

## **MORPHOMETRIC ANALYSIS OF DRAINAGE BASIN AT AND AROUND SYLHET CITY: A REMOTE SENSING & GIS BASED APPROACH.**

**Emruz Arafat<sup>1</sup>, Sohana Alam Promi<sup>2</sup> and Aqib Mahmood\*<sup>3</sup>**

<sup>1</sup>Student, Bangladesh University of Engineering & Technology, Bangladesh, e-mail: [emruz10826@gmail.com](mailto:emruz10826@gmail.com)

<sup>2</sup>Student, Bangladesh University of Engineering & Technology, Bangladesh, e-mail: [sohanapromi@gmail.com](mailto:sohanapromi@gmail.com)

<sup>3</sup> Student, Khulna University of Engineering & Technology, Bangladesh, e-mail: [aqb.mahmood@gmail.com](mailto:aqb.mahmood@gmail.com)

**\*Corresponding Author**

### **ABSTRACT**

Rapid urbanization, industry, and population growth deplete land and water resources. Due to rising demand, these resources must be optimally used for sustainable development. A comprehensive morphometric analysis of the Surma river basin was done. This study looked at both the linear and the area-based morphometrics of the basin using remote sensing techniques. The study's methodology includes calculating the Topographic Wetness Index (TWI), Topographic Roughness index (TRI), Sediment Transport Index (STI), Stream Power Index (SPI) and Drainage Density (DD) for Sylhet Sadar, Golapganj, Bishwanath thana area, which includes the Surma basin. One of the factors that impacts the watershed's hydrological process is the drainage density. Reduced material permeability, low vegetative cover, and moderate to high basin relief are all signs of a high drainage density. The research result show that high drainage density and high flood hazard concentrates in Sylhet Sadar with respect to Bishwanath & Golapganj. The data indicates that there is relatively high risk in Sylhet Sadar because very low hazards are reported to be 62.81 percent, 84.88 percent, and 63.36 percent in Sylhet Sadar, Golapganj, and Bishwanath, respectively. When drainage density is high, flood peaks are higher, and when it's low, flood levels are lower. The basin's modest drainage density suggests that the subsurface and vegetation cover be quite permeable. This parameter indicates a higher probability of flooding in Sylhet Sadar than in Golapganj and Bishwanath. STI accounts for topography-induced erosion. It describes erosion and deposition. Flood conditioning factors like STI characterize water-borne sediment transport. STI ranged from 47.75 to 3044.08. The values are grouped into five groups. Very low (0-47.75), low (47.76-226.81), moderate (226.82-549.12), high (549.13-1074.38), very high. Areas with higher STIs move more sediment. The study shows that Sylhet Sadar has a higher Sediment Transport Index than Bishwanath & Golapganj. Sylhet Sadar has significant danger, according to statistics. Sylhet Sadar, Bishwanath, and Golapganj had STI high values of 3044.08, 2484.34, and 2441.91 percent. The TWI helps determine upslope moisture and contributing locations. These non-dimensional indicator values depend on the region's topography and DEM resolution. Raw TWI indications are usually -3 to 30. TWI ranged from 0.61 to 21.24. The data are classed as extremely low (0.61-5.27), low (5.28-8.61), moderate (8.62-12.27), high (12.28-16.80) and very high (16.81-21.24). The study found that Sylhet Sadar has a higher Topographic Wetness Index than Bishwanath and Golapganj. Sylhet Sadar has significant danger, according to statistics. . TWI map moisture and contributing areas on upslope slopes. After analyzing all of the parameters, we determined that Sylhet Sadar will be more vulnerable than Golapganj and Bishwanath. Lower slope, high flow accumulation, high terrain roughness index (TRI), topographic wetness index (TWI), stream power index (SPI), and sediment transport index (STI) are all calculated.

**Keywords:** *Morphometric Parameter, Remote Sensing, Drainage Density, Sediment Transport Index.*

## 1. INTRODUCTION

Bangladesh is situated at the bottom section of the basins of the three big rivers, the Ganges, the Brahmaputra, and the Meghna. The nation is deltaic. The primary geographical characteristic of the nation is the vast river floodplain and all of the rivers that flow into and out of it. In fact, about four-fifths of Bangladesh is floodplain (JAHIR UDDIN CHOWDHURY, 1997). Floods are regular natural disasters that damage people, infrastructure, and properties and indirectly affect the economy (IBRAHIM N.F ZARDARI N.H., 2017). Thus, flood damage mitigation requires flood prone area identification. Hydrological models and land surface characterization can anticipate geomorphic processes and runoff over Earth and a wide river basin. Digital elevation models (DEMs) are frequently employed for the purpose of characterizing land surfaces and facilitating the analysis of topographic features, especially for expansive drainage basins, through the utilization of hydrological models (MOORE I.D, 1991). Advancements in the availability of GIS and Digital Elevation Models (DEM) in the last few years have allowed for the depiction of more comprehensive and precise surface topography (BUCHANAN B.P, 2014). Due to advancements in hydrological models, there has been a notable improvement in accuracy, level of detail, and reduction in time required (LACROIX M.P., 2002). Many scientific, engineering, and planning applications commonly utilize various elements and land surface features obtained from hydrological models (Montgomery, 1994). Some of the many important fields that make use of DEM-processed topographical and hydrological data are species distribution modelling, climate modelling, agricultural suitability analysis, tree species modelling, hydrological modelling, and risk assessment for landslides and floods. Researchers from all around the world collaborated to take measurements and analyse the data using digital elevation models in order to determine whether or not there was a connection between landslides and a variety of topographical, morphological, and hydrological aspects (DEMs) (BUDIMIR M.E.A, 2015). These factors included things like the aspect of the slope, the slope angle, the elevation, the plan curvature, the profile curvature, the general curvature, the topographic wetness index (TWI), the stream power index (SPI) and the distance to the stream density, amongst other things. In the context of the mapping and evaluation of landslide susceptibility, independent variables include these features, whereas dependent variables are made up of landslides (CHOWDHURY M.S., 2022). The utilization of these parameters has experienced a surge in popularity as a result of the widespread accessibility of open-source digital elevation model (DEM) data encompassing the entire planet. The factors can be derived from a Digital Elevation Model (DEM) using Geographic Information System (GIS) software, such as ArcMap. ArcMap is a very advanced geographic information system (GIS) software that facilitates the manipulation of raster data and the storage of individual cell data within the raster. In addition to numerous built-in tools, the raster calculator offers a range of advanced analytical capabilities that prove highly advantageous in the application of physically based hydrological models. This section focuses on the utilization of ArcMap software for hydrological modelling, which proves to be highly advantageous, particularly in the domain of hazard modelling. The Ganges, Brahmaputra, and Meghna rivers of Bangladesh are among the world's main rivers. The cumulative drainage basin of the G-B-M river system spans 1.74 million square kilometres, encompassing regions of China, India, Nepal, Bhutan, and Bangladesh. The G-B-M river system discharges into the Bay of Bengal via a solitary exit located in Bangladesh, with just 8% of the total drainage area falling inside the borders of Bangladesh. The combined size of the three basins is 1.72 million square kilometres. The primary factor leading to riverine floods in Bangladesh is the abundant precipitation in the GBM basins. There are 57 rivers that have their source beyond the borders of Bangladesh. Approximately 1.18 trillion cubic meters of water are discharged into the sea each year, with 1.07 trillion cubic meters (equivalent to 91%) entering. Bangladesh receives water from the catchments located upstream. The rest is attributed to the cumulative effect of precipitation occurring inside the boundaries of the area. Although the basin area is less in comparison (JAHIR UDDIN CHOWDHURY, 1997).

## 2. METHODOLOGY

The methodology of the study consists of obtaining the TWI, SPI, STI, and Drainage Density from the Sylhet, Bishwanath, and Golapganj subdistrict areas, which contain the Surma Basin. Figure depicts the systematic development of this study's technique using a flow diagram. The section that follows provides a brief description of the methodology used in this investigation. Figure 1 depicts a detailed description of the method's workflow.

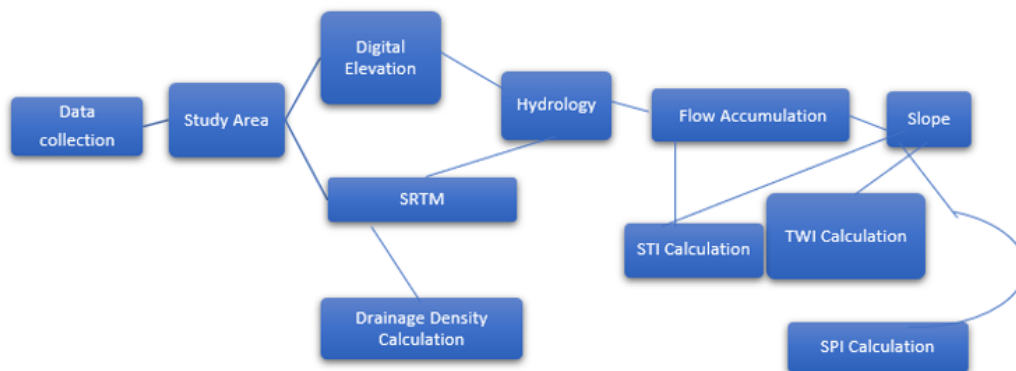


Figure 1: Methodology Flow Chart

### 2.1 Study Area

Bangladesh, situated in the delta of the Ganges, Brahmaputra, and Meghna (GBM), three major rivers, is extremely prone to flooding. A tributary of the Meghna River is the Surma. The Meghna River traverses the Sylhet District. Fisheries, navigation, and the provision of domestic and industrial water in Sylhet, Bishwanath, and Golapganj may all be affected by the Surma basin. The 2nd Sub-heading. The study areas are selected between Latitude and Longitude  $24^{\circ} 53' 30.12''$  N and  $91^{\circ} 52' 59.88''$  E,  $24^{\circ} 51' 29.88''$  N and  $92^{\circ} 01' 14.88''$  E,  $24^{\circ} 48' 29.88''$  N and  $91^{\circ} 45' 50.04''$  E for Sylhet Sadar, Golapganj and Bishwanath respectively. Figure 2 represents the study area.

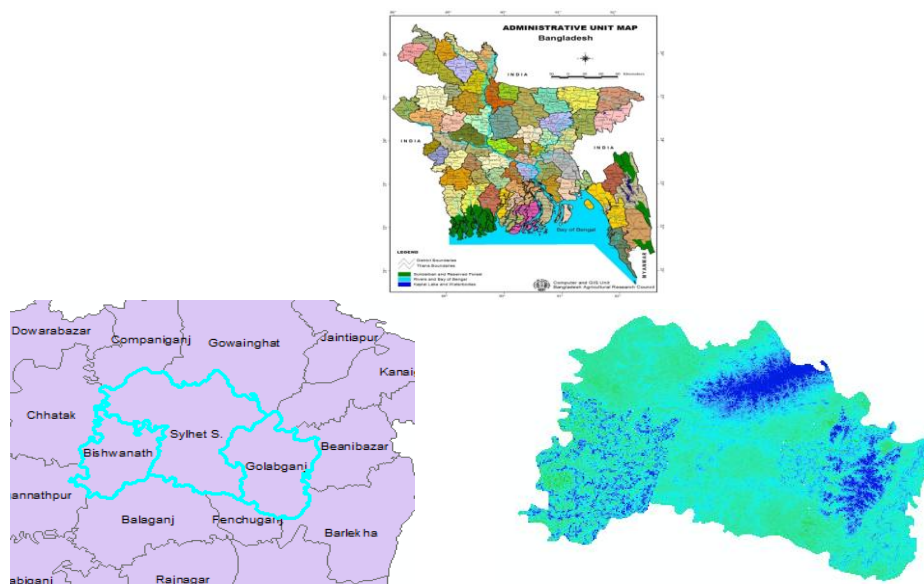


Figure 2: Map showing selected location of study area at Sylhet Sadar, Golapganj, Bishwanath.

## 2.2 Data Collection

The digital elevation data was available for free download at [www.glovis.usgs.gov](http://www.glovis.usgs.gov) and [www.earthexplorer.usgs.gov](http://www.earthexplorer.usgs.gov), both of which are websites operated by the USGS. The corresponding path and row numbers are 137 and 43, respectively. Following the modification of multiple DEM data sets with ARCGIS, the data was analysed with ArcGIS. The Agricultural Research Council of Bangladesh supplied the Golapganj, Sylhet Sadar, Bishwanath shape file.

### 2.2.1 Drainage Density

- Step 1: The study area is used to cut the DEM. Next, the DEM is filled in. The fill tool keeps iterating until every sink inside the designated z limit is filled. Others are formed around the edges of the filled areas as sinks are filled, and they are eliminated in the subsequent cycle.
- Step 2: A raster showing the flow direction between each pixel and its neighbour, which is the steepest downslope, is generated using a surface as input by the Flow Direction raster function.
- Step 3: The output raster's cumulative flow is determined using the Flow Accumulation tool, which measures the total weight of all the cells that flow into each downslope cell.
- Step 4: A particular stream is chosen using map algebra in Step 4. The figures selected here are not predetermined. More specific stream network information is located with this. The value selected is not subject to any criteria. Users frequently tinker until an output that resembles an aerial photo or topographic map is obtained. Any value can be chosen until the output resembles your topographic or aerial image.
- Step 5: Stream Link: A link joins two junctions that come after it in a stream channel segment, or a junction with the drainage split or the outflow.
- Step 6: The stream was Divided according to the hierarchy. The order of the stream determines flow based on its tributaries.
- Step 7: The data was projected using the local projection system.
- Step 8: Grid index was created along the basin.
- Step 9: The grid was clipped using the basin area, and the length was determined. The length and basin grid were now connected. Area of the Grid Basin was Computed. Units are identical; DD stands for drainage density.

These represent a certain grid area's drainage density

### 2.2.2 Topographic Wetness Index (TWI)

In a significant way, the hydrological conditions shape the landscape. Topography is just the undulation or unevenness of the surface. This topographic irregularity imposes a first-order constraint on the spatial variability of a region's hydrological characteristics (Sørensen R., 2006). Topographic wetness index (TWI) was first proposed by Beven and Kirkby (1979) (Beven K.J, 1979). Water storage capacity and surface saturation of the soil in a basin are used to calculate runoff generation over the surface of the basin using equation 1 established by Beven and Kirkby (1979) (Beven K.J, 1979). The TWI can be used to pinpoint the source and extent of water damage on steep slopes. TWI can be calculated by following equation.

$$TWI = \ln\left(\frac{\alpha}{\tan \beta}\right) \quad (1)$$

The formula  $\tan(\beta)$  represents the frequency distributions of the slope and sharpest downslope directions, where  $\beta$  is the upslope contributing area per unit contour length and is the slope angle. To determine the local storage capacity of a basin under steady-state conditions, Beven and Kirkby (1979) devised a model (Beven K.J, 1979). Accumulation of water at a fixed location in a constant state. The influence of gravity on water flow at any given location is represented by the local slope  $\tan(\beta)$ , defined by Eq. (1) (Pourali S.H, 2016). The following procedures are used to determine this in ArcMap:

$$\text{Slope } S = (\text{"Slope\_1.tif"} * 1.570796) / 90 \quad (2)$$

$$\text{Tan slope} = \text{Con}(\text{"Slope\_s"} > 0, \text{Tan}(\text{"Slope\_s"}), 0.001 \quad (3)$$

This limitation allows us to set the Slope s equal to 0.001 when s is less than 0. Avoid using the zero value when calculating the tan slope in the raster file. For analytical purposes, this number is meaningless. TWI will be determined using equation 1. "Flow accumulation" raster has some 0 values that will be undefined in the computation process and will generate mistakes. This mistake (the 0 value) can be fixed by rescaling the "flow accumulation" raster by 1. Using the flow accumulation multiplied by the pixel size, the flow path may be determined (Chowdhury, 2023).

$$\text{Rescaled flow accumulation} = (\text{"FlowAccu.tif"} + 1) * \text{cell size} \quad (4)$$

Rescale flow accumulation, then use the Tan slope from equation 1 to derive the TWI. Then the final Equation 1 yields the Tan slope, which is divided by the Rescaled flow accumulation, to get the TWI.

### **2.2.3 Stream Power Index (SPI)**

An additional topographical element, the Stream Power Index (SPI) is computed using the area of flow accumulation and slope as inputs. A channel's erosive capacity and the terrain's suitability for deposition can be measured using the Stream Power Index (SPI) (shown by low or negative values) or erosion (indicated by positive values). The calculation of the Stream Power Index (SPI) for the designated research region was performed utilizing the specified command line within the Raster Calculator tool (Ahmad I., 2019). The technique for calculating the Stream Power Index (SPI) in ArcMap

$$\text{"FlowAcc.tif"} * \text{cell size} * \text{Tan}(\text{"Slope\_1"} * 0.017453) \quad (5)$$

### **2.2.4 Slope**

In the hydrological analysis, the initial step involves the calculation of flow direction and flow accumulation. Subsequently, the slope is determined using the Hydrology tool available in the Arc toolbox.

### **2.2.5 Sediment Transportation Index (STI)**

Critical information regarding the potential for sediment transport through the stream network can be obtained from the STI. It takes topographical influence on erosion into consideration (Mojaddadi, 2017) and Therefore, As a flood conditioning factor, it is used to describe the processes of erosion and deposition and to describe the movements of sediments in water generated by flow (Kalantari, 2014). STI offers data on the capacity and buildup of sediment transport, as well as their spatial distribution (Ahmad I., 2019). The Moore and Wilson (1992) approach is the most suitable for integration into a GIS platform to measure STI. The non-linear connection between specific discharge and slope is represented by STI, a dimensionless index, according to Moore and Wilson (1992). To calculate the STI (Spectral Transform Index) in ArcMap, use the following command line in the "raster calculator" function (Bannari A, 2017).

$$\text{Power}(\text{"flow accumulation"} / 22.13.0.6) * \text{power}(\text{sin}(\text{"slope"}) / 0.0896, 1.3) \quad (6)$$

### **2.2.6 Topographic Roughness Index (TRI)**

Topographic roughness is a term that can be used interchangeably with terrain complexity, surface roughness, and rugosity. The term refers to the divergence of the orientation of a normal vector of a specified surface from its intended or ideal shape (Whitehouse, 1994). The roughness of terrain is a

measure of the difference in elevation between a central cell and its adjacent cells. Riley et al. (1999) present the methods for calculating terrain roughness, a regularly employed technique for preparing spatial data related to landslides (Riley S.J, 1999).

With ArcGIS's "focal statistics" tool, you may calculate the statistics of a focal cell inside a predefined moving frame. Using the data from a selected neighbourhood, this tool calculates a statistic for each input cell location. Finding the maximum, minimum, and average values of a cell relative to its neighbours is essential for this computation. Just enter the parameter you want to use in the "focal statistics" interface, and the numbers will be calculated. The TRI values for every cell are then calculated using the following command.

$$TRI = ("mean\ dem" - "minimum\ dem") / ("maximum\ dem" - "minimum\ dem") \quad (7)$$

### 3. RESULT AND DISCUSSION

The river network significantly impacts flow formation and characteristics, contributing to floods in the basin. The varied terrain and high slope of the Surma basin make determining its drainage density a challenging task. Table 1 shows the susceptibility class score and flood conditioning factors such as drainage density, TWI, TRI, Slope for our three-study area (Sylhet Sadar, Golapganj, Bishwanath).

Table 1: classification of susceptibility for each of the causal factors

Location		Sylhet Sadar	Golapganj	Bishwanath
Criteria	Class & Ranges	Area Percentage	Area Percentage	Area Percentage
<b>Topographic Wetness Index (TWI)</b>	Very low (0.61-5.27)	39.12	0.096	0.002
	Low (5.28-8.61)	25.46	60.82	57.92
	Moderate (8.62-12.27)	15.48	25.99	28.28
	High (12.28-16.80)	15.92	12.18	12.90
	Very high (16.81-21.24)	4.00	0.89	0.88
<b>Topographic Roughness Index (TRI)</b>	Very low (0.01-0.47)	3.94	47.03	41.05
	Low (0.48-0.58)	19.85	41.63	46.33
	Moderate (0.59-0.66)	30.32	9.67	10.78
	High (0.67-0.75)	31.19	1.57	1.74
	Very high (0.76-1)	14.67	0.07	0.08
<b>Slope</b>	Flat (0-1.15)	39.53	41.92	46.29
	Gentle (1.16-2.74)	34.76	34.29	36.91
	Moderate (2.75-5.22)	17.70	18.40	15.73
	Steep (5.23-8.85)	6.01	4.91	1.04
	Very steep (8.85-22.56)	2.00	0.46	0.01
<b>Drainage Density (1/Km)</b>	very low hazard (0 to 0.5)	62.81	84.88	63.36
	low hazard (0.5 to 1.0)	32.99	15.11	36.34
	moderate hazard (1.0 to 1.5)	4.2	0.00	0.00
	High Hazard (1.5 to 2.0)	0.00	0.00	0.00
	Very High Hazard (2.0 to 2.5)	0.00	0.00	0.00

### 3.1 Drainage Density

A characteristic that impacts the hydrological process of the watershed is the drainage density. Reduced material permeability, low vegetation cover, and moderate to high basin relief are all signs of a high drainage density. The research results show that high drainage density and high flood hazard concentrates in Sylhet Sadar with respect to Bishwanath & Golapganj. Figure 6 indicates that there is relatively high risk in Sylhet Sadar because Very low hazards are reported to be 62.81 percent, 84.88 percent, and 63.36 percent in Sylhet Sadar, Golapganj, and Bishwanath, respectively. Low drainage density results in lower flood levels, but high drainage density causes flood peaks to rise. The basin's moderate drainage density suggest that the subsurface and vegetation cover are very permeable. The risk of flooding is higher in river basins that are not wooded than in those that are. This is due to interception. Figure 6 shows a comparison of the drainage density data for Sylhet Sadar, Golapganj, and Bishwanath in terms of the area percentage of low, moderate, and high dangers. Figure 3, Figure 4, and Figure 5 show the classed pictures of the drainage density in Sylhet Sadar, Golapganj, and Bishwanath, India, respectively.

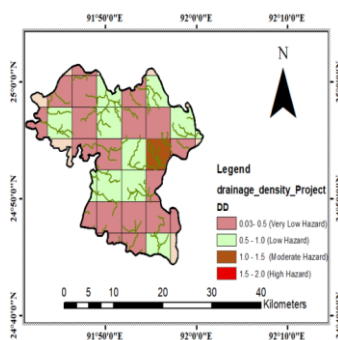


Figure 3: Reclassified DD Image of Sylhet Sadar

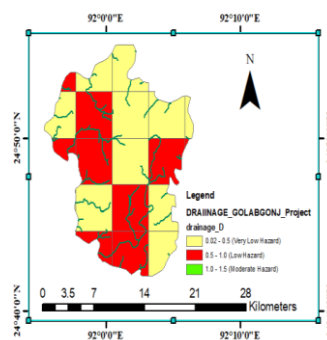


Figure 4: Reclassified DD Image of Golapganj.

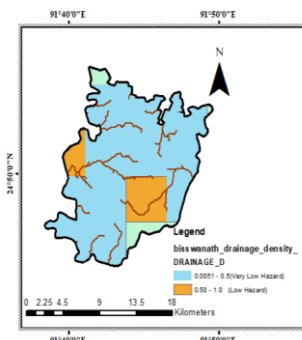


Figure 5: Reclassified DD Image of Bishwanath.

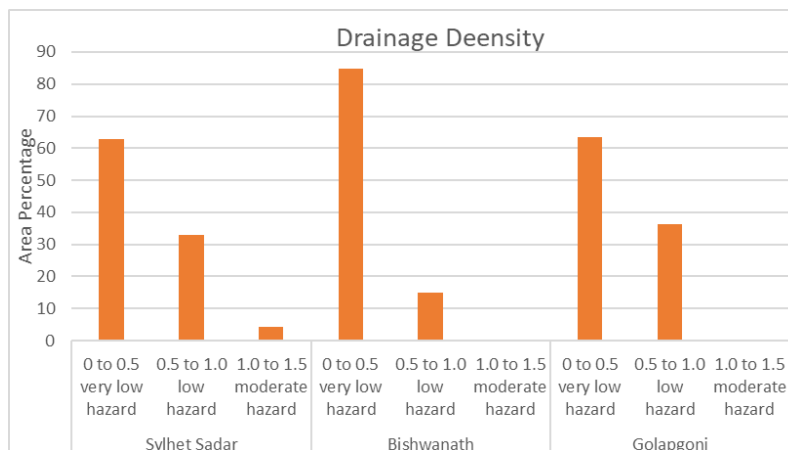


Figure 6: Area percentage of drainage density in Sylhet Sadar, Golapganj, Bishwanath.

### 3.2 Topographic Wetness Index (TWI)

Raw TWI indications are usually -3 to 30. Figure 7,8 & 9 shows the Sylhet Sadar, Golapganj, and Bishwanath topographic wetness maps. TWI ranged from 0.61 to 21.24. The data were classed as extremely low (0.61-5.27), low (5.28-8.61), moderate (8.62-12.27), and high (12.28-16.80). Very high (16.81-21.24). The study found that Sylhet Sadar has a higher Topographic Wetness Index than Bishwanath and Golapganj. Sylhet Sadar has significant danger, according to statistics. High TRI values are 4.00 percent, 0.89 percent, and 0.88 percent in Sylhet Sadar, Golapganj, and Bishwanath. Lower

index cells signify sharpest slopes and are usually ridges or crests. Higher cell values indicate more runoff. These locations have low slopes and substantial upslope contributions. Figure 10 shows a comparison of TWI data for Sylhet Sadar, Golapganj, and Bishwanath in terms of the area percentage of very low, low, moderate, and high, very high.

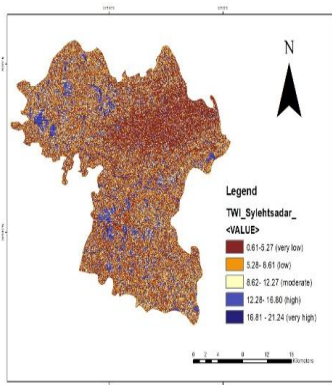


Figure 7: Reclassified TWI Image of Sylhet Sadar

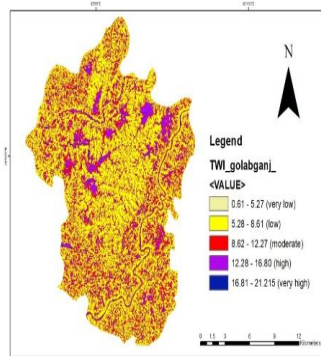


Figure 8: Reclassified TWI Image of Golapganj

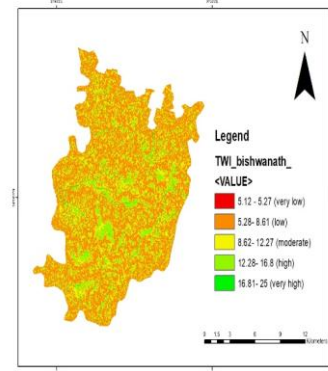


Figure 9: Reclassified TWI Image of Bishwanath

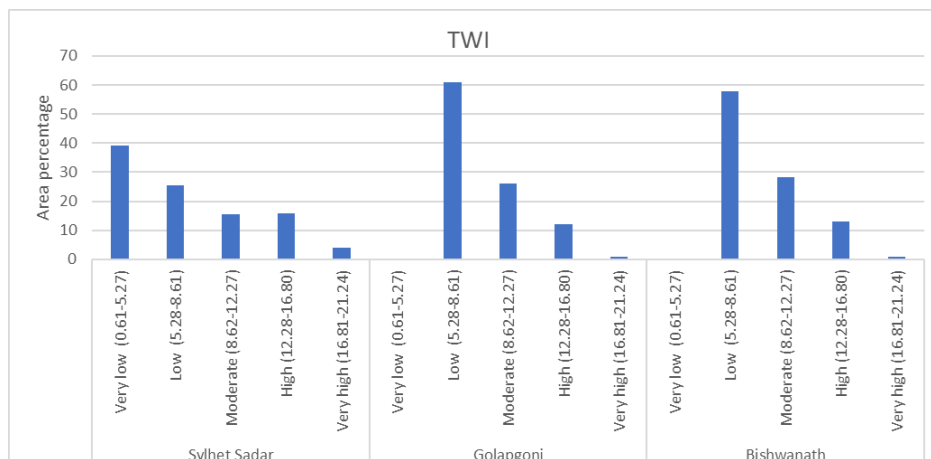


Figure 10: Area percentage of TWI in Sylhet Sadar, Golapganj, Bishwanath.

### 3.3 Topographic Roughness Index (TRI)

Figure 11,12 & 13 shows the roughness maps of Sylhet sadar, Golapganj, and Bishwanath, with TRI values from 0.01 to 1. The values are grouped into five groups. Very low (0.01-0.47), Low (0.48-0.58), Moderate (0.59-0.66), High (0.67-0.75), Very high (0.76-1). Roughness index often indicates terrain undulation. Undulation increases with roughness and vice versa. The Topographic Roughness Index is greater in Sylhet Sadar than Bishwanath & Golapganj, according to study. Sylhet Sadar has significant danger, according to statistics. High TRI values are 14.67 percent, 0.07 percent, and 0.08 percent in Sylhet Sadar, Golapganj, and Bishwanath. Figure 4 shows a comparison of the Topographic Roughness Index data for Sylhet Sadar, Golapganj, and Bishwanath in terms of the area percentage of low, moderate, and high dangers. Figure 14 shows a comparison of TRI data for Sylhet Sadar, Golapganj, and Bishwanath in terms of the area percentage of very low, low, moderate, and high, very high.

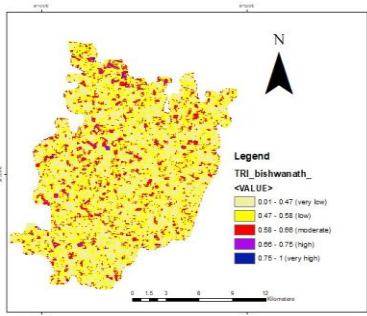


Figure 11: Reclassified TRI Image of Bishwanath

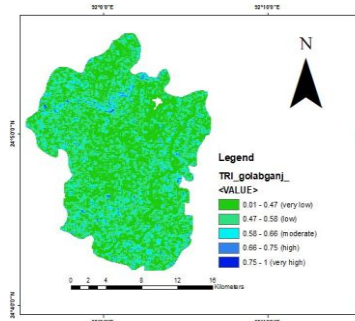


Figure 12: Reclassified TRI Image of Golapganj

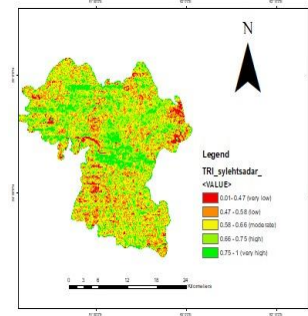


Figure 13: Reclassified TRI Image of Sylhet Sadar

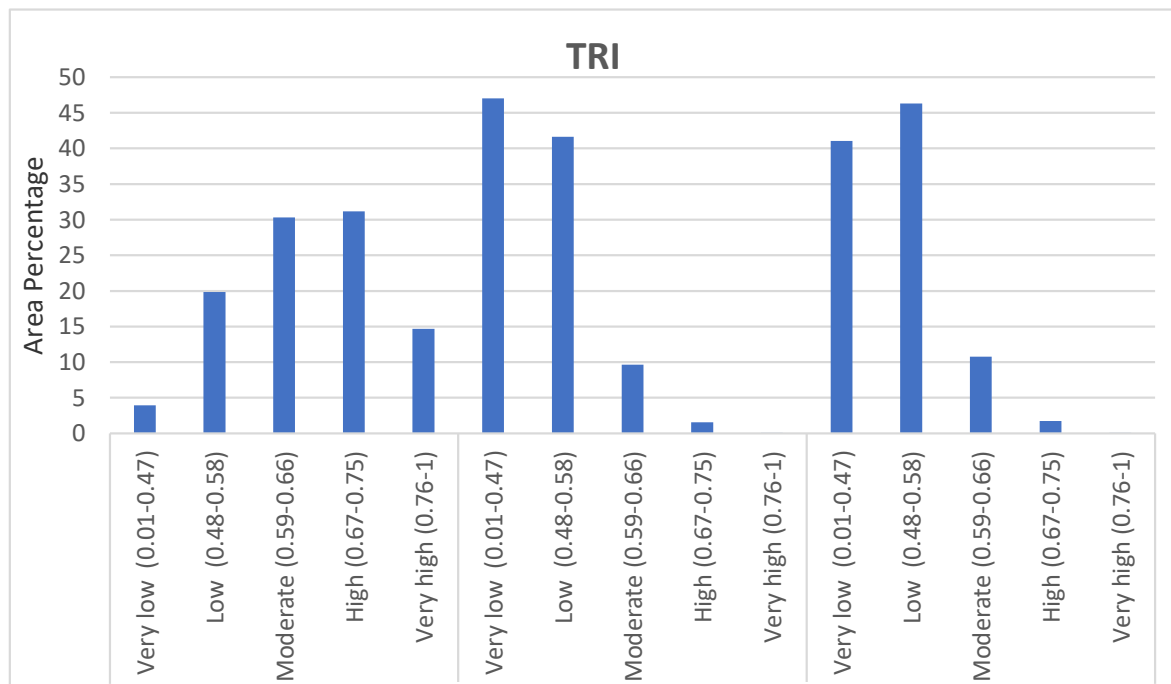


Figure 14: Area percentage of TRI in Sylhet Sadar, Golapganj, Bishwanath.

### 3.4 Slope

Hydrologic processes on Earth depend on slope. For instance, flow across steep terrain concentrates water flow, forming channels, while flow across flatter terrain decreases water movement and increases the likelihood of ponding. Mountain summits cannot flood, but lowlands can. Steep slopes speed up surface runoff and reduce soil water absorption. In Sylhet Sadar, Golapganj, and Bishwanath, slope values range from 0 to 22.566, 21.1704, and 17.1559. Respectively. Bishwanath has a steeper slope than Sylhet Sadar and Golapganj. Steeper slopes imply inundation. Figure 15,16 &17 shows the Reclassified image of Sylhet Sadar, Golapganj & and Bishwanath. Figure 18 shows a comparison of Slope data for Sylhet Sadar, Golapganj, and Bishwanath in terms of the area percentage of flat, gentle moderate, steep, very steep.

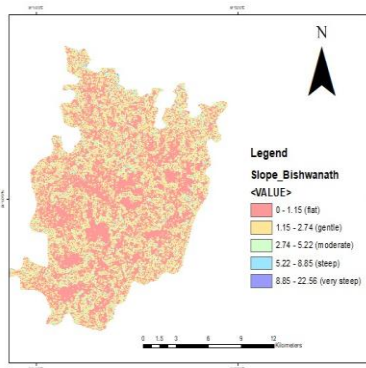


Figure 15: Reclassified Slope Image of Bishwanath

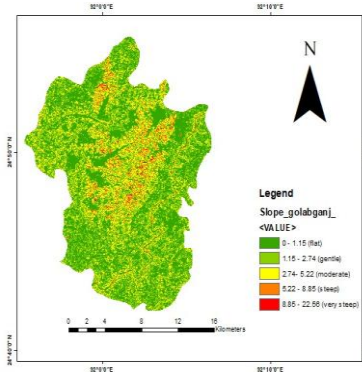


Figure 16: Reclassified Slope Image of Golapganj

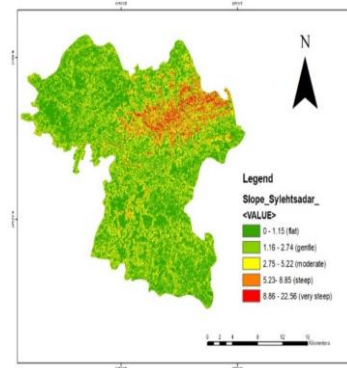


Figure 17: Reclassified Slope Image of Sylhet Sadar

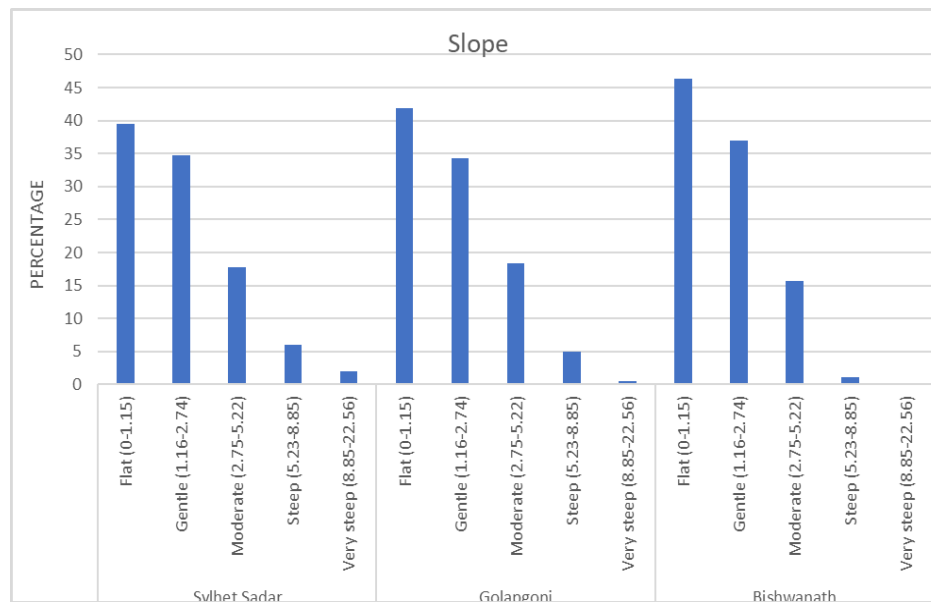


Figure 18: Area percentage of Slope in Sylhet Sadar, Golapganj, Bishwanath.

### 3.5 Sediment Transport Index (STI)

Figure 19,20 & 21 shows the sediment movement map of Sylhet Sadar, Golapganj, and Bishwanath. STIs ranged from 47.75 to 3044.08. The values were grouped into five groups. Very low (0-47.75), low (47.76-226.81), moderate (226.82-549.12), high (549.13-1074.38), very high. Areas with higher STIs move more sediment. The study shows that Sylhet Sadar has a higher Sediment Transport Index than Bishwanath & Golapganj. Sylhet Sadar has significant danger, according to statistics. Sylhet Sadar, Bishwanath, and Golapganj had STI high values of 3044.08, 2484.34, and 2441.91 percent. Table 2 shows a comparison for maximum and minimum value of the Sediment Transport Index data for Sylhet Sadar, Golapganj, and Bishwanath.

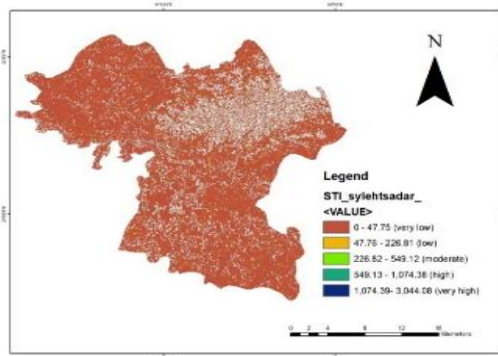


Figure 19: Reclassified STI Image of Sylhet Sadar

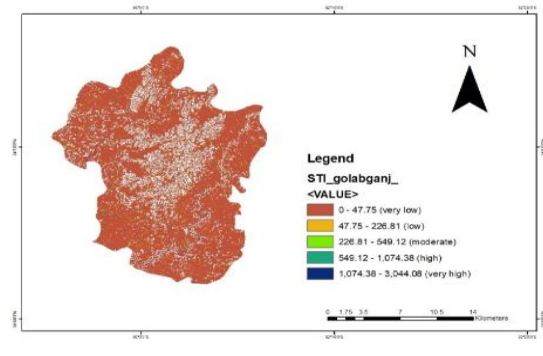


Figure 20: Reclassified STI Image of Golapganj

Table 2: Comparison of minimum & maximum value of STI

Sediment Transport Index (STI)		
Location	Maximum value	Minimum value
Sylhet Sadar	3044.08	47.75
Golapganj	2441.9	76.6
Bishwanath	2484.34	77.94

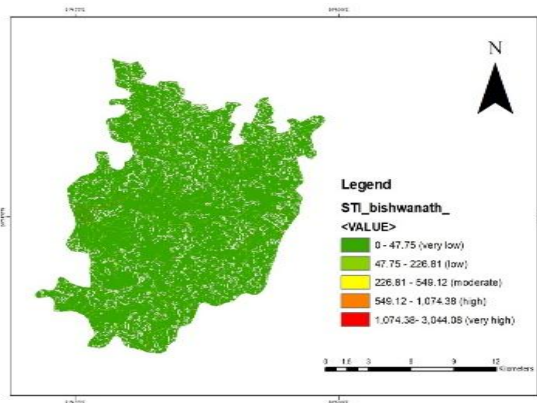


Figure 21: Reclassified STI Image of Bishwanath

#### 4. CONCLUSIONS

Flood causes establish flood danger criteria. The major causes of floods are natural, socio-economic, and infrastructural elements. Choosing these criteria relies on geography, study approach, and data collecting. Depending on basin circumstances, each ingredient will have distinct effects. In the physical geographical group impacted by flood, drainage density is important. Numerous studies demonstrate the influence of drainage density on flood risk in high and medium river basins. This study aim to construct a flood susceptible area of Sylhet Sadar, Golapganj, Bishwanath which is located around Surma Basin through morphometric analysis using Geographic Information Systems (GIS) technique. Here flood conditioning factors such as Drainage density, TWI, TRI, Slope, STI were represented by a raster dataset developed in GIS. The TWI helps determine upslope moisture and contributing locations. These non-dimensional indicator values depend on the region's topography and DEM resolution. TRI determines elevation difference between neighbouring digital elevation model cells. Mountainous regions have undulated topography because weathering and erosion gradually soften the terrain. Hydrologic processes on Earth depend on slope. There is less chance of flooding in areas with steep slopes since water flows swiftly there. The area danger decreases as the slope of the ground increases. STI accounts for topography-induced erosion. It describes erosion and deposition. Flood characterizing factors like STI characterize water-borne sediment transport. All these factors determine that Sylhet Sadar is more susceptible for flooding other than Golapganj and Bishwanath area. In this paper, methods of hydrological modelling using open-source DEM and GIS are shown. We only show how

GIS can be used in making the factors and levels of complexity that show up when you do research in GIS. When DEM is used with different levels, the results for the same place to study the result can also be very different if we use different GIS tools or different modelling approach. As we used open-source DEM, this result can vary if we could use a better resolution image for the same approach.

### **Declaration of Use of AI**

This research paper does not involve the use of any artificial intelligence-based tools or methods.

### **REFERENCES**

- Ahmad I., D. M. (2019). Application of hydrological indices for erosion hazard mapping using Spatial Analyst tool. *Environ. Monit. Assess.*, 482.
- Bannari A, G. A.-B. (2017). Detection of Areas Associated With Flash Floods and Erosion Caused By Rainfall Storm Using Topographic attributes, Hydrologic indices, and GIS. In *Global Changes and Natural Disaster management: Geo-information technologies*. Springer, 155–174.
- Beven K.J, K. M. (1979). A physically based, variable contributing area model of basin hydrology. *Hydrol. Sci. J.*, 43–69.
- Buchanan B.P, F. M. (2014). Walter, Evaluating topographic wetness indices across central New York agricultural landscapes, *Hydrol. Earth Syst. Sci.* 18, 3279-3299.
- Budimir M.E.A, A. P. (2015). A systematic review of landslide probability mapping using logistic regression,. *Landslides* 12 (3), 419–436.
- Chowdhury M.S., H. B. (2022). Landslide susceptibility mapping using bivariate statistical models and GIS in chattagram district, Bangladesh,. *Geotech. Geol. Eng.* 40, 1–24.
- Chowdhury, M. S. (2023). Modelling hydrological factors from DEM using GIS. *ELSEVIER*.
- Ibrahim N.F Zardari N.H., S. S. (2017). Identification of Vulnerable Areas to Floods in Kelantan River Sub-basins by using Flood Vulnerability Index,. *International Journal of GEOMATE*, 107-114.
- Jahir Uddin Chowdhury, M. R. (1997). *Flood control in a floodplain country Experiences of Bangladesh*. . Morocco: Islamic Educational, Scientific and Cultural Organization (ISESCO).
- Kalantari, Z. N. ( 2014). A Method for Mapping Flood Hazard along Roads. *Journal of Environmental Management*, , 69-77.
- Lacroix M.P., M. L. (2002). Using digital terrain analysis modeling techniques for the parameterization of a hydrologic model,. *Environ.Model. Softw.* 17, 125-134.
- Mojaddadi, H. P. (2017). Ensemble Machine-Learning-Based Geospatial Approach for Flood Risk Assessment Using Multi-Sensor Remote-Sensing Data and GIS. *Geomatics . Natural Hazards and Risk*, 1080-1102.
- Montgomery, Z. W. (1994). Digital elevation model grid size, landscape representation, and. *Water Resour. Res.* 30 (4), 1019– 1028.
- Moore I.D, G. R. (1991). Digital terrain modelling: a review of hydrological, geomorphological, and biological applications, *Hydrol. Process. Process.*5, 3-30.
- Pourali S.H, A. C. (2016). Topography wetness index application in flood-risk-based land use planning,. *Appl. Spatial Anal.*, 39–54.
- Riley S.J, .. S. (1999). Index that quantifies topographic heterogeneity. *Int. J. Sci.*, 23–27.
- Sørensen R., Z. U. (2006). On the calculation of the topographic wetness index: evaluation of different methods based on field observations. *Hydrol. Earth Syst. Sci.*, 101–112.
- Whitehouse, D. (1994). *Handbook of Surface Metrology*. CRC Press.