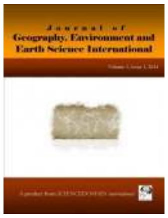

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Morphometry and Flood in Small Drainage Basin: Case Study of Mayogwoi River Basin in Jalingo, Taraba State Nigeria

E. D. Oruonye[1*]

[1]*Department of Geography, Taraba State University, P.M.B. 1167, Jalingo, Taraba State, Nigeria.*

Author's contribution

The sole author designed, analyzed and interpreted and prepared the manuscript.

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ABSTRACT

Drainage basin morphometric information is very important in any undertaking to control incidence of flooding in an area. In the present study, morphometrc analysis using remote sensing and GIS techniques have been carried out to examine the flood potentials of the Mayogwoi river basin. The Mayogwoi basin is a small basin. The pattern of this basin is dendritic. The values of bifurcation ratio (2.45), circularity ratio (0.64), elongation ratio (0.66) and form factor (0.35) indicates that the basin is moderately circular and somewhat elongated. The length of overland flow of the basin is 1.25, indicating matured topography and low surface runoff in the study area. The low drainage density (0.4 km/km^2) and low stream frequency (0.11) is indicative of low relief, low surface flow, high infiltration and consequently low flood potentials of the basin. The basin has a low relief ratio (0.074) and low relative relief (2.38) indicating low relief and gentle slope. The result of the findings also shows that the basin has a short basin length of 32.2 km indicative of higher chances of the basin been flooded after heavy rainfall of short duration. Consequently, the result shows that there will hardly be enough water supplies to support large scale water resource development prospects particularly irrigation and hydropower project in the basin except with intensive development of land

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**Corresponding author: E-mail: eoruonye@gmail.com;*

and water resources of the basin. Thus, high intensity of rainfall is required for the generation of flash flood in the drainage basin because of its relatively small basin size. The morphometric parameters of the basin therefore suggest low to moderate flash floods chances and high potential of groundwater aquifers recharge. Thus, heavy rainfall is the most important flash flood - causing factor, followed by morphometric characteristics and land uses in the basin.

Keywords: Basin; dendritic; drainage; flood; mayogwoi; morphometry.

1. INTRODUCTION

Drainage Morphometry is defined as the measurement and mathematical analysis of the configuration of the earth's surface and of the shape and dimension of its landforms [1]. Morphometric analysis is significantly used for various small river basins and sub basins in the various parts of the world [2-8]. Morphometric parameters such as drainage density, stream magnitude, and relief ratio are practical measures of flood potential in small drainage basins. Most authors have defined flood potentials using shape indices [9,10]. Others have used both morphometric parameters and shape indices [11-15]. In Nigeria, similar studies have been carried out which include those of [16-19].

Drainage basin has been seen as the fundamental hydrologic and geomorphic areal unit through which the precise description of the geometry of landforms could be harnessed as data could be collected, organized and analyzed [20]. The drainage basin analysis is important in any hydrological investigation like assessment of groundwater potential, groundwater management, pedology and environmental assessment [21]. Morphometric studies in the field of hydrology were first initiated by [22,3]. The morphometric characteristics of drainage basins have been studied by many scientists using conventional methods [2,4,23] and Remote Sensing and GIS methods [24-28]. Remote sensing techniques using satellite images are convenient tools for morphometric analysis [29]. The satellite in remote sensing has the ability to provide synoptic view of large areas and is very useful in analyzing drainage basin morphometry. Remote sensing data can be used in conjunction with conventional data for delineation of ridgelines, characterization, priority evaluation, problem identification, assessment of potentials and management needs, identification of erosion prone areas, evolving water conservation strategies, selection of sites for check dams and reservoirs etc [30].

This type of study has not been carried out on River Mayogwoi. No segment of the basin is gauged and information on the drainage system is very scarce as not much research work has been carried out in this direction. It has been observed that there is relationship between drainage basin morphometric parameters and flood potentials. Drainage basin morphometric information is very important in any undertaking to control incidence of flooding in an area. In this study, basin morphometric parameters using GIS was used to examine the flood potentials of the Mayogwoi basin. This will provide information about floods in the drainage basin. The data on the drainage basin morphometric parameters will enhance the management of flooding in the area.

1.1 Description of the Study Area

River Mayogwoi is the major tributary of River Lamurde in Jalingo LGA, Taraba State, Nigeria. The drainage basin is located between latitudes 8°45' to 9°05'N and longitudes 11°15' to 11°35'E (Fig. 1). River Mayogwoi takes it sources from the hills in Yorro LGA and flow through the northern part of Jalingo metropolis. The river flows for a short distance of 36 km before emptying into the Lamurde basin at Magami ward in Jalingo town. The area is characterized by sub humid climate with well-defined wet and dry season. Average rainfall is about 850 mm^3 annually and mean temperature of 30°C. The study area falls under the guinea savanna vegetation zone characterized by grasses interspersed with tall trees and shrubs. Some of the trees include locust bean, sheabutter, eucalyptus and silk cotton tree. Geologically, the drainage basin consists of cretaceous rocks of Bima sandstone formation with isolated flat-toped hills. Greater parts of the basin consist of scattered remnants of highly metamorphosed sedimentary rocks and diverse predominantly granitic and plutonic masses generally known as old granites [31]. Soils of the basin are ferruginous tropical soils derived from crystalline acid rocks of the basement complex. The basin is drained by ephemeral rivers that have been affected by flash floods in the past few decades.

The basin was affected by heavy rainfall and flash floods on 7th August 2005 and 11th August 2011 [32,33] suggesting high possibilities of flash flood occurrence. This suggests that the possibilities of flash floods have increased from an event per 30 years to an event per 6years in the area. This could probably be attributable to climate changes and global warming [34].

2. METHODOLOGY

The data used in this study includes field generated data and data derived from topographical map as well as Etm+ (2015) and Shuttle Radar Topographic Mission (SRTM) data obtained from the United State Geological Survey (USGS) online open resources. The map of the study area was obtained from the Taraba State Bureau of Land and Survey. Satellite images of Landsat 8 were used as base map for the GIS technique. The images were acquired on 15th March 2015 and the projection type is UTM and spheroid is WGS 1984. The datum is the Minna datum, UTM zone 32N and the pixel size is 15 meter. Morphometric analysis and prioritization of basin was based on the integrated use of remote sensing and GIS technique. The drainage map of the study area was prepared using geo-coded data and verified with survey of Jalingo toposheets no. 193, 194, 195, 214, 215, 216, 235, 236 and 237 of the area at 1:50000. The toposheets and satellite data were geometrically rectified and georeferenced to World space coordinate system using ERDAS IMAGINE 9.2 software package.

After georeferencing, on-screen digitization process was carried out to extract the stream network according to their order following [5] stream ordering technique. The entire drainage segments were digitized as lines separately for each order [3]. Digitization work was carried out

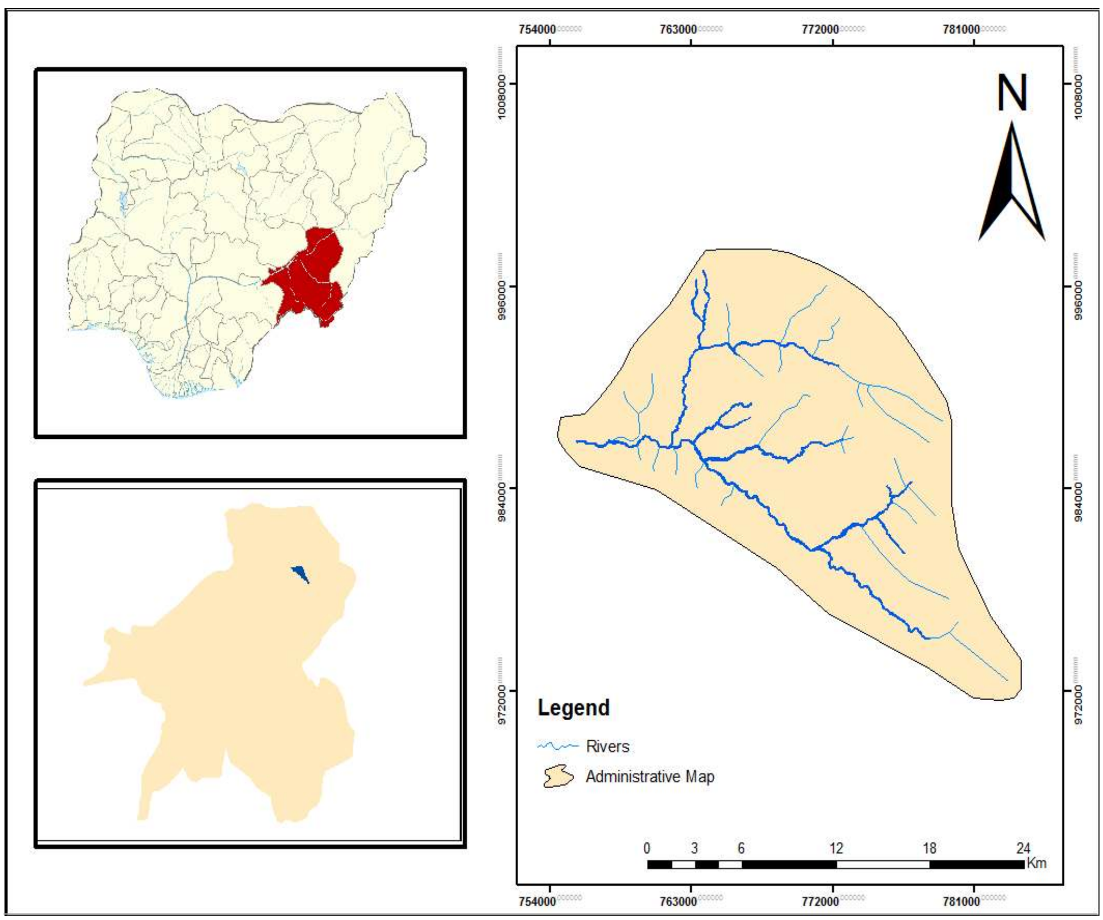

Fig. 1. Location map of the study area

using Arc GIS 9.2 software. The attributes were assigned to create the digital data base for the drainage layer of the river basin. The map showing the drainage pattern in the study area (Fig. 2) was prepared after detailed ground checks with GPS survey on channel networks. Image interpretation comprises data derivation from map analysis, map work, computation from topographical maps and satellite imageries pertaining to different components of the drainage basin morphometric parameters in the study area. The Area (A) and Perimeter (P) of the drainage basin was calculated using measurement tool option of ArcGIS version 9.2. Morphometric parameters such as linear aspects of the drainage network: Stream order (Nu), bifurcation ratio (Rb), stream length (Lu), and areal aspects of the drainage basin: drainage density (D), stream frequency (Fs), texture ratio (T), elongation ratio (Re), circulatory ratio (Rc), form factor (Rf) of the basin were computed. Various morphometric parameters of the whole basin were calculated based on literatures [2,3,5,9,35,36].

3. RESULTS

The various morphometric parameters of the Mayogwoi river basin have been computed and summarized below. The result of the study shows that the study area is a fourth order drainage basin. The stream network shows a dendritic pattern, indicating the homogeneity in texture and lack of structural control.

3.1 Linear Aspects

3.1.1 Stream order (Nu)

The first step in drainage basin analysis is to determine the stream orders. Stream order has been defined as a measure of the position of a stream in the hierarchy of tributaries [37]. Hierarchical ordering of streams is necessary to understand the hydrodynamic character of a drainage basin. In the present study, the various stream segments of the drainage basin have been ranked according to Strahler's stream ordering system. According to [5], the smallest fingertip tributaries are designated as first stream order. Where two first stream order meets, a second stream order is formed; where two second stream order meets, third stream order is formed and so on. The study area is a fourth order drainage basin (Fig. 1). The total numbers of 40 streams were identified, of which, 30 are first order streams, 7 are 2^{nd} order, 2 are 3^{rd} order and 1 is indicating 4^{th} order streams. The trunk stream through which all discharge of water and sediment passes is therefore the stream segment of the highest order. River Mayogwoi which is the trunk stream in the study area is of the fourth order.

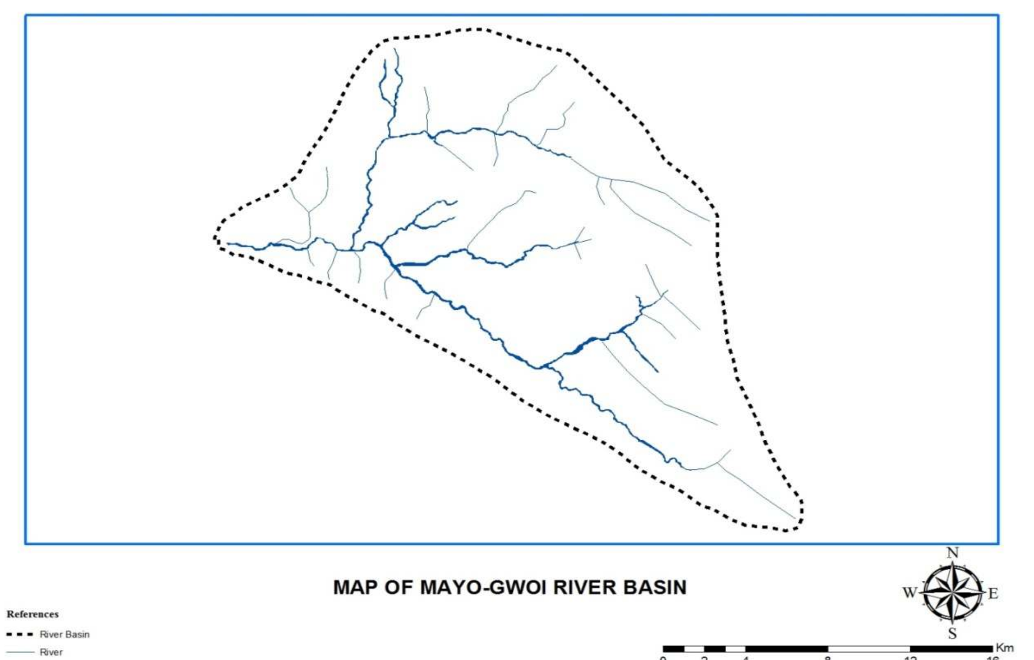

Fig. 2. Mayogwoi river basin

Table 1. Stream orders, stream number, stream length in the Mayogwoi river basin

S/No	Stream order	Stream numbers	Total stream length (km)	Mean stream length (S.L/SN)	Bifurcation ratio
1	1st order	30	78.8	2.63	4.29
2	2nd order	7	42.3	6.04	3.5
3	3rd order	2	20.1	8.9	2
4	4th order	1	6.9	10.05	

Drainage patterns of stream network in the basin have been observed as mainly dendritic type which indicates the homogeneity in texture and lack of structural control. The total number of stream segments is found to decrease as the stream order increases in the basin.

3.1.2 Stream length (Lu)

The total length of individual stream segments of each order is the stream length of that order. Stream length measures the average (or mean) length of a stream in each orders, and is calculated by dividing the total length of all streams in a particular order by the number of streams in that order. The numbers of streams of various orders in the basin were queried and their lengths also determined and summed up in ArcGIS 9.3 environment. The stream length in each order increases exponentially with increasing stream order as shown in Table 1.

Stream length is one of the most important hydrological features of the basin as it reveals the surface runoff characteristics. Streams of relatively smaller lengths indicate that the area is with high slope [38] and finer textures. Streams with longer lengths are generally indicative of flatter surface with low gradients. Stream length is a revelation of the chronological developments of the stream segments including interlude of tectonic disturbances. Usually, the total length of stream segments is highest in first stream orders and decreases as the stream order increases.

3.1.3 Mean stream length

The mean stream length is a characteristic property related to the drainage network components and its associated basin surfaces [5]. The mean stream length is calculated by dividing the total stream length of given order by number of stream of that order as shown in Table 1. The value for any given order is greater than that of the lower order and less than that of its next higher order in the whole drainage basin.

3.1.4 Bifurcation ratio (Rb)

Bifurcation ratio is related to the branching pattern of a drainage network and is defined as the ratio between the total numbers of stream segments of one order to that of the next higher order in a drainage basin [36]. Bifurcation ratios usually range between 3.0 – 5.0 for basins in which the geologic structures do not distort the drainage pattern [5]. The R_b values of the study area (Table 1) indicates that there is a uniform decrease in the R_b values from the first stream order to the fourth stream order. The R_b values in the study area ranges from 2.0 to 4.29. The sum of all the bifurcation ratios in the basin was divided by the number of bifurcation ratios to give the mean bifurcation ratio of the basin. The calculated mean bifurcation ratio for the study area is 2.45; an indication that the study area is a lowland area. This suggests that the study area has low potentials for discharge compare to those of highland areas with bifurcation ratio of 5.0 [3].

3.1.5 Length of overland flow

Length of overland flow is defined as the length of flow path, projected to the horizontal, non channel flow from point on the drainage divide to a point on the adjacent stream channel [2]. Horton, for the sake of convenience, had taken it to be roughly equal to half the reciprocal of the drainage density. Overland flow is significantly affected by infiltration (exfiltration) and percolation through the soil, both varying in time and space [39]. In this study, the length of overland flow of the Mayogwoi drainage basin is 1.25 kilometers, which shows low surface runoff in the study area.

3.2 Areal Aspects

The areal aspects of drainage basin include different morphometric parameters, like drainage density (Dd), stream frequency (Fs), form factor (R_f), circulatory ratio (Rc), elongation ratio (Re) and length of overland flow (L_g). The values of these parameters were calculated and results are presented in Table 2.

Table 2. Areal aspects of Mayogwoi river basin

S/No	Parameter	Calculated value
1	Area (Sqkm)	366.2
2	Perimeter (Km)	84
3	Elongation Ratio	0.66
4	Drainage density	0.4
5	Stream frequency	0.11
6	Length of overland flow	1.25
7	Form factor	0.35
8	Circulatory ratio	0.64
9	Drainage texture	0.48

3.2.1 Drainage area (Au)

The drainage area is the entire area drained by a stream or system of streams such that all streams flow originating in the area is discharged through a single outlet. In other words, the drainage area is defined as a collecting area from which water would go to a river. The boundary of the area is determined by the ridge separating water flowing in opposite directions. The total area of the Mayogwoi drainage basin is 366.2 km^2. Basin area has been identified as the most important of all the morphometric parameters controlling catchment runoff pattern. This is because, the larger the basin, the greater the volume of rainfall it intercepts, and the higher the peak discharge that result [8,18,40]. The maximum flood discharge per unit area is inversely related to the size of the basin [41].

3.2.2 Drainage density (Dd)

By definition drainage density of a basin is the total length of the streams of all orders per drainage area. Dd is expressed as the ratio of the total sum of all channel segments within a basin to the basin area i.e., the length of streams per unit of drainage density. It is a dimension inverse of length [9]. Drainage densities can range from less than 5 km/km^2 when slopes are gentle, rainfall low and bedrock permeable (e.g. sandstones), to much larger values of more than 500 km/km^2 in mountainous areas where rocks are impermeable, slopes are steep and rainfall totals are high [42]. The drainage density (Dd) of the study area is 0.4 km/km^2. Thus, in this study, the drainage density falls less than 5km/km^2 which indicates that the area has a gentle slope, low rainfall and permeable bedrock. Generally, lower values of drainage density tend to occur on granite, gneiss and schist regions. The rocks of the study area consists of highly metamorphosed sedimentary and basement complex rocks. This may have influenced the low drainage density observed in the drainage basin. It reflects the land use and affects infiltration and the basin response time between precipitation and discharge. It is also of geomorphological interest particularly for the development of slopes. On the other hand, a low drainage density indicates that most rainfall infiltrates into the ground and few channels are required to carry the runoff.

Dd is a measure of the texture of the network, and indicates the balance between the erosive power of overland flow and the resistance of surface soils and rocks. The factors affecting drainage density include geology and density of vegetation. The vegetation density influenced drainage density by binding the surface layer and slows down the rate of overland flow, and stores some of the water for short periods of time. The effect of lithology on drainage density is marked. Permeable rocks with a high infiltration rate reduce overland flow, and consequently drainage density is low.

3.2.3 Stream frequency (Fs)

The stream frequency (Fs) or channel frequency or drainage frequency of a basin may be defined as the total number of stream segments within the basin per unit area [2]. The stream frequency value of the study area is 0.11 indicating very low stream frequency (Fs) which can be attributed to the low relief and high infiltration capacity. The low stream frequency of the basin is indicating low relief and permeable sub surface material. The existence of less number of streams in a basin indicates matured topography, while the presence of large number of streams indicates that the stream is youthful and still undergoing erosion. It is an index of the various stages of landscape evolution. Number of streams in each order varied because of the physiographic conditions of particular area. Both values of stream frequency and drainage density show that Mayogwoi basin has a low relief and by implication has a low response to surface runoff and by implication low flood potential.

3.2.4 Drainage texture (Rt)

Horton [2] defined drainage texture as the total number of stream segments of all order in a basin per perimeter of the basin. The drainage texture is considered as one of the important concept of geomorphology which shows the relative spacing of the drainage lines [41]. Drainage texture is on the underlying lithology, infiltration capacity and relief aspect of the terrain. The drainage texture of the study area is 0.48. This shows that the basin has a very coarse texture. Smith have classified five different drainage textures related to various drainage densities as very coarse (below 2), coarse (2 - 4), moderate (4 - 6), fine (6 - 8) and very fine (8 and above). Drainage texture depends on a number of natural factors such as climate, rainfall, vegetation, rock and soil types, infiltration capacity, relief and stage of development. Weak rocks devoid of vegetative cover produce fine texture, while rocks which are hard and with vegetative cover produce coarse texture. The higher the drainage texture, the more the dissection and erosion in the basin.

3.2.5 Basin shape (Rf)

The shape of the basin mainly governs the rate at which water is supplied to the main channel. Three parameters viz. Elongation Ratio (Re), Circulatory Ratio (Rc) and Form Factor (Rf) are used for characterizing drainage basin shape, which is an important parameter from hydrological point of view. The basin has an elongation ratio (0.66), circularity ratio (0.64) and form factor (0.35) which indicates that the shape of the basin represent oval shape tending towards elongation. The oval basin tending towards elongation indicates that the basin will have a flatter peak of flow for longer duration. Basin shape reflects the way that runoff will bunch up at the outlet. A circular basin would result in runoff from various parts of the basin reaching the outlet at the same time. An elongated basin having the outlet at one end of the major axis and having the same area as the circular basin would cause runoff to be spread out over time, thus producing a smaller flood peak than that of the circular basin.

3.2.6 Basin perimeter (P)

Basin perimeter is the outer boundary of the drainage basin that encloses its area. It is measured along the divides between basins and may be used as an indicator of basin size and shape [36]. The basin perimeter of Mayogwoi basin is 84 kilometers.

3.2.7 Elongation ratio (Re)

Elongation ratio (Re) is defined as the ratio of diameter of a circle of the same area as the basin to the maximum basin length [38]. Values of elongation ratio ranging from 0 – 0.6 indicate rotundity and low degree of integration within a basin and values between 0.6 and 1.0 assumes pear shaped characteristics of a well-integrated drainage basin [5]. The value of Re varies from 0 (in highly elongated shape) to unity i.e. 1.0 (in the circular shape). Values close to 1.0 are typical of regions of very low relief, whereas that of 0.6 to 0.8 are usually associated with high relief and steep ground slope [5]. The Re value of the study area is 0.66. The basin in the study area assumed rotundity, tending towards pear shape, indicating more integration. It is a very important index in the analysis of basin shape which helps to give an idea about the hydrological character of a drainage basin. Circular watersheds are more efficient in the discharge of runoff. They are at greater risk from flood hazard because they have a very short lag time and high peak flows than the elongated basins. Elongated watersheds have low side flow for shorter duration and high main flow for longer duration and are less susceptible to flood hazard.

3.2.8 Circularity ratio (Rc)

The circularity ratio is a similar measure as elongation ratio, originally defined by Melton [6], as the ratio of the area of the basin to the area of the circle having same circumference as the basin perimeter. Schumm [36] described the basin of the circularity ratios of the range 0.4 to 0.5 as indicative of strongly elongated and highly permeable homogenous geologic materials. The calculated Rc value of the study area is 0.64 which indicates that the drainage basin is less elongated and is characterized by medium to low relief. Such drainage systems are partially controlled by structural disturbances [43].

The value of circularity ratio varies from 0 (in line) to 1 (in a circle). The circularity ratio (Rc) has been used as a quantitative measure for visualizing the shape of the basin and is expressed as the ratio of basin area (A) to the area of a circle (Ac) having the same perimeter as the basin [1,6,5]. It is affected by the lithological character of the basin. The ratio is more influenced by length, frequency (Fs), and gradient of streams of various orders rather than slope conditions and drainage pattern of the basin. It is a significant ratio, which indicates the dendritic stage of a basin. Its low, medium and high values are indicative of the youth, mature and old stages of the life cycle of the tributary basins.

3.2.9 Form factor (Rf)

Form factor is the numerical index commonly used to represent different basin shapes [9]. The value of form factor ranges between 0.1 to 0.8. The form factor value of the study area is 0.35 which indicate lower value of form factor and indicates that the basin is tending towards elongation. Basins with high form factors of 0.8, have high peak flows of shorter duration, whereas, elongated drainage basin with low form factors have lower peak flow of longer duration. Elongated basin with low form factor indicates that the basin will have a flatter peak of flow for longer duration. The Smaller the value of form factor, the more elongated will be the basin. Flood flows of such elongated basins are easier to manage than that of the circular basin [15].

3.3 Relief Aspects of the Study Area

Basin relief is an important factor in understanding the denudational characteristics of the basin. Relief is the difference between the maximum and minimum elevations in the basin. The maximum height of the Mayogwoi basin is 375 m and the lowest is 175 m. The relief of the basin is 200 m. The basin length, relative relief and relief ratio of the study area is presented in Table 3.

Table 3. Relief aspects of river Lamurde

S/No.	Morphometric parameters	Result
1	Basin length	32.3km
2	Relative relief	2.38
3	Relief ratio	0.074

3.3.1 Relief ratio (Rh)

This is a unitless measure of the overall gradient across a basin. It is calculated by dividing the relief (H) of a basin by its length (L). Relief is the altitudinal difference between the maximum and minimum elevation points in the basin. It is an important factor indicating the denudational characteristics of the basin. It is also an indicator of intensity of erosion processes and sediment delivery rate of the basin [5]. Normally the relief ratio is inversely proportional to the drainage area of the basin. The maximum elevation of the basin is 375 m, while minimum elevation is 175 m, with differences in height of 200 m. The relief ratio of the Mayogwoi basin is 0.074. The relative ratio of the basin is low, which is characteristics features of less resistant rocks. The low relative ratio (0.074) is due to low relief and gentle slope (Fig. 3). This implies low erosive energy of the stream and less sediment loss from this basin [36,44]. The lower values may indicate the presence of basement complex rocks that are exposed in the form of small ridges and mounds with lower degree of slope [45]. Low relief ratios also indicate that the discharge capabilities of the basin are low and chances of ground water potential are good [46].

3.3.2 Relative relief

Relative relief is defined as the differences in height between the highest and the lowest points (height) in a unit area. It is an important morphometric parameter used in the overall assessment of morphological characteristics of terrain [38]. Melton [47] suggested to calculate relative relief by dividing the difference of height between the highest and lowest points in the basin (H) with basin perimeter (P), thus relative relief = H/P. The relative relief of the study area is 2.38. Relative relief is calculated on the basis of highest and lowest elevations and the data of relative relief so derived are tabulated and classified into three categories viz. (i) low relative relief = 0 m – 100 m, (ii) moderately relative relief 100 m – 300 m and (iii) high relative relief = above 300 m.

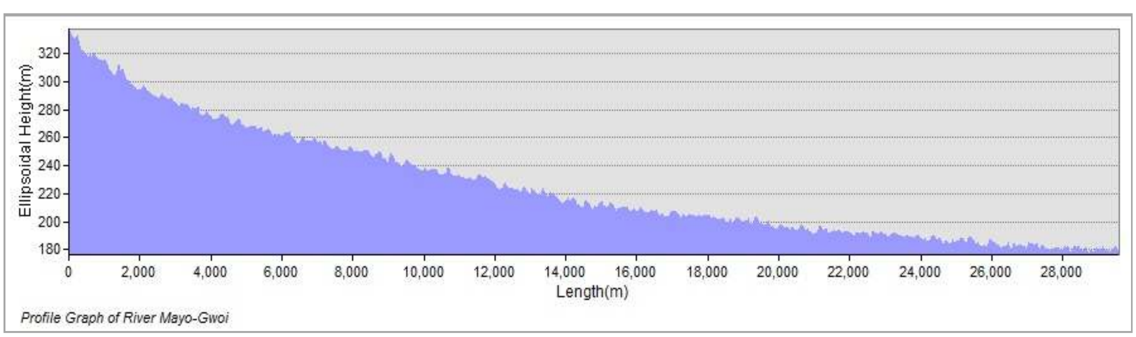

Fig. 3. Profile of river Mayogwoi

3.3.3 Basin length (Lb)

Basin length is the longest dimension of a basin to its principal drainage channel. The longer the length of a basin, the lower the chances that such a basin will be flooded when compared with a more compact basin. The length of the Mayogwoi drainage basin is 32.3 kilometers. Basin length (Lb) has been given different meanings by different workers [36,48-50]. The Lb is the longest length of the basin, from the catchment to the point of confluence [48].

3.4 Basin Morphometry and Flood Potentials of the Mayogwoi Basin

Basin morphometry is important in studying flood incidence in any given basin especially in ungauged and flood prone basin like the study area. It has been shown that basin morphometry controls its hydrologic response [51-54]. The values of the basin shape indicators such as elongation ratio (0.66), circularity ratio (0.64) and form factor (0.35) shows that the basin has oval shape tending towards elongation. The bifurcation ratio (Rb) value of 2.45 is indicative of low surface runoff, high infiltration and low chances of water to flood [2]. Stream perimeter is directly proportional to the area of basin and the curvature of the basin margin [36]. The basin drainage density of 0.4 km/km^2 is very low and indicative of regions of highly permeable or resistant subsoil material under dense vegetation. This will create low flood potential and high contribution to ground water. The low stream frequency of the basin (0.11) implies less number of tributaries and chances of collecting water into the main trunk stream resulting in low flood potentials. These characteristics would cause runoff to be spread out over time, thereby producing smaller flood peak than that of the circular basin.

Factors that might have contributed to the low potentials of flooding in the Mayogwoi river basin include lower drainage density, low stream frequency, lower relief, low bifurcation ratio and circulatory ratio. The results of the morphometric parameters show that the basin has a low relief and by implication has a low response to surface runoff. This also points to the fact that there will hardly be enough water supplies to support large scale water resources development projects particularly hydropower and large irrigation project in the region except with intensive development of the land and water resources of the region.

4. CONCLUSION

The morphometric analysis of Mayogwoi drainage basin has been carried out through measurement of linear, areal and relief aspects of basins using GIS technique. The result of the study shows that the study area is a fourth order drainage basin. The stream network shows a dendritic pattern, indicating the homogeneity in texture and lack of structural control. The mean bifurcation ratio of the basin is 2.45; an indication of low flood potential in the basin. The values of circularity ratio (0.64), elongation ratio (0.66) and form factor (0.35) indicates that the basin is moderately circular and somewhat elongated. The length of overland flow of the basin in the study area is 1.25, indicating matured topography and low surface runoff in the study area. The low drainage density (0.4 km/km^2) and low stream frequency (0.11) is indicative of low relief, low surface flow, high infiltration and consequently low flood potentials of the basin. The basin has a low relief ratio (0.074) and low relative relief (2.38) indicating low relief and gentle slope. The result of the findings also shows that the basin has a short length of 32.2 km indicative of higher chances of the basin been flooded after heavy rainfall of short duration. Consequently, the result shows that there will hardly be enough water supplies to support large scale water resource development prospects particularly irrigation and hydropower project in the basin except with intensive development of land and water resources of the basin. Thus, high intensity of rainfall is required for the generation of a flash flood in the drainage basin because of its relatively small basin size. The morphometric parameters of the basin therefore suggest low to moderate flash floods chances and high potential of groundwater aquifers recharge in the basin. Thus, heavy rainfall is the most important flash flood - causing factor, followed by morphometric characteristics and land uses of the basin. This study therefore recommends the need for flood forecasting and early warning system which comprises of precipitation measuring Doppler radar, weather surveillance radar and Meteor burst communications for the transmission of hydrometric data.

COMPETING INTERESTS

Author has declared that no competing interests exist.

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