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Morphometric Characteristics of River Chanchaga Using Hydrological (Rainfall) Variable, Minna, Niger State, Nigeria

M. B. Yunusa & Abdulkadir Nasiru
Geography Department, Federal University of Technology, Minna.

Keyword: *River Chanchaga, Rainfall, Morphometric characteristics.*

Abstract

The river Chanchaga is understood to be characterized by hydrologic and geomorphologic problems such as erosion and flooding. Though studies on Morphometric characteristics of rivers exist in Nigeria generally, not much exist about this study area. Therefore evaluating the morphometric characteristic of River Chanchaga was necessary. To achieve this, secondary and primary of data collection such as rainfall data, questionnaire administration and reconnaissance survey were undertaken. The finding revealed that entire length of river Chanchaga is a constant variable, 15km of the river downstream from the bridge was evaluated. It was ascertained that the relationship between the width and depth of the river varies from one point to another. In determining the relationship between morphometric characteristics and hydrological (rainfall), it was ascertained that an increase in rainfall amount also leads to a proportional increase in the depth and width of River Chanchaga. Therefore this evaluation is an essential tool in the river analysis in terms of planning to develop a better water usage mechanism adequate water supply and water conservation for sustainability.

Introduction

River Morphometry is the mathematical measurement and analysis of the configuration of the natural streams, size, shape, elevation, drainage density, stream density, drainage pattern, slope, surface and subsurface runoff, vegetative cover, sediment erosion and sediment yield of catchment (Babita *et al.*, 2012). In a related definition, morphometric studies is the evaluation of rivers through the measuring it's various properties, it also provides a description of the drainage system that is quantitative and the various connection between the drainage parameters and other morphometric characteristics. Morphometric analysis of a drainage basin indicates the changes that occur due to climatological, hydrological and geo-morphological changes over the space and time. It is helpful in predicting floods, their extent and intensity (Rajat and Mubeen, 2016). Morphometric analysis is very important since it can be used for the interpretation of drainage basin conditions with regards to hydrology of the basin, erosion course and water quality distribution (Mohammed *et al.*, 2011).

Literature survey reveals that some of the important variables of a drainage basin namely: stream length, stream depth, stream width, stream length ratio, bifurcation ration, stream order, drainage Pattern, areal aspect, circularity ratio, form factor, elongation ratio, stream frequency and drainage density are discussed by many investigators. In recent times, such works in Nigeria includes those of Mohammed *et al.*, (2011), Samson *et al.*, (2016), Eze, and Joel (2010). The evaluation of morphometric characteristics is discovered to be of enormous utility in river basin evaluation, prioritization of watershed for conservation of soil and water and natural resources management. As much as important the morphometric studies are noted, not much on morphometric studies exist about River. In the light of the above this research examined the impact of hydrological variables on the morphometric characteristics of River Chanchaga. Bawa *et al*, (2014) studied the factors that control the morphological variation of river systems. Stream power distribution and sediment load are used to analyze the morphological variability. For this, geomorphic mapping and analysis of Landsat satellite data for the year 2010 was done.

ERDAS software, ArcGIS and Global mapper were used for image processing of remote sensing data and for GIS analysis. The three major process domains are natural, anthropogenically altered and rejuvenated zones. They were governed by anthropogenic disturbances and major tributary influence. They analyzed that stream power variability successfully explained morphological variability in the upstream natural domain but it fails in the downstream anthropogenically altered and rejuvenated zones domains. Its role was confined in defining the geomorphic diversity of the whole Yamuna River. It was also reported that the stream power with sediment load can provide an important tool for geomorphic variability.

They concluded that the basin scale approach is more important than isolated local scale analysis in river system, but they did not consider the hydrological parameters. In a particular basin sprawl, a Morphometric analysis of a watershed provides a quantitative description of the drainage system which is an important aspect of the characterization of watersheds.

Rivers are dynamic entities and their characteristics vary over time and space in response to effects of hydrological variables. They are usually well defined, aerial unit which can be analyzed by a set of quantifiable basin characteristics and the quantity of water available per time and per season is determined by hydrological variables. The river Chanchaga is understood to be characterized by hydrologic and geomorphologic problems such as erosion and flooding. Though studies on Morphometric characteristics of rivers exist in Nigeria generally, not much exist about this study area. Therefore evaluating the morphometric characteristic of River Chanchaga was necessary.

River Chanchaga is situated in Bosso Local Government, Niger State. It is located in the middle belt of Nigeria since it falls within the temperate humid regions of the country. It is situated in the tropical hinterland and in the Guinea savannah zone. It lies between longitude 6º32’25” - 6º35’00” North of the Greenwich meridian and latitude 9º36’50”- 9º39’72”East. River Chanchaga is a stream and is located in the capital of Niger State, Minna Nigeria. The estimated terrain elevation above sea level is 74meters.

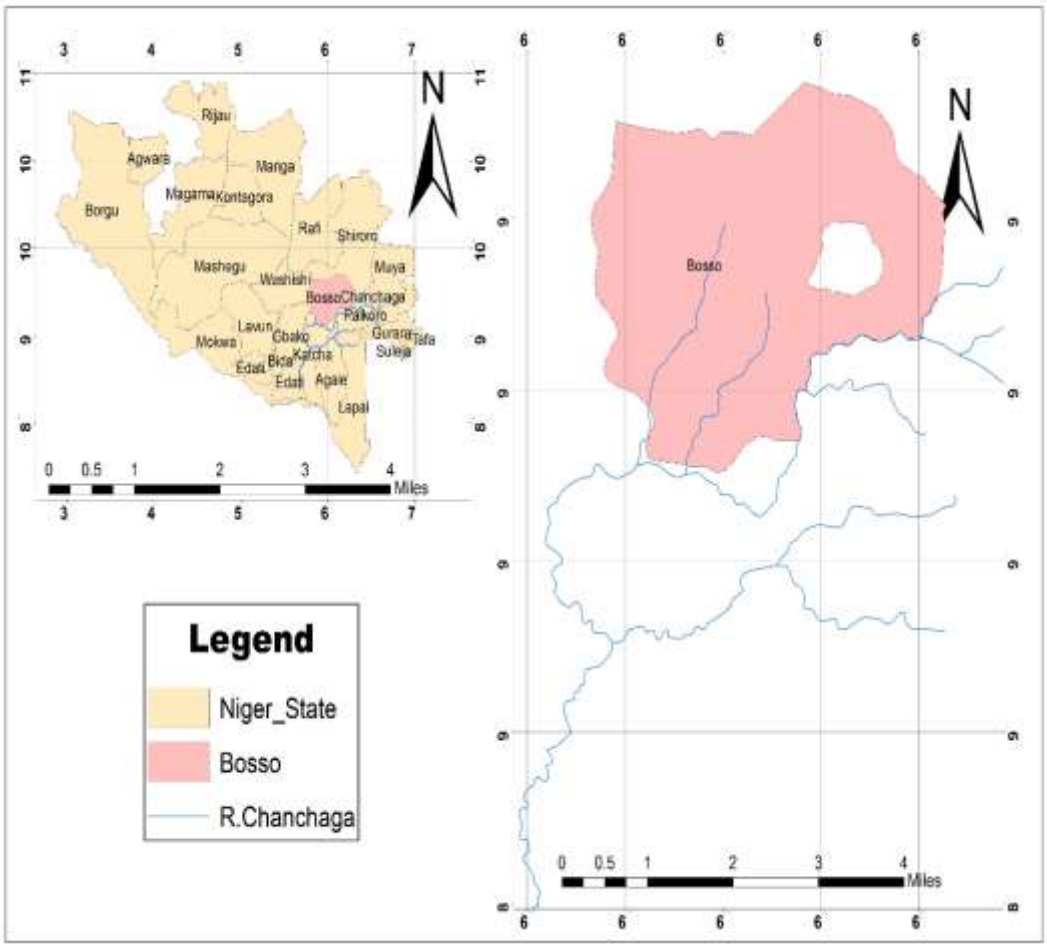

Figure 1: The Study Area Coverage (Bosso Local Government) Niger State, Nigeria

Materials and Methods

A variety of secondary data were used which were also obtained from a variety of sources. These includes:

Maps and Landsat images for the year 2016, Digital Elevation Model (DEM) and a 3D spatial analysis was used to acquire the length, depth and the Width of the River. Rainfall Hydrological data (2002-2016) was acquired and used for this research work. The data was obtained from the Nigerian Meteorological Agency, Minna (NIMET). In determining the morphometric characteristics of River Chanchaga, 3D spatial analysis was used to get the length, depth and width of the river. In examining the rainfall pattern of the study area, descriptive analysis (bar chart) and linear Regression Analysis (Trend) were used.

Results and Discussion

This section covered the results and discussion of morphometric analysis of River Chanchaga.

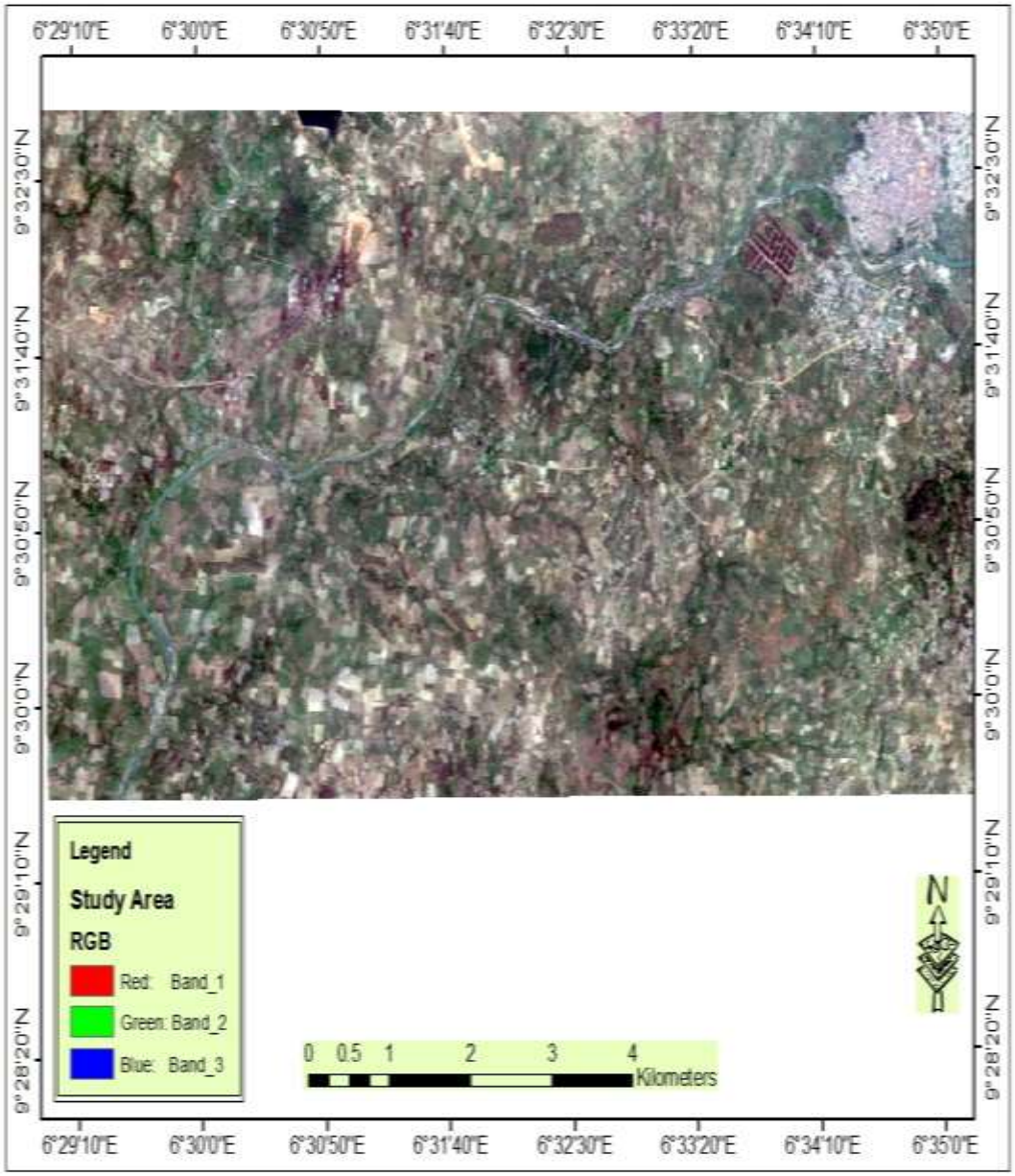

Figure 2: Landsat Satellite Imagery of the Study Area

Figure 2 present the Landsat imagery of the study area showing true natural color of the study area, the various landforms, vegetation, built ups and the river itself. The river flows from North-east of the map downwards South-west on the map.

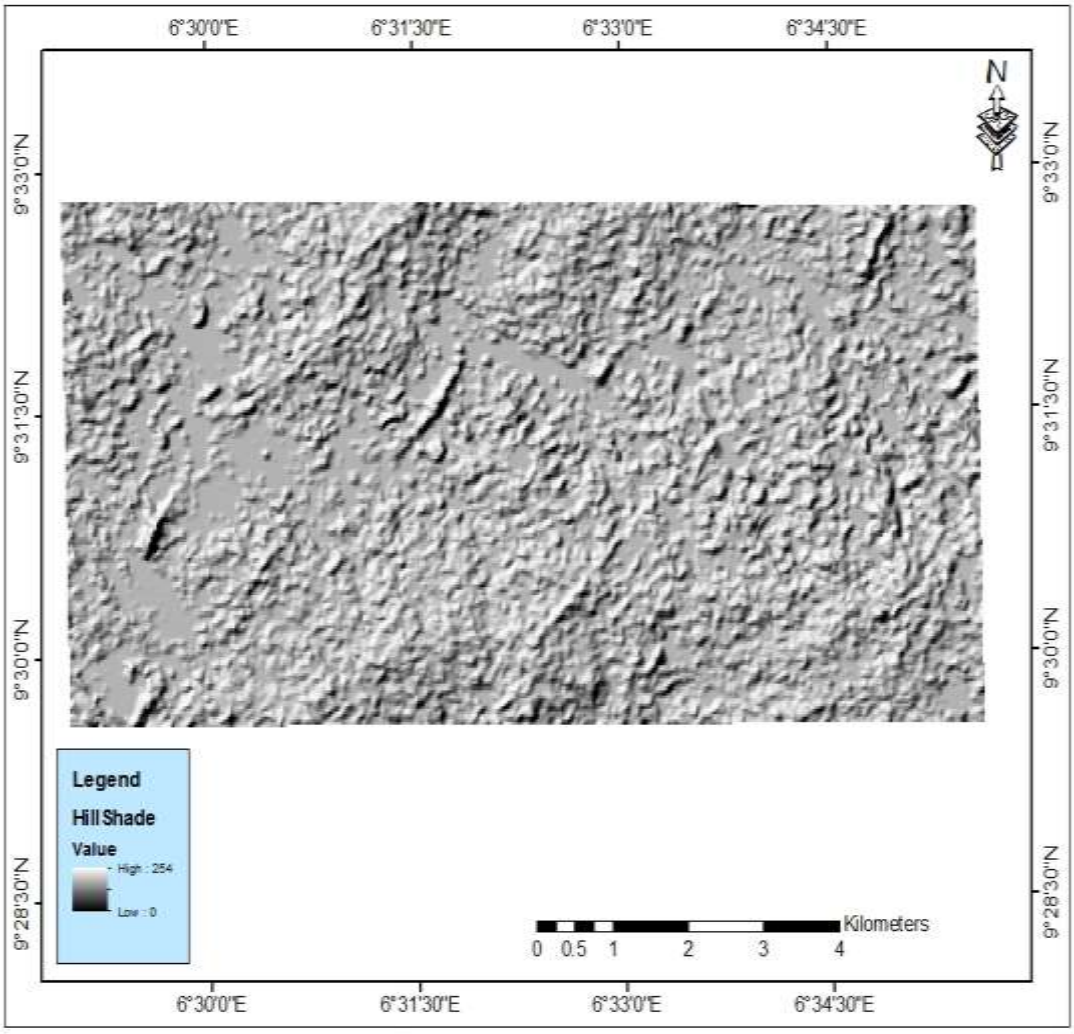

Figure 3: Hill Shade of the Study Area

Figure 3 shows the hill shade of the study area which indicates the surface representation of the topography of the area. The black patches are shadows of high landforms, the rough surface are highland forms while the smooth surface are lowlands. These therefore implies that the northern, southern and south eastern part of the map are rocky. The geomorphological features of an area determines the route in which the river will flow through, hence the river channel is in between the northern and southern hilly parts on the map. Also the sloppiness of a surface determines the velocity of the runoff of water, along the rocky areas water flows downwards with higher velocity and while getting to areas where it is less rocky the velocity of runoff reduces. These therefore indicates the possibility of flooding when there are any upsurges.

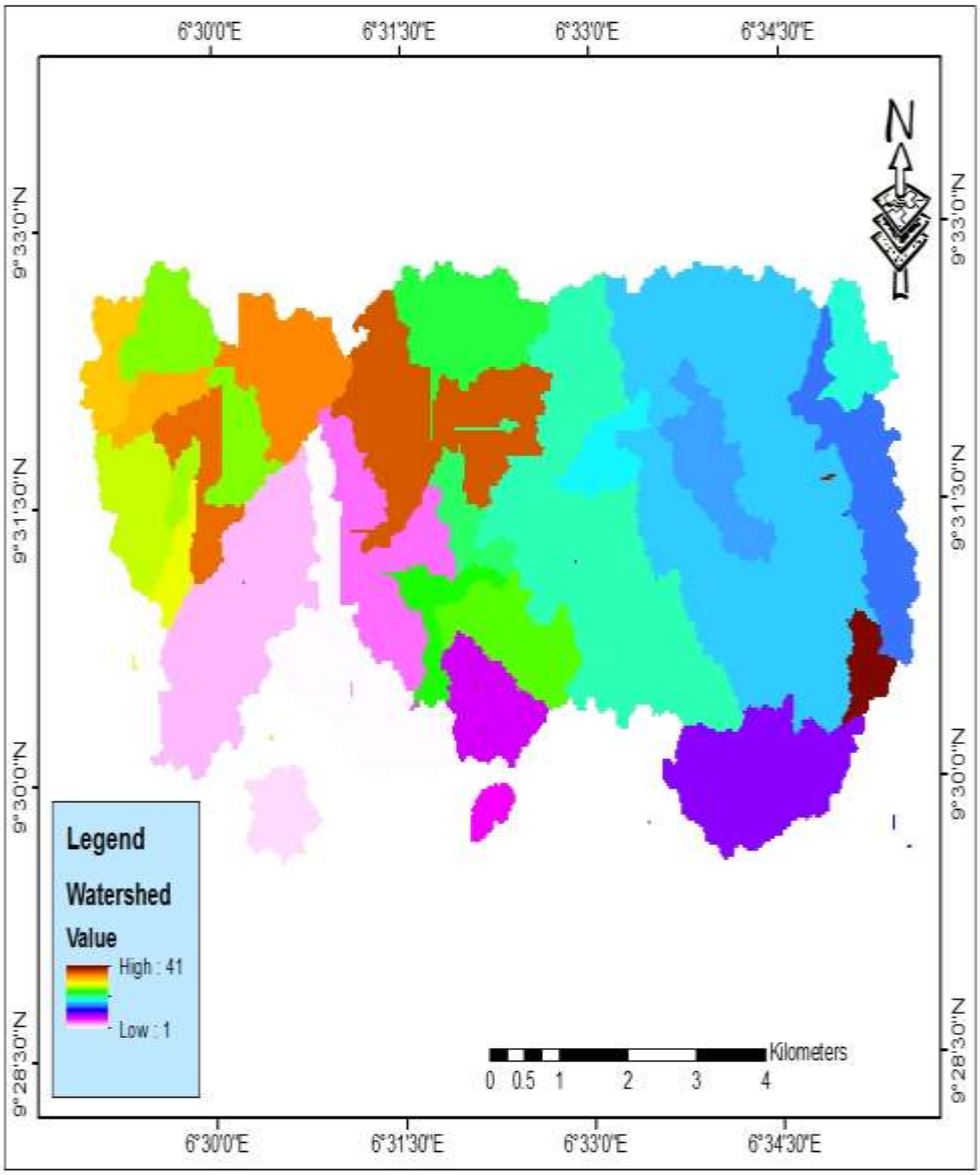

Figure 4: The Watershed of the Study Area

Figure 4 shows the watershed of the study area which reveals the drainage area of land that surface and sub-surface where water flows from, into various sizes of catchments. This implies that the North-western (brown, orange and yellow colored) part of the map has high watershed. The North-eastern part (blue colored) part of the map and other green patches have medium watershed and the South-western parts of the map (ranging from deep and light purple to the white patches on the map) as low watershed.

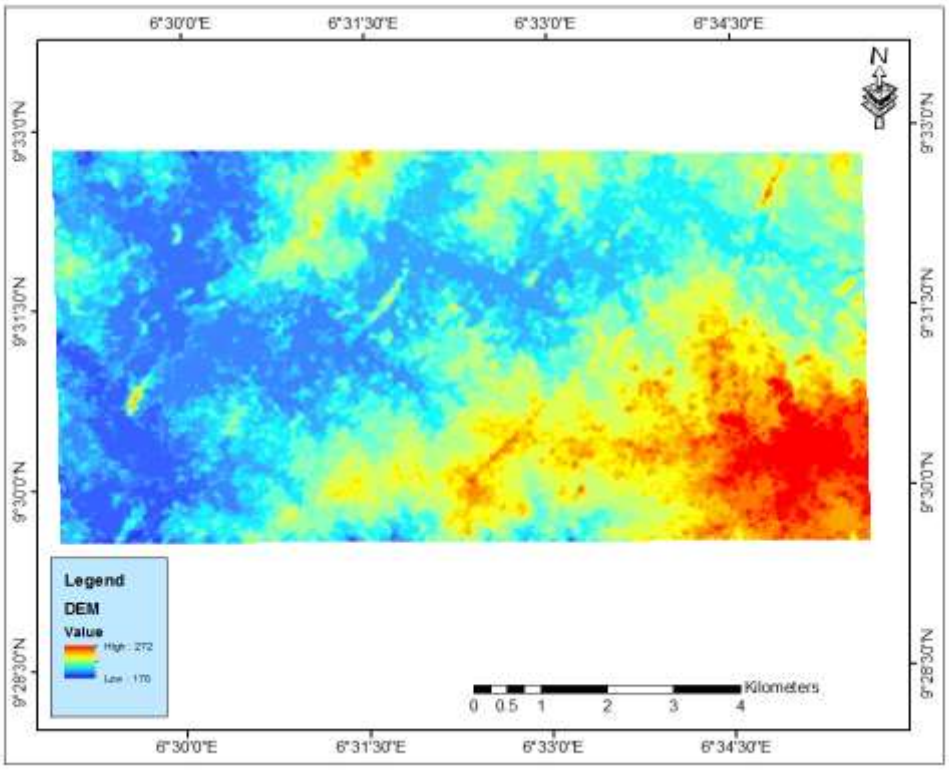

Figure 5: DEM image of the study area

Taking a look at the Figure 5 symmetrically, the South-eastern part of the map has the highest elevation of 272m, the Northern, north-eastern and the Southern part of the map have an average elevation of 221m while the Western part of the map has the lowest elevation of 170m.

Depth and Width Variation of River Chanchaga

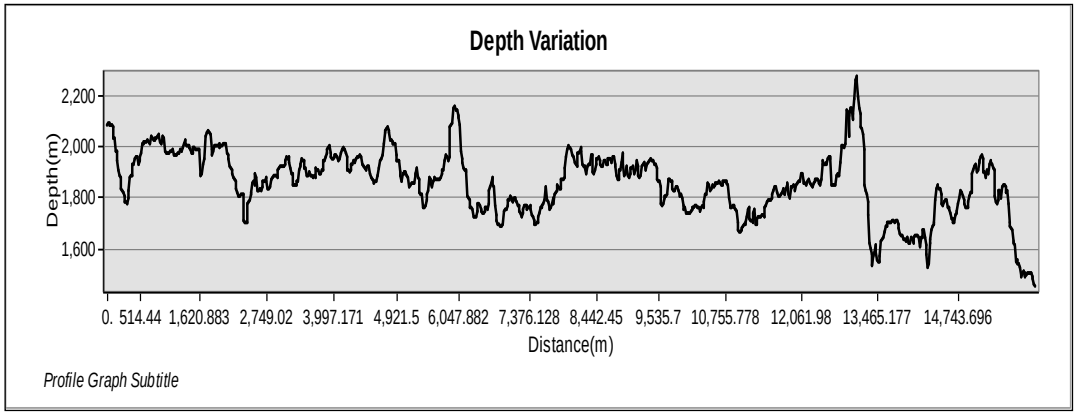

Figure 6: Depth Variation of River Chanchaga

Figure 6 shows the change in depth of the study area with respect to the width of the study area. The lowest depth of the river is 1510m at 14743.696m, the highest depth of the river is 2280m at 12762.5485m. At the lowest depth, the river channel is narrow and there is a tendacy of the river overflowing its bank which may lead to flooding and affects near by farm land negatively and lead the the death of farm animals and desruction of cultivated crops. At the highest depth the water is contained in the that portion of the river and flows without overflowing its bank.

Mean Annual Rainfall Distribution

Figure 7 revealed the trend in mean annual rainfall distribution with consistently changing over the 15years, having the lowest rainfall in the year 2011 of 965.3mm, while 2006, 2007 and 2009 have received equal amount of rainfall was recorded of 1423.2mm, 1423.2mm and 1421.6mm respectively. The highest amount of rainfall was recorded in the year 2012 with 1543mm. The overall trend in the distribution generally reveal a decreasing trend with about 0.54mm over the study period.

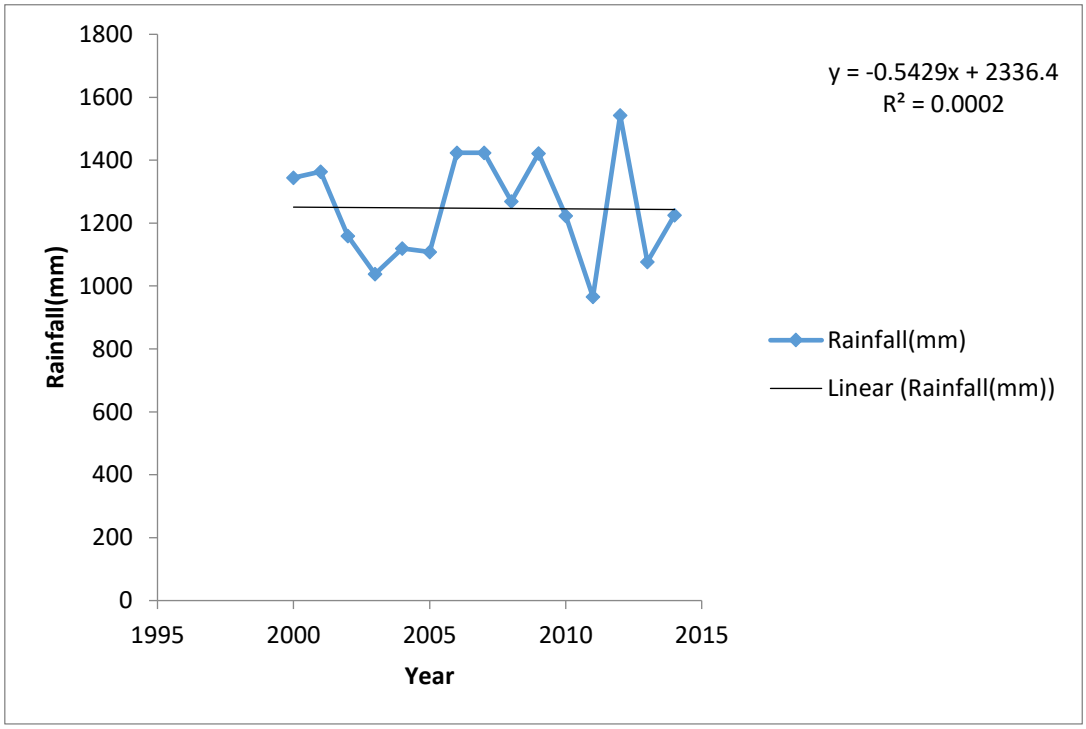

Figure 7: Annual Rainfall of the Study Area (2002-2016)

Relationship between Morphometric Characteristics and Hydrological (rainfall) Variable of River Chanchaga

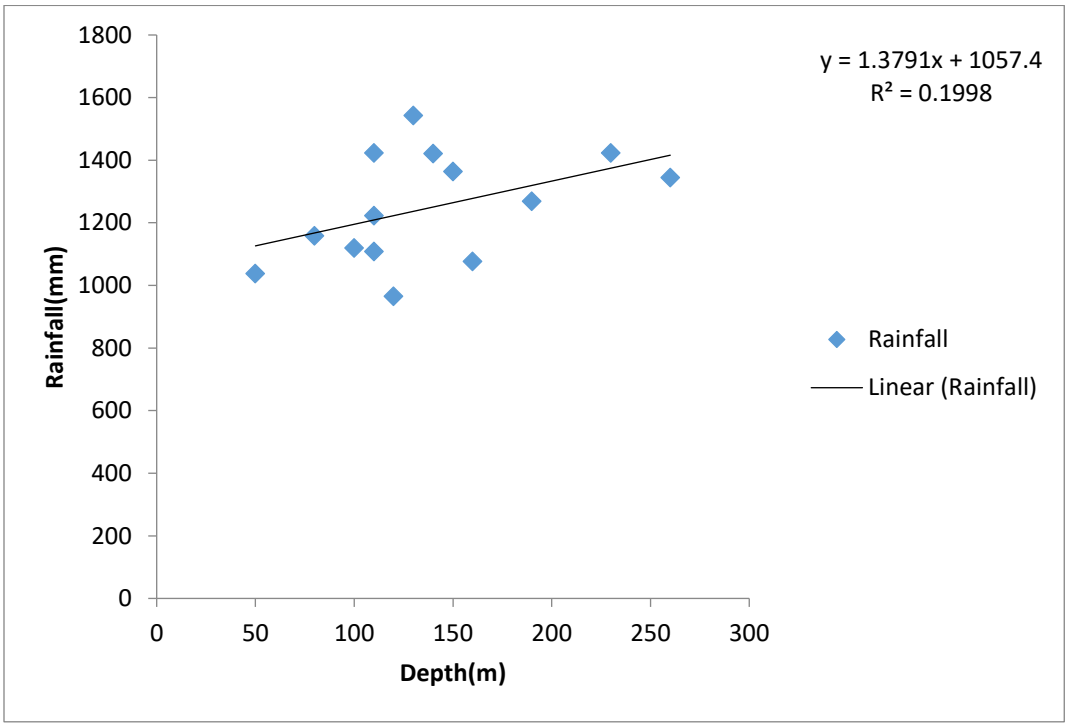

Figure 8: Relationship between Annual Rainfall and Depth of the River

As revealed in Figure 8, the lowest depth is 50m with annual rainfall amount of 1038.2mm and the highest depth is 260m with annual rainfall amount of 1344.5mm. The multiple regression gave an R^2 value of 0.1998 which is 19.98%, this show that there is a positive relationship between rainfall and the depth of the river. This therefore implies that an increase in rainfall amount leads to an increase in the depth of the river.

Conclusions

The main aim of this research was to evaluate the morphometric characteristics of River chanchaga using hydrological (rainfall variable), by making analysis with the use of multiple regression it shows that rainfall to an extent determines the depth and width of river Chanchaga. The highest annual rainfall was in 2012 with rainfall amount of 1543mm with a depth and width of 130m and 250m respectively. This research has exhibited that rainfall pattern influences the morphometric characteristics of the river which are its depth and width except for the length because it is a constant variable. Minna the capital of Niger State is noted to experience shortage of water supply despite the presence of river Chanchaga that cut across the whole Bosso local government, this research can

be applied for water basin planning and other water conservation measures. Therefore this evaluation is an essential tool in the river analysis in terms of planning to develop a better water usage mechanism adequate water supply and water conservation for sustainability.

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