

Analysis of Ground Water Availability in Hand-Dug Wells of Minna and Bida Metropolis

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ABSTRACT

The study takes a look at the analysis of groundwater availability in hand-dug wells in Minna and Bida, Niger State. The study analyzed the bedrock factors between the Basement Complex (Minna) and Sedimentary (Bida), described the seasonal variation of the bedrock within a period and then prepared water table contour maps for Minna and Bida. Data for the study were collected through a general study of the area, measurement of the well depth through the use of ropes and measuring tapes, location and elevation of wells through the use of a Global Positioning System (GPS), and taking readings of the physical parameters through the use of a Total Dissolved Solid (TDS) meter. A total of forty sampling points were tested; twenty sampling points in Minna (both rainy and dry seasons) and twenty sampling points in Bida (both rainy and dry seasons). Results show that the average water depths in the wells of Minna are shallower (both in the rainy and dry seasons) than those of Bida. The variations in water depths are higher during the wet season at both Bida and Minna. Provision for an alternative, reliable sources of water should be made available to complement the wells in the Sedimentary basins especially during the dry season.

Keywords: Ground Water Availability, Physical Parameters, Basement Complex, Sedimentary Basin,

INTRODUCTION

Water is the most essential commodity for all living creatures. Organisms cannot survive without water. Water is one of the most essential constituents of the human environment. Man needs it, in the first place for his physiological existence. It is used for many purposes e.g. agricultural, domestic, industrial and hydro-powers generation purposes. Water is a source of energy and governs the evolution and functions of the universe on Earth. Water is one of the most important valuable natural resources and is essential for the maintenance of all forms of life. Water is important to life, without it life cannot go on (Yerima *et al* 2008). Human life as with animals and plant life on the planet is dependent on water (Domenico, 1972).

Water is a critical factor in any sustainable development project. Its constraints pose important risks for business and livelihood (Obaje, 2015). Inadequate access to clean drinking water is a major problem in many states in Nigeria. Niger State, like other states in Nigeria, is becoming heavily populated such that many of the inhabitants lack adequate pipe-borne water because of the rising population and

pressure on water infrastructure. There is more dependence on groundwater as alternative supplies. Therefore, the development and efficient management of groundwater resources is a particular concern. The alternative for many who can afford it is to install hand pumps or deep wells (drilled and hand dug) to draw clean water from the ground depending on the depth of the water table. The depth of potable water tables generally depends on the geology as well as on the regional and local topography. Groundwater have unique features, which render them suitable for public water supply (Offodile, 2002).

Obaje (2015) reported that in many places of the world where water scarcity exists, it is not because of a physical lack of water, but because of the complexity of the geological bedrock and the poor knowledge of these geological complexities. Geology is a significant determinant in both surface and groundwater availability and supply. In Niger State, the geology which is the bedrock on which water flow and in which water is stored is made up of

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crystalline basement rocks or sedimentary rocks in the geological sedimentary basin. Water availability in crystalline basement rocks is usually stored in weathered layers (weathered basement) and the fracture systems. Even though Isah (2012), Baraje (2012), and Suleiman (2014) conducted research on this issue in the study area, more has to be done for an update and to account for the fact that natural phenomena change with time. The aim of this research therefore, is to analyze the groundwater availability in hand-dug wells in the basement complex (Minna) and sedimentary basin (Bida) and prepare water table contour maps for Minna and Bida metropolises.

METHODOLOGY

Study Area

The study was conducted in the Minna and Bida areas of Niger State. Minna is the capital city of Niger State. Niger State is one of the 36 states of Nigeria, created out of the defunct North central geo-political zone located between longitude 3°30' and 7°20' East of the Greenwich Meridian and latitude 8°20' and 11°30' North of the equator. The Provisional result of the 2006 National Population Census of Niger State is 3,950,249. There are three major ethnic groups in the study area namely Nupe, Gbagyi and Hausa.

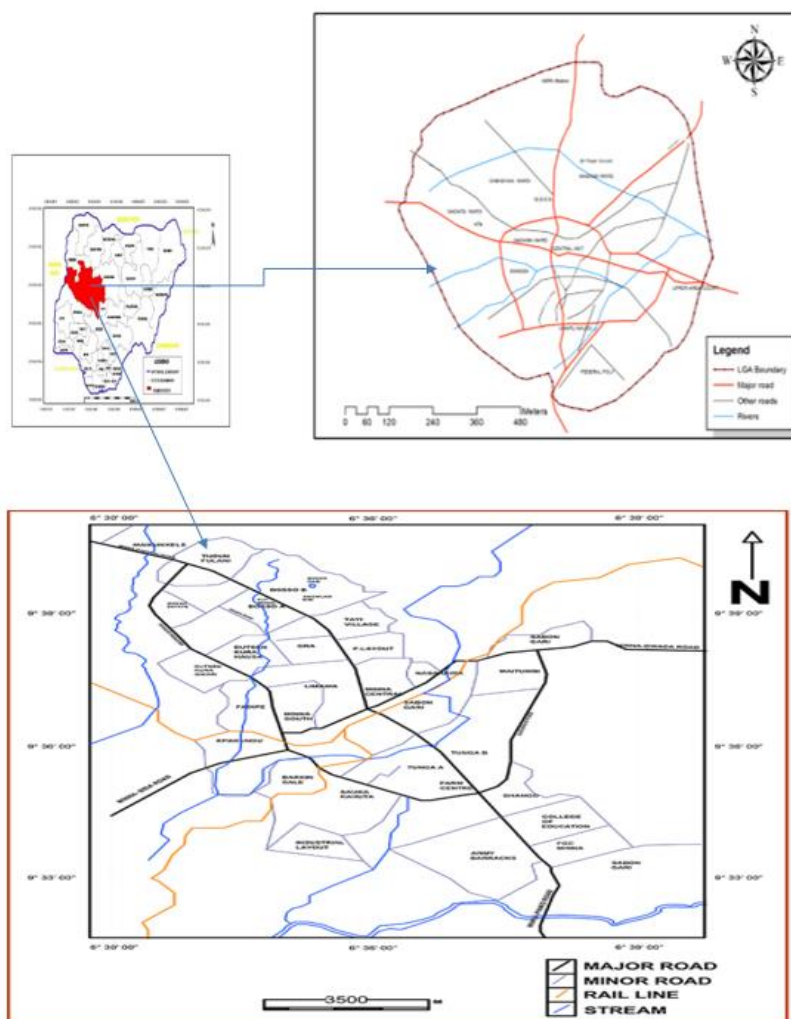


Figure 1: Map of Niger State showing Minna (down) and Bida (up) Metropolises

Niger State covers a total land area of 76,363km² or about 8.3 million hectares which represents 8% of the total land area of Nigeria. About 85% of the land is arable; the vegetation consists mainly of short and scattered trees. Soils are predominantly light and well-drained. The state

experiences distinct dry and wet seasons with annual rainfall varying from 1,100mm in the Northern part to 1,600mm in the Southern parts. The temperature ranges from 23°c to 37°c and daylight duration is an average of 8.5 hours and it has a relative humidity of 40%. The dry season

commences in November and ends in March while the rainy season commences in April and stops in October.

Bida is a Local Government Area in Niger State; it has an area of 51 km² and a population of 188,181 at the 2006 Population Census. Bida is the second largest town in Niger State that is located southwest of Minna, the capital of Niger State, and is a dry, arid town. Niger State, like other states on the same latitude, is covered by two major rock formations: the sedimentary and basement complex rock cover about 20% and the remaining 80% is covered by arable land that is good for farming. The sedimentary rocks to the south are characterized by sandstones and alluvial deposits, while to the north is the basement complex, characterized by granite outcrops or inselbergs which can be found in the vast topography of rolling landscape.

Sampling and Analysis

A total of forty (40) water sampling points were tested throughout the research. Twenty sampling points were tested in October in Bida and Minna. Ten sampling points each in Bida and Minna. This process was repeated in January. The depths of the wells were measured, the coordinates were recorded and samples were taken in sterile bottles and the physical parameter analyses were carried out to compare the quality of water in Minna and Bida Metropolis. The coordinates of the well measured were used to prepare water table contour maps for Minna and Bida using Surfer 8 software.

RESULTS AND DISCUSSION

Water Availability and Supply Within the Bedrocks

This study on bedrock correlation to the availability of water and its physical parameters in hand-dug wells was conducted in Minna and Bida which are areas with basement complexes and sedimentary basins respectively.

Field survey shows that the water levels of the wells during the wet seasons are shallow while the water levels during the dry seasons are deeper. This trend is seen from well 1 to well 9 while there is a slight reverse in the trend in well 10. This is because well 10 is located near a river which recharges the well. Though the depths of the water tables vary from one area to another in Minna, the characteristics of the basement

complex rocks are similar in the wells that were sampled.

The trend recorded in the well 1 to well 6 in the sedimentary basin (Bida) is similar to that of the basement complex (Minna) where the water levels are deeper during the dry season and shallow during the rainy season. The change in the trend in wells 7 to well 10 is because these wells fall in the Eastern region of the study area where rivers and streams are found, these water bodies recharged the wells during the dry season when rainfall is absent.

The results for Figure 2 and Figure 3 shows that climate trends have high correlations with the groundwater table. The increase in water table was observed in wells during the wet seasons which is attributed to the high rainfall, high infiltration and high recharge rate into the aquifer. The water table also influences the velocity of groundwater flow in the area.

Baraje (2012) assessed the sources and quality of water supply in Zone 'A' districts and discovered that climate trends have high correlations with the groundwater table, although there was a slight difference in the result obtained in Zone 'A' districts because there was no water body close to the sampled wells.

Figure 4 shows the groundwater levels in the Basement Complex (Minna) and the Sedimentary Basins (Bida) during the dry season. It is observed that the wells in the Sedimentary Basins are deeper than those in the Basement Complex even though it's the same season.

The result in Figure 5 shows that climate trends have high correlations with the ground water table. The increase in water table was observed in wells during the wet season which is attributed to the high rainfall, high infiltration and high recharge rate into the aquifer. The water table also influences the velocity of groundwater flow in the area.

Isah (2012) assessed the sources and quality of water supply in Zone 'B' districts and discovered that climate trends have high correlations with the groundwater table, although there was a slight difference in the result obtained in Zone 'B' districts.

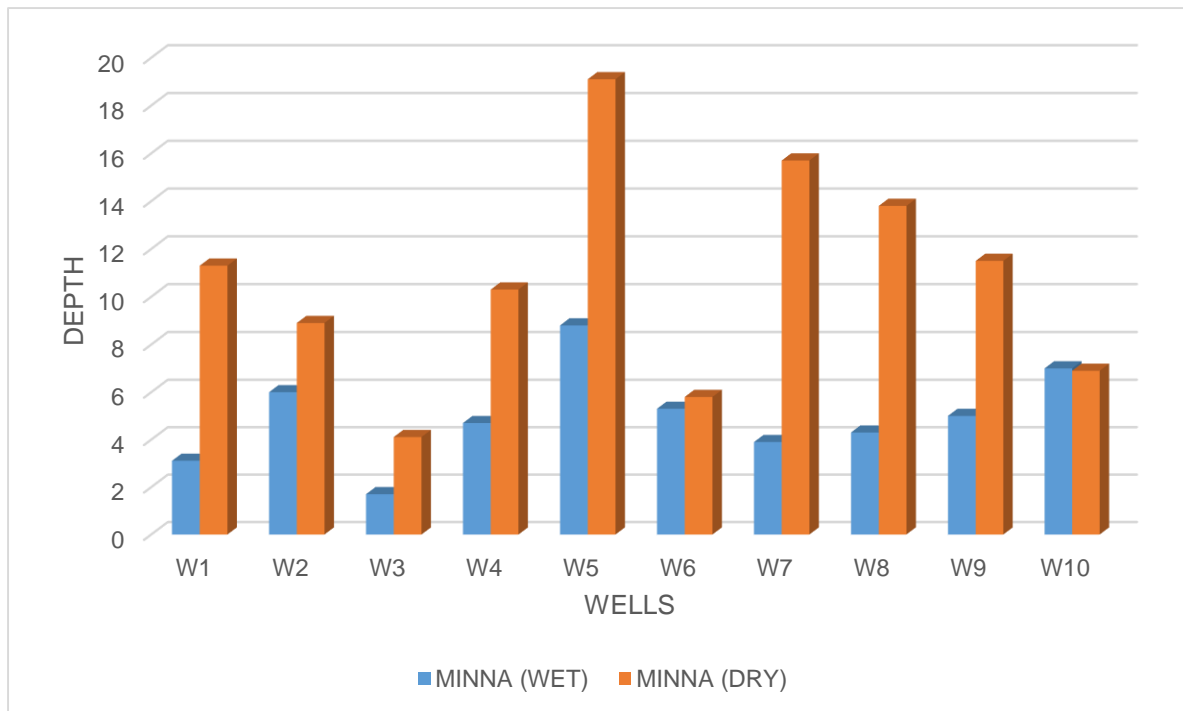


Figure 2: Comparison of groundwater availability in the basement complex (Minna).

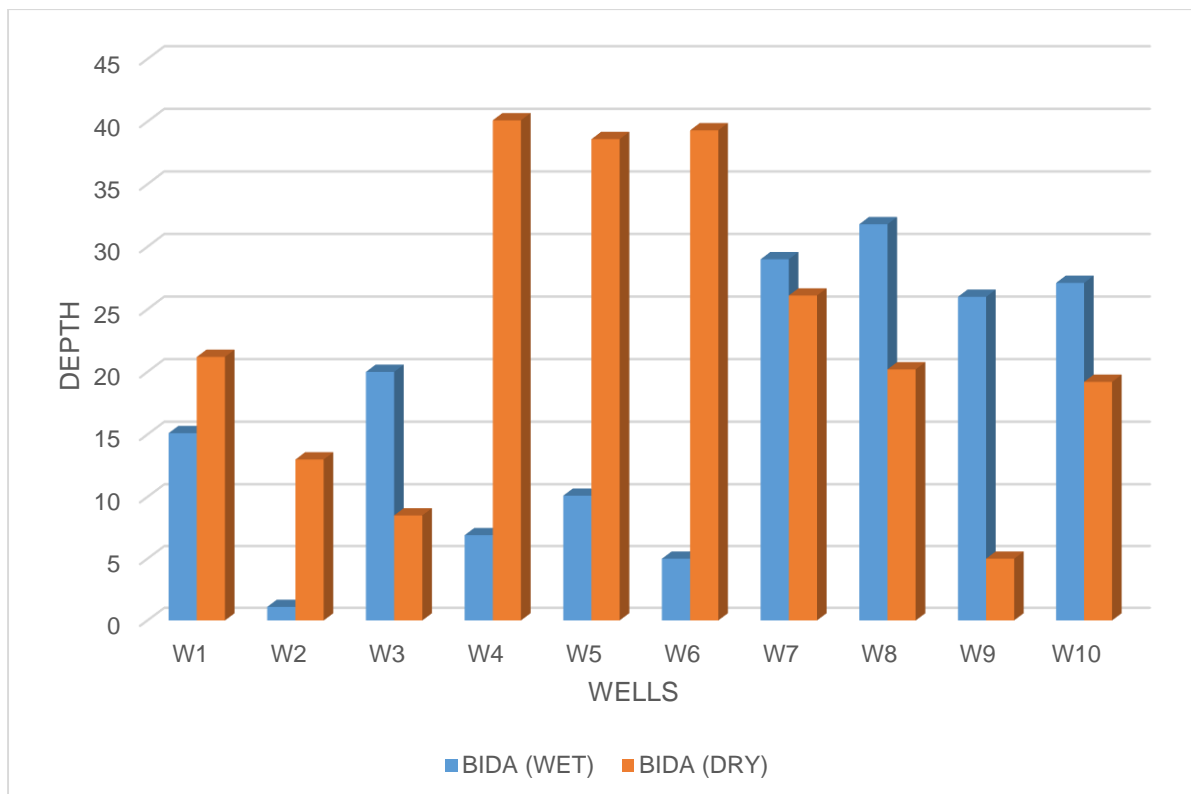


Figure 3: Comparison of groundwater availability in the sedimentary basin (Bida).

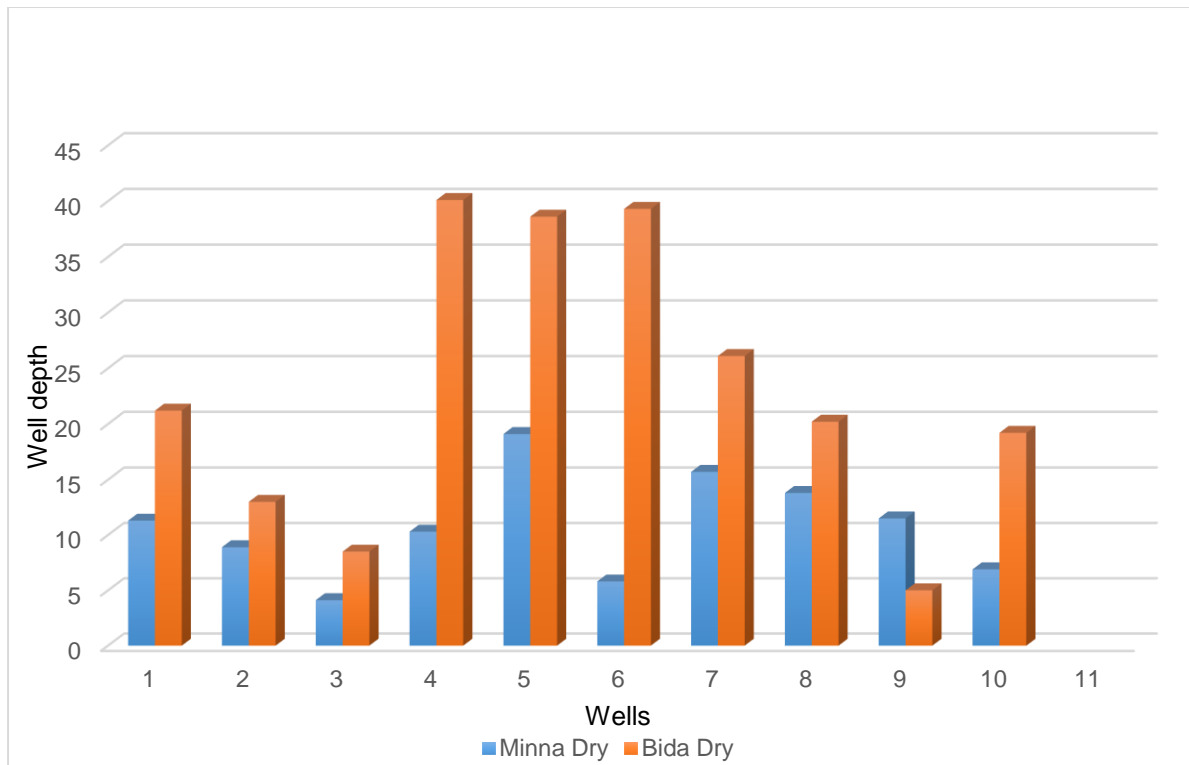


Figure 4: Groundwater levels in the Basement Complex (Minna) and the Sedimentary Basins (Bida) during the dry season.

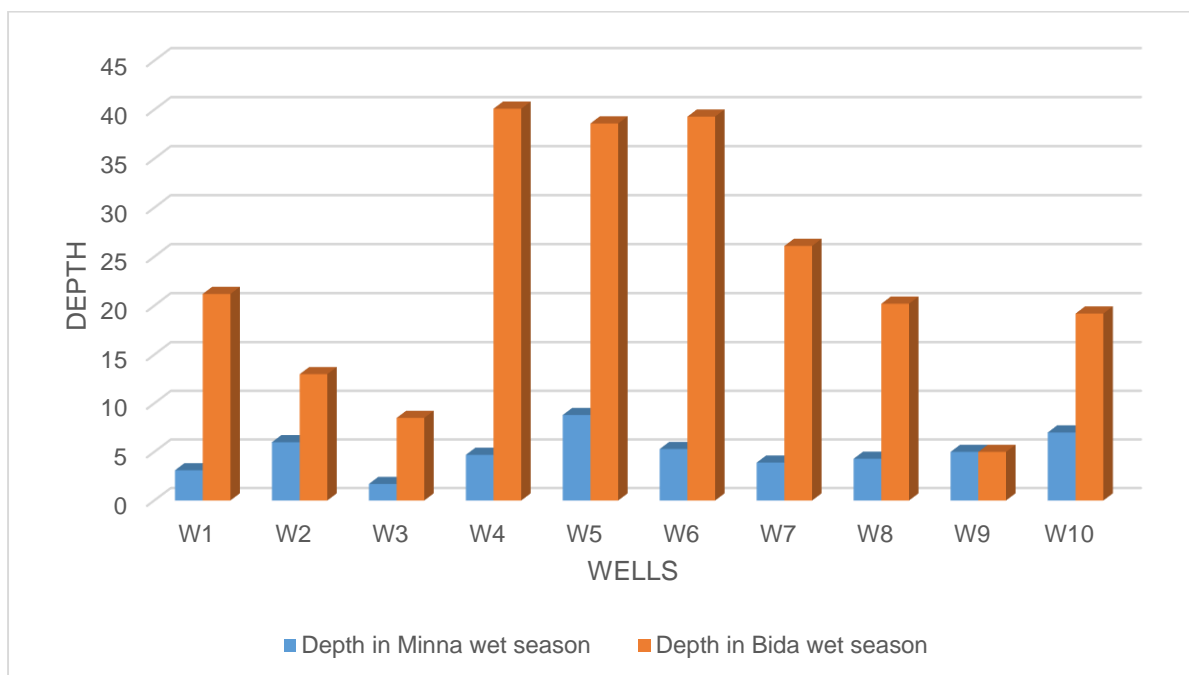


Figure 5: Groundwater levels in the Basement Complex (Minna) and the Sedimentary Basins (Bida) during the wet season.

Water table contour maps for Minna and Bida

Water table contour maps were used to indicate groundwater flow directions. From field

measurements of static water levels in wells, water table contour maps were plotted.

Groundwater movement is very slow compared to surface water movement. Groundwater like surface water flows downhill in the direction determined by the slope of the water table. Groundwater flow is therefore from high hydraulic head (low water level) (Buddemeier and Schloss, 2000). Figures 6 and 7 below shows the groundwater contour maps for Minna during

the wet and dry season respectively while figures 8 and 9 shows the groundwater contour maps for Bida during the wet and dry season respectively. The result shows that the wells located at lower elevations tend to have higher water table as compared to wells located at higher elevations. This is due to the fact that water generally flows from higher elevations to lower elevations.

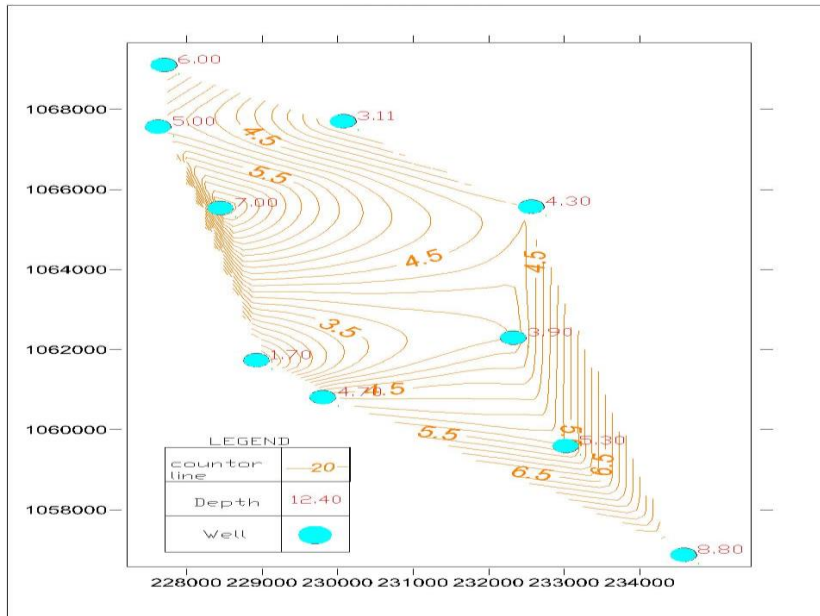


Figure 6: Water Table Contour Map for Minna during the wet season.

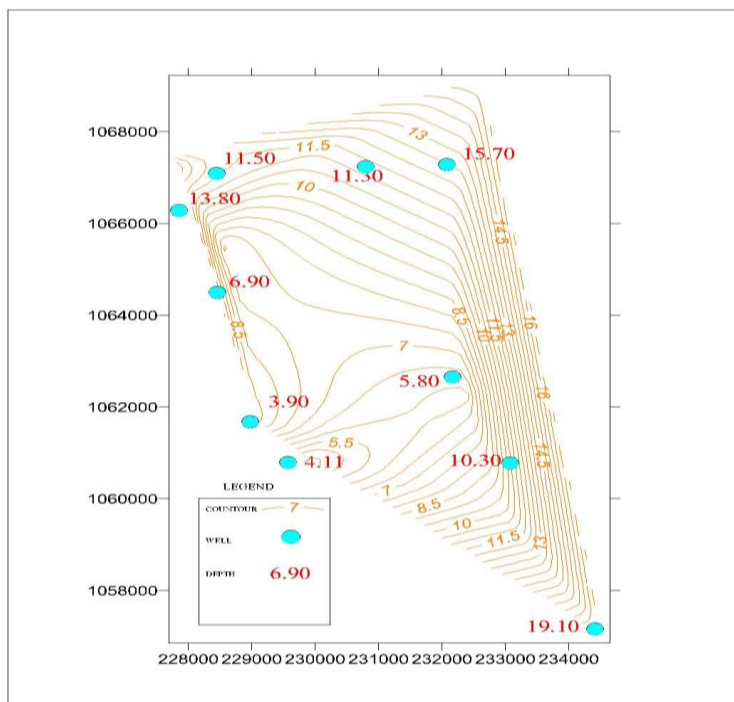


Figure 7: Water Table Contour Map for Minna during Dry Season

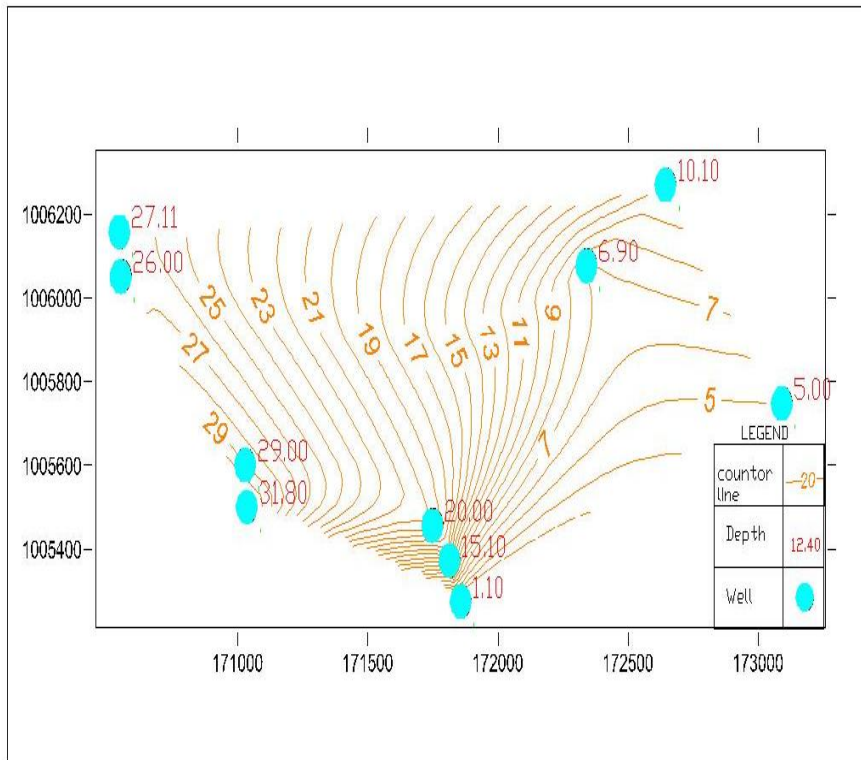


Figure 8: Water Table Contour Map for Bida during the Wet Season

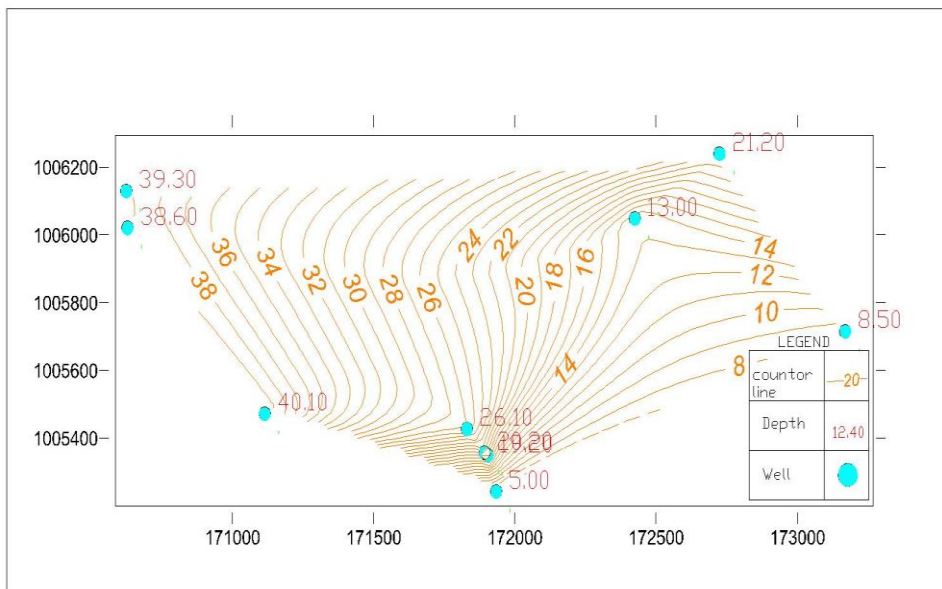


Figure 9: Water Table Contour Map for Bida during the Wet Season

Conclusion

This study analyzed the ground water availability in hand-dug wells in Minna and Bida. Based on the findings of the study, the water levels of the wells during the wet seasons are shallow in both the Sedimentary Basins and the Basement

Complex while the water levels during the dry seasons are deeper. The wells in the Sedimentary Basins are generally deeper than those in the Basement Complex regardless of the seasons.

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