International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 15 Issue 06 , June - 2026

Feasibility Study of the Newly Proposed Embankment on Both Banks of Kalajal River From Rangia-goreswar Railway LINE to National Highway-31

Meghna Sharma[1], Prajna Parmita[2], and Bibhash Sarma[3]

[1]Assistant Professor, Department of Engineering and Technology, University of Science and Technology, Meghalaya, India.

[2]Assistant Professor, Assam Engineering College, Jalukbari, Guwahati, Assam, India.

[3] Professor, Assam Engineering College, Jalukbari, Guwahati, Assam, India.

ABSTRACT

The Kalajal River of Assam, India, is generally calm. Though occasional marginal overflow occurs at some places, the river does not cause enough damage. Major flood situations occurred during 2004 and 2022, when the embankments of two other rivers, Puthimari and Suklai, breached upstream. The Kalajal River acted as an escape route for the spilled waters from these two rivers. So, the construction of new embankments is proposed in the Kalajal River. In this study, the feasibility of the newly proposed embankments is evaluated through field visits and morphometric analysis. Technically, an embankment system in the Kalajal River can be constructed by taking care of surface and groundwater hydrology, geotechnical parameters, and topography of the area, but analysis of the Kalajal River catchment has shown that an embankment system in the Kalajal River may be counterproductive in the long run. From the study, it is found that though the newly constructed embankments will prevent the spilled flood water from Puthimari and Suklai rivers from entering Kalajal river, the embankments will serve as a boundary between Puthimari and Kalajal river, enclosing a vast, substantial area susceptible to prolonged waterlogging. Hence, some alternative ideas are proposed to mitigate the flood in the Kalajal River caused by spilled water.

Keywords: embankment, breaching, morphometric analysis

1.INTRODUCTION

The Kalajal River is a minor yet significant tributary of the Brahmaputra River, flowing through the Kamrup district of Assam, India. The ecosystem and socio-economic life of the community living in the area are governed by the Kalajal River. Though the river is usually calm, it caused significant havoc in 2022, and many people had to stay in temporary makeshift arrangements away from their homes. In the year 2022, the maximum water level in the Kalajal River had almost touched the bottom of the bridge on NH-31. This had created drainage congestion just upstream of NH 31. To relieve the possibility of future floods, a new embankment on the Kalajal River was proposed from the Rangia-Goreswar railway line to National Highway-31, Assam, India. In this study, the feasibility of this newly proposed embankment is carried out using morphometric analysis and site visits.

The Kalajal River in the Baska and Kamrup districts of Assam is rainfed. The river originates around Kukaldonga (near the zero chainage point of the Puthimari embankment) and carries the waters from neighbouring crop fields. The river flows almost parallel to the river Puthimari, on

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 15 Issue 06 , June - 2026

its eastern side, crosses N.H. 31 and the Guwahati-Rangia railway line, and ultimately falls into the Hazo river. Hazo River is a North bank tributary of the Brahmaputra River. Figure 1 shows the compass map of the Kalajal River, and Figure 2 shows the relative location of the Kalajal River with respect to other major drainage systems in the region. The Kalajal river catchment area up to Bridge point on NH 31 is small (only 530.94 sq. Km). The drainage pattern of the Kalajal River Catchment is dendritic, with a total number of streams of 710. There are 446 1st order streams, 129 2nd order streams, 99 3rd order streams, 23 4th order, and 13 5th order streams out of 710. Morphometric analysis shows that the basin is very elongated and has a low peak flow for a longer duration. The area has a gentle to moderate slope with permeable bedrock and less resistant rocks. Deep recharge capabilities of the basin are low, and the groundwater table is at a very shallow depth.

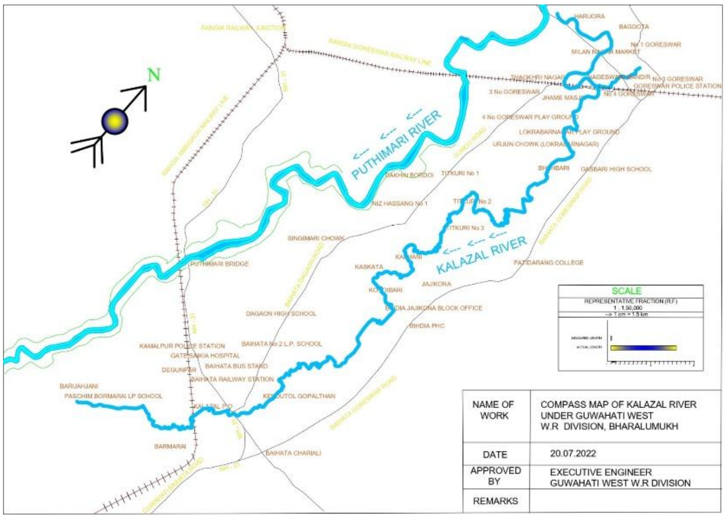

Fig. 1: *The compass map of Kalajal river (Source: Water Resources Department, Govt of Assam)*

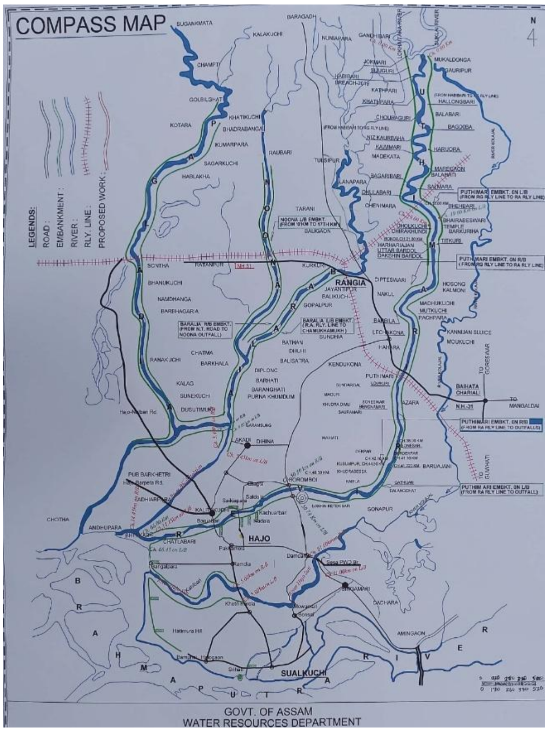

Fig. 2: *Relative location of Kalajal river with respect to other major drainage system (Source: Water Resources Department, Govt of Assam)*

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 15 Issue 06 , June - 2026

2. MORPHOMETRIC ANALYSIS OF KALAJAL RIVER CATCHMENT CONSIDERING BRIDGE ON NH 31 AS OUTLET

The analysis of morphometric parameters is an essential part of hydrological investigations as it provides critical insights into watersheds (Shekar et al., 2024). The main objective of morphometric analysis is to find out the drainage characteristics to explain the overall evaluation of the basin and to prepare different thematic maps, like DEM of the Catchment, drainage, flow direction, flow accumulation, soil erosion status, aspect, and slope. Morphometric analysis involves quantitative interpretation of various land and basin characteristics of the study area such as area, altitude, volume, slope, profiles etc. (S. Singh,1972). The watershed morphometric characteristics included in this study are: Area of watershed, perimeter, Bifurcation ratio, Elongation ratio, Circulatory Ratio, Form factor, Stream order, Drainage density, Average slope of watershed, Main stream channel slope, etc. Drainage networks are delineated using ArcMap 10.8.2 and the DEM of ASTER. The flow chart for the methodology adopted for morphometric analysis is shown in Figure 3.

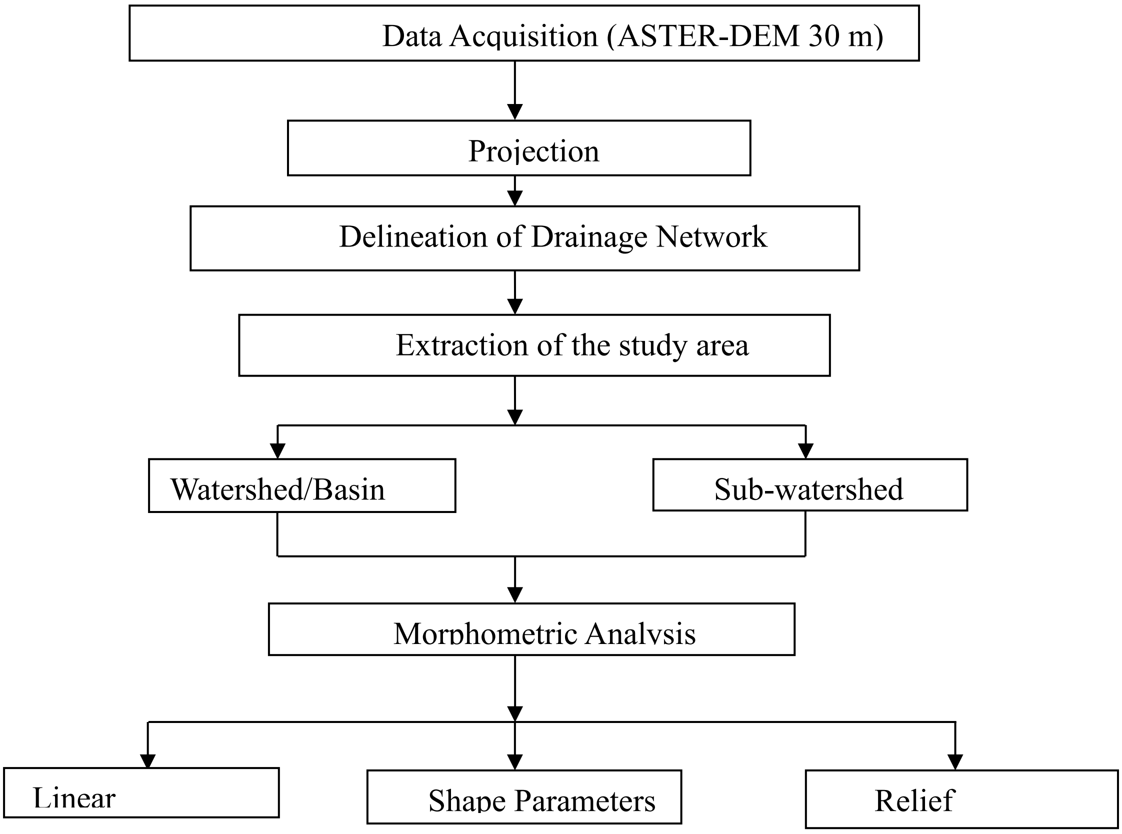

Fig. 3: flow chart for morphometric analysis of watershed

3. RESULTS AND DISCUSSIONS

3.1 Drainage analysis and Values of Morphometric parameters

The morphometric analysis of the parameters, namely area of the basin and perimeter of the basin are obtained from the sofware ArcGIS 10.8.2 and other parameters such as srtream order, stream length, drainage density, relief ratio, bifurcation ratio, elongation ratio, drainage frequency, basin length, drainage texture, ruggedness number, constant of channel

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 15 Issue 06 , June - 2026

maintenance, form factor, stream length ratio, circulatory Ratio etc are calculated using various mathematical formulae from the topographic maps derived from ASTER DEM in GIS software. Table 1 below shows the lengths and number of streams associated with each stream order. Table 2 represents the Values of Morphometric parameters.

Table 1: *Drainage analysis obtained from ASTER DEM and its results*

Stream order	**No. of Streams (N_u)**	**Length of Streams (km) (L_u)**
1	446	199.75
2	129	88.24
3	99	76.07
4	23	29.46
5	13	12.48
	Total = 710	**Total = 405.60**

Table 2: *Results of Morphometric parameters*

Sl No	**Morphometric parameters**	**Unit**	**Results**	**Significance**
1	Area, A	Sq. Km	530.94	The larger the area, the larger the runoff and vice versa
2	Basin Perimeter, P	Km	191.66	The basin perimeter affects the elongation and circulatory ratios.
3	Basin Length, L_b	Km	55.50	Peak discharge decreases as the length of the basin increases.
4	Total no of Streams, N_u	Nos	710	Higher value means high drainage frequency
5	Total stream length, L_u	Km	405.6	A small value signifies a hilly area; a large value signifies a flat area.

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 15 Issue 06 , June - 2026

6	Drainage Density, D_d	Km/ Sq. km	0.764	A low value indicates a flat region with permeable underlying strata. It's a metric for how well or badly a stream channel drains a watershed.
7	Constant of Channel maintenance, C_m		1.309	Low value indicates rocky impermeable underlying strata.
8	Total Relief, H	Km	0.305	Increases with an increase in the elevation difference between the source and the outlet of the stream.
9	Length of Overland Flow, L_o	Km	0.654	An independent variable that has a significant impact on the amount of water needed to meet a certain erosion threshold. This element is inversely proportional to the channel's average slope.
10	Drainage Frequency, D_f		1.337	It mainly depends on the topographical features and the drainage network of the area. Lower values of stream frequency indicate a lower volume of surface runoff. Higher stream frequency is related to impermeable subsurface material, sparse vegetation, high relief conditions, and low infiltration capacity.
11	Drainage Texture, T	Unit/ Km	3.704	Coarse drainage texture (2<value<4)
12	Form Factor, R_f		0.172	Smaller value signifies an elongated watershed and longer time of concentration, low peak flows of longer duration Duration.

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 15 Issue 06 , June - 2026

13	Bifurcation Ratio, R_b		2.708	Bifurcation ratio is lower in the alluvial region as compared to the hilly areas. Relatively high value signifies hilly terrain, and the water body is prone to flooding during the rainy season.
14	Stream Length Ratio, R		0.529	
15	Elongation Ratio, R_e		0.468	A smaller value means an elongated watershed. Indicates more elongation and is more prone to erosion and sediment load, with less infiltration capacity.
16	Circulatory Ratio, R_c		0.182	A smaller value means an elongated watershed. A lower value of the circulatory Ratio indicates a less circular shape of a basin, slower discharge, and a lower possibility of erosion.
17	Relief Ratio, R_h		0.0055	Higher values indicate the existence of basement rocks exposed in the form of small ridges and mounds with a lower degree of slope, while higher values indicate the strength of erosion processes and sediment delivery rate of the basin, while lower values indicate the presence of basement rocks exposed in the form of small ridges and mounds with a lower degree of slope.
18	Relative Relief, R_r		0.0016	Increase with an increase in total relief.
19	Ruggedness Number, R_n		0.232	A lower value means a basin with a relatively flat area and a low drainage level.

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 15 Issue 06 , June - 2026

The values of form factor, circulatory Ratio, and elongation Ratio of the study area show that the basin is very elongated and thus has a low peak flow of longer duration. Consequently, the flood flow of this type of basin is more difficult to manage than that of a circular basin. Drainage density (D_d) of the study area is 0.764 km/km^2. Thus, in this study, the drainage density falls less than 5 km/km^{2,} which indicates that the area has a gentle to moderate slope with permeable bedrock. The relief ratio and relative relief of the basin are low, which is a characteristic feature of the presence of less resistant rocks. Low relief ratios also indicate that the deep recharge capabilities of the basin are low and chances of deep groundwater percolation are poor, i.e., if there is surface runoff, the groundwater table would be at a very shallow depth. The mean bifurcation ratio calculated for the study area is 2.708, which indicates that the drainage pattern is not affected by geologic structures.

From the facts observed during the site visit, it is known that the Kalajal River is generally calm. Though occasional marginal overflow occurs at some places, the river does not cause much damage. As per the narrated history of the region by the residents, major flood situations occurred only in the years 2004 and 2022. Both in these years, the embankments of Puthimari and Suklai were breached upstream, and water from these two rivers entered the Kalajal river. The Kalajal River acted as an escape route for this floodwater. If there had been embankments in the Kalajal River, the spilled flood water from the Puthimari and Suklai rivers could not have entered the Kalajal River, and vast areas between the Puthimari and Kalajal rivers would have been underwater for a longer period.

Technically, an embankment system in the Kalajal River can be constructed by taking care of surface and groundwater hydrology, geotechnical parameters, and topography of the area, but findings of the visit and the results of the morphometric analysis of the Kalajal River catchment have shown that an embankment system in the Kalajal River may be counterproductive in the long run. So, it is recommended that the idea of the construction of a new embankment on both banks of the Kalajal River be dropped from the Rangia-Goreswar Railway Line to the National Highway-31. However, the river section just upstream of the NH-31 may be resectioned to reduce drainage congestion at that point.

4. CONCLUSION

The maximum water level in the Kalajal River in 2022 had almost touched the bottom of the bridge on NH-31. This had created drainage congestion just upstream of NH 31. The presence of an embankment system on either bank to confine the water would increase the

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 15 Issue 06 , June - 2026

water level. It would give additional horizontal thrust to the bridge and its abutments and to the embankment system. The Kalajal High School, which would fall within the river and the embankment, would also be damaged.

Field investigations indicated that the presence of a shallow groundwater table and extensive low-lying depressions would significantly compromise the performance of embankments constructed as per existing design specifications without incorporating core cutoff walls. The observations obtained from the field can be further supported through numerical or mathematical modelling developed for the study area.

References

1. Shekar, P. R., Mathew, A. (2024), "Morphometric analysis of watersheds: A comprehensive review of data sources, quality, and geospatial techniques". *Watershed Ecology and the Environment,* Vol 6, pp 13-25.
2. Singh, S. (1998), "Physical Geography", Prayag Pustak Bhawan, Allahabad, India.