through the identification of possible areas for the sitting of water reservoirs/tanks on high elevated plane for distribution of water due to gravity by employing Geographic Information Systems (GIS) techniques. Different layers were used: Digital Terrain Model (DTM) were developed, land use and land cover map, contour map and a water pipeline layout map were prepared by various primary and secondary data available. These layers were integrated to produce a map showing possible locations for water reservoirs/tanks for water distribution network for adequate supply of water without absolute dependent on the public power supply. This research recommends that, water distribution network should be designed such that water pressure is adequate at all locations, water are conveniently available at different locations for steady supply, and that the water sectors should harness the topography of an area to provide sufficient water through her liable distribution network.

Keywords: Water Distribution, Water Reservoir, Pipeline Networking Systems, ArcGIS 9.3, EPANET 2.0.

INTRODUCTION

Nigeria has adequate surface and groundwater resources to meet its current water demands. However, in spite of the tremendous efforts put by the various arms of Government to improve access to portable water supply to all Nigerians, statistics shows that only 58% of the inhabitants of the urban and semi-urban areas and 39% of rural areas have access to portable water supply. Water shortage is acute in some major urban centers and in numerous rural communities due to a variety of factors including variations in climatic conditions, drought, distribution system losses, and breakdown of

works and facilities. Other challenges facing the sector include funding constraints for improving and rehabilitating broken down schemes, competition between water users (Onugba and Sara, 2003).

In this paper, an attempt was made to locate the suitable sites for an overhead water tanks/reservoirs and the different components for a proper water distribution network. Improved efficiency of urban water supply and distribution system is the only possible way which cuts across innovative sciences and technologies. One such technology is the Geospatial Information System (GIS) that generates useful information necessary to perform spatial and hydraulic analyses, thus playing an important role in urban water distribution networks (Cunha M. C. and Sousa J., 1999). The purpose of the reservoir site selection process is to provide a methodical and understandable process by which potential sites can be identified.

STUDY AREA

Lokoja, the capital of Kogi State (the confluence state) is geographically located within the coordinate of $7^0 49' 02'' N$ and $6^0 44' 14'' E$. With a population above 200,000 the occupation includes mostly fishermen, civil servants and Farmers. The crops produced include cassava, yam, rice, maize, guinea corn, beans, soya beans, melon, asha and millet. The State is blessed with precious mineral resources like columbite, aquamarine, limestone, iron, tin, coal.

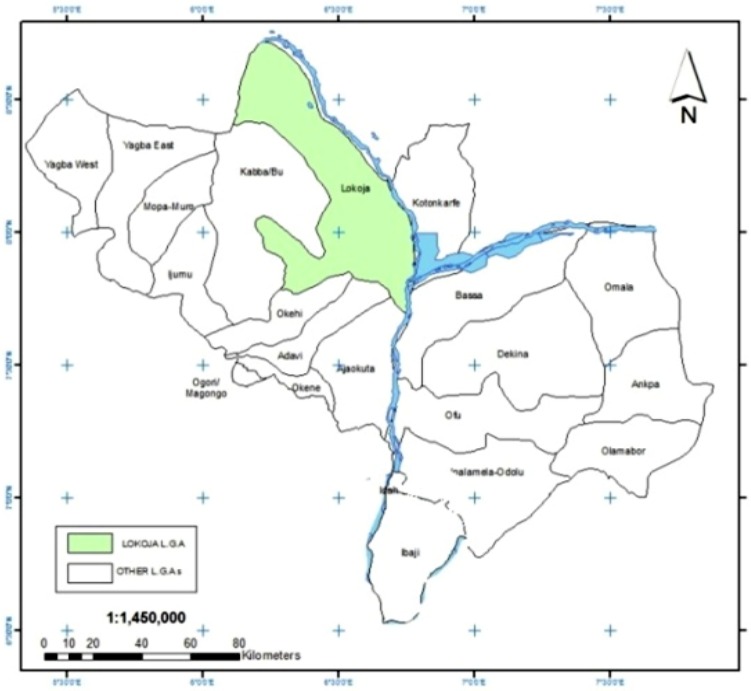

Figure 1.2 Map of Kogi State Showing Lokoja The Study Area (Source: Lab. work, 2012)

METHODOLOGY

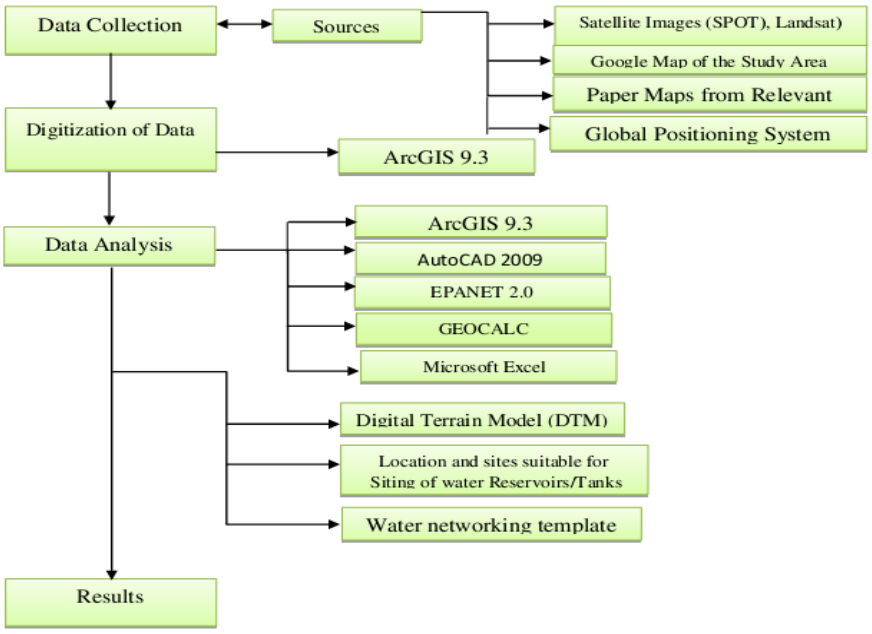

Figure 3.1 Methodology Flow Chart Diagram

DATA PROCESSING AND RESULTS

To Produce a Digital Terrain Model (DTM) of the Study Area

Data collected (SRTM) was geo-referenced using ArcGIS 9.3 environment by selecting the coordinate system, then from the ArcToolbox window drop down select Spatial Analyst Tools – surface - contour and select the necessary input and output raster. Then the software is used to generate the Digital Terrain Model of the study area with contour interval of 10meters.

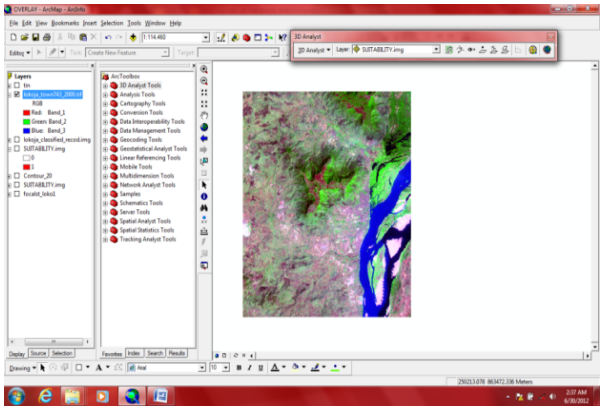

Figure 4.2: Showing the Image Subset of Study Area

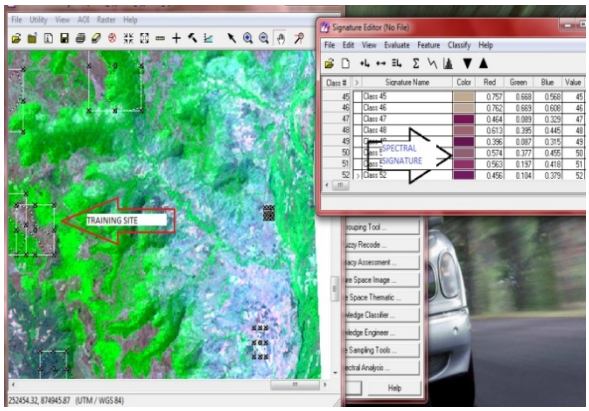

Figure 4.3: Showing Landcover Classification

Source: Laboratory Work, 2012

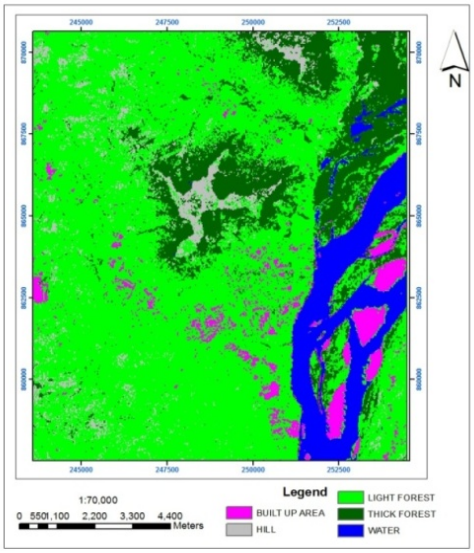

Figure 4.2: Showing Landuse/Landcover

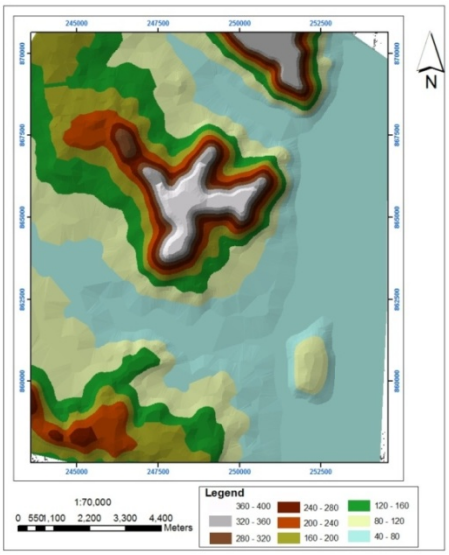

Figure 4.3: Showing Digital Terrain Model of Lokoja

Source: Laboratory work, 2012

To Prepare a Water Pipeline Layout of Lokoja

Data collected from SPOT 5 was digitized and geo-referenced using ArcGIS 9.3, then shape-files of the area of interest was created. It was imported into AutoCAD environment and after it was digitized, it was then exported as window media format (.wmf) (metafile format) into the EPANET 2.0 environment Water modeling software). Then the various water parameters were then added i.e pipes, nodes (junctions), valves, tanks/reservoirs. Also, from ArcGIS 9.3, shapefile can also be exported in bit map format (Bmp) and in (emf) which are all compatible with EPANET 2.0. Thus, the production of a pipeline layout of the study area is done by inserting the various water elements ranging from pipes, nodes, reservoir, tanks, valves, etc and then water simulation can be ran to confirm a close network.

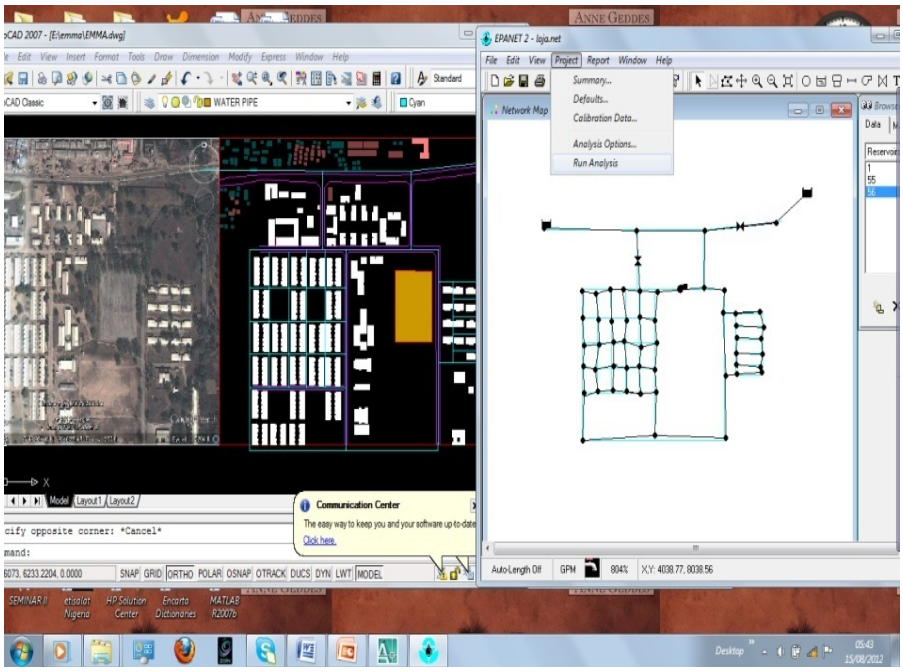

Figure 4.8: Showing How Water Pipeline of an Area was Produced in EPANET 2.0
Source: Laboratory Work, 2012

To Identify Possible Areas to Site Water Reservoir/Tank(s) To Enable Potable Water Distribution by Gravity

GPS Field data collected from various locations/areas was converted to degrees, minutes and seconds. Computed in Excel then was imported to Arc Map (ArcGIS 9.3) to show the potential areas that reservoirs/tanks could be sited.

Table 4.1 Potential Areas That Reservoirs/Tanks Could Be Sited

S/N	Location description	Northern (N)	Eastern (E)	Latitude	Longitude	Approx. Height (m)
1	Behind redeem church opp. Phase 2	0862939	0247276	7^0 48′ 2″	6^0 42′30″	55
2	Opp phase 2 junction	0862939	0247599	7^0 48′4″	6^0 42′40″	39
3	Peace community	0858774	0250269	7^0 45′47″	6^0 44′8″	26
4	Kogi poly	0866906	0250746	7^0 50′11″	6^0 44′22″	23
5	Kogi poly quarters	0867388	0250121	7^0 50′27″	6^0 44′2″	80
6	Kabawa area	0864753	0251754	7^0 49′1″	6^0 44′55″	43
7	Ganaja junction	0862312	0248936	7^0 47′42″	6^0 43′24″	55

Source: GPS Field Survey, 2011

Table 4.2: Other Areas of Interest

S/N	Name of Place	Northern (N)	Eastern (E)	Latitude	Longitude	Elevation above sea level
1	Greater Water Treatment Plant	0855381	0251494	7^0 43'56''	6^0 44'49''	44
2	Ganaja Ferry Point By River	0855752	0251855	7^0 44'9''	6^0 45'0''	38
3	Phase 2 (Meme River))	0861971	0246552	7^0 47'30''	6^0 42'6''	55
4	Old Market Riverside	0864751	0251921	7^0 49'1''	6^0 45'1''	41

Source: GPS Field Survey, 2011

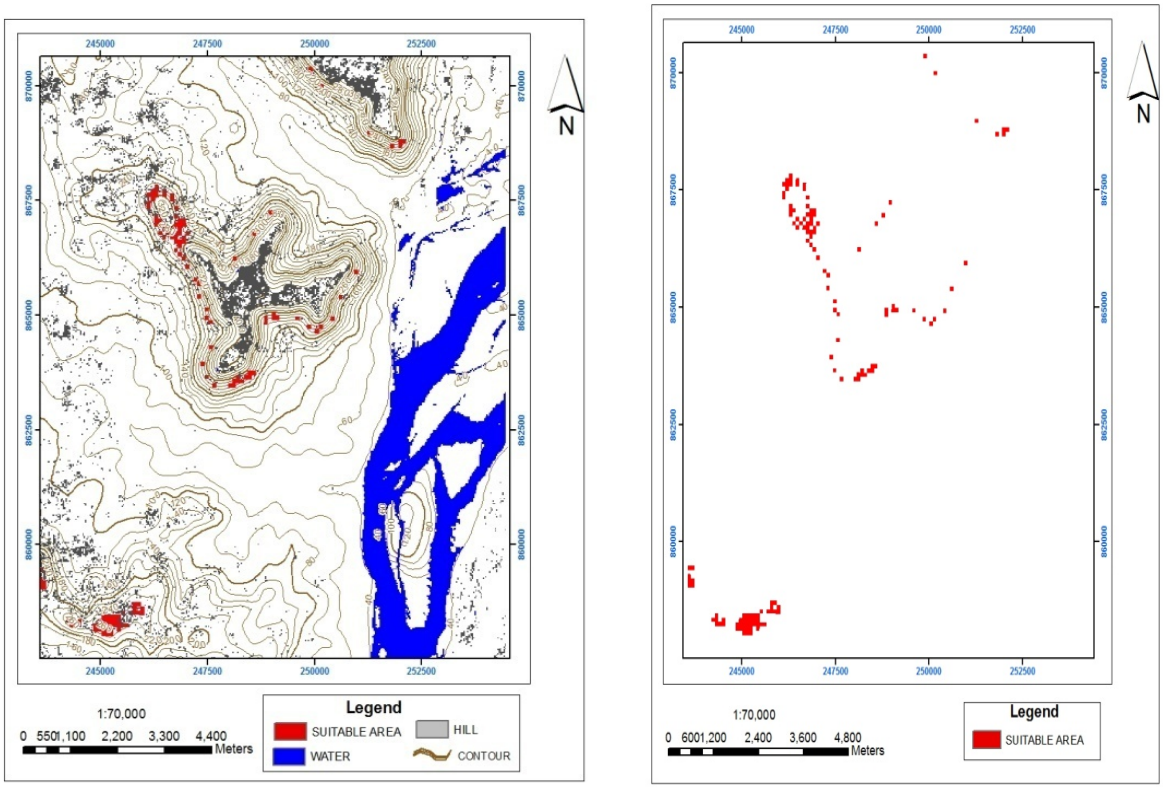

Figure 4.11: Topographical Map Showing Possible Areas for the Sitting of Reservoirs/Tanks

Source: Laboratory Work, 2012)

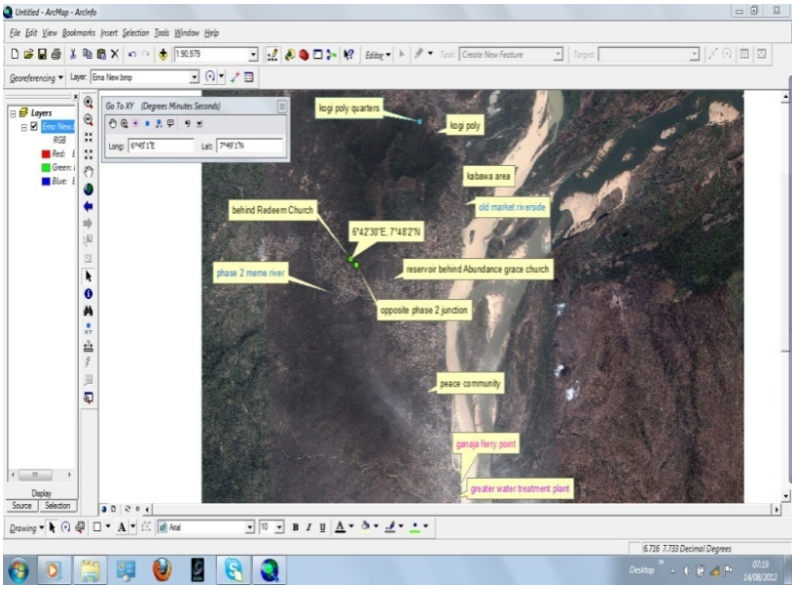

Figure 4.12 Map Showing Possible Areas for the Siting of Reservoirs/Tanks

CONCLUSION

Water is a basic human need and must be accessible to all for its social, economic, industrial and commercial uses. Clearly, a major need is to provide water at good pressure and high quality, using the topographic nature and water bodies of the study area for a better water distribution system. The researcher therefore concludes that the problems can be solved or minimized by following the recommendations earlier mentioned.

The above suggestions, if properly implemented, will go a long way to enhance water distribution and networking by gravity, even though cost should be attached to providing water service to all water users.

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