A HOLISTIC EVALUATION OF TOPOGRAPHIC FEATURE WITH DEM

INTERNSHIP REPORT

Submitted by

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BONOFIDE CERTIFICATE

Certified that this internship report **“A HOLISTIC EVALUTION OF TOPGRAPHIC FEATURE WITH DEM”** is bonofide work of **Mr. Tharun,** who carried out the project work under my Supervision.

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ABSTRACT

Digital elevation models (DEMs) are widely used terrain representations in geosciences applications. The quality of DEMs can be assessed through visual, relative, and absolute comparison methods, depending on user’s knowledge and application requirements. This study focuses on applying these assessment methods to DEMs, considering factors like hill shade, slope, aspect, curvature, and contours that may affect their quality. Four different DEMs (ASTER, ALOS, SRTM, CARTOSAT) obtained from optical and radar technology were used in this study to assess the quality of an area in Vikkiramangalam hills RF. The results show the magnitude and distribution of errors within different terrain characteristics, presented through maps and profiles. Visual assessment is suitable for low accuracy applications, while relative and absolute assessments are more appropriate for high accuracy applications. The findings indicate that accuracy decreases as slope increases, with an average standard deviation of 30 m for a very low slope class. In the cartosat the slope various gental and terrain surface.

Key word: Digital Elevation Models, Geosciences applications, Visual comparison methods, Hill shade, Slope, Aspect, Curvature, Contours

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LIST OF ABBREVIATIONS:

ALOS - Advanced land observed satellite

ASTER - Advanced Spaceborne Thermal Emission and Reflection

SRTM - Shuttle Radar Topography Mission

DEM - Digital Elevation Model

DSM - Digital surface model

INTRODUCTION

A Digital Elevation Model (DEM) is a computerized representation of the height of the land surface with respect to a reference datum. It is commonly used to refer to any computerized representation of an earth surface. DEMs are the most straightforward type of computerized representation. DEMs are widely employed to determine landscape characteristics such as elevation, slope, aspect, and hill shade. Additionally, features like drainage and channel networks can be identified using the Digital Elevation Model. These models are extensively utilized in hydrologic and geologic studies, hazard monitoring, natural resource analysis, agricultural management, and more. A Digital Elevation Model (DEM) is essentially a digital or 3D representation of a landscape's surface, created from elevation data. It is worth noting that digital terrain model (DTM) and digital surface model (DSM) are two other terms that are often used interchangeably with digital elevation model (DEM).

OPEN-SOURCE DATA:

ALOS – Advanced Land Observed Satellite

DEM (downloaded from the USGS web site: www.usgs.org)

ALOS_ High level Land Noticing Satellite (ALOS), likewise called Daichi (a Japanese word signifying "land"), was a 3810 kg Japanese satellite sent off in 2006. Following five years of administration, the satellite lost power and stopped correspondence with Earth, yet stays in orbit. ALOS was sent off from Tanegashima, Japan, on 24 January 2006 by H-IIA No. 8. The send-off had been deferred multiple times by climate and sensor issues.

RESOLUTION: 30 Meter

ASTER – Advanced Spaceborne Thermal Emission and Reflection

The principal rendition of the ASTER GDEM, delivered in June 2009, was created utilizing sound system pair pictures gathered by the ASTER instrument locally available Land. ASTER GDEM inclusion ranges from 83 degrees north scope to 83 degrees south, including the vast majority of Earth's expanse of land. The better GDEM V3 adds extra sound system matches, further developing inclusion and diminishing the event of antiques. The refined creation calculation gives worked on spatial goal, expanded flat and vertical precision. The ASTER GDEM V3 keeps up with the GeoTIFF design and the equivalent gridding and tile structure as V1 and V2, with 30-meter postings and 1 x 1degree tiles.

RESOLUTION: 30 Meter in the horizontal plane

CARTOSAT: DEM (downloaded from Bhuvan - geoportal of ISRO)

Cartosat-1 launched by ISRO on 5th May 2005, provides stereo data for entire India. Under Space based Information Support for Decentralized Planning (SIS-DP) project. Dem (1 arc Sec) were generated country wide using digital photogrammetric techniques. To generate seamless DEMs, photogrammetric blocks were formed and with minimal break-lines, DEMs were edited across the scenes. Automatic process of seamless DEM data generation is done by making use of Ground Control Points through dense feature matching, Triangulated Irregular Network modelling and automated strip mosaicking. Quality verification process is done by panning and draped visualization to demarcate distortions. Further validation is done for height accuracy for stereo pairs overlapping portions.

RESOLUTION: 30 Meter

SRTM – Shuttle Radar Topography Mission

DEM (downloaded from the USGS web site: www.usgs.org)

The high – resolution topographic database for the entire earth is Shuttle Radar Topography Mission (SRTM) by the collaborative effort of National Aeronautics and Space Administration. SRTM launched February 2003, carries Space borne Imaging Radar-C (SIR-C) hardware. Data points are collected in 3 arc-seconds spacing referred as SRTM3. Speckle, the error source in synthetic aperture radar data is overcome through averaging.

RESOLUTION: 1 arc sec (30 Meter)

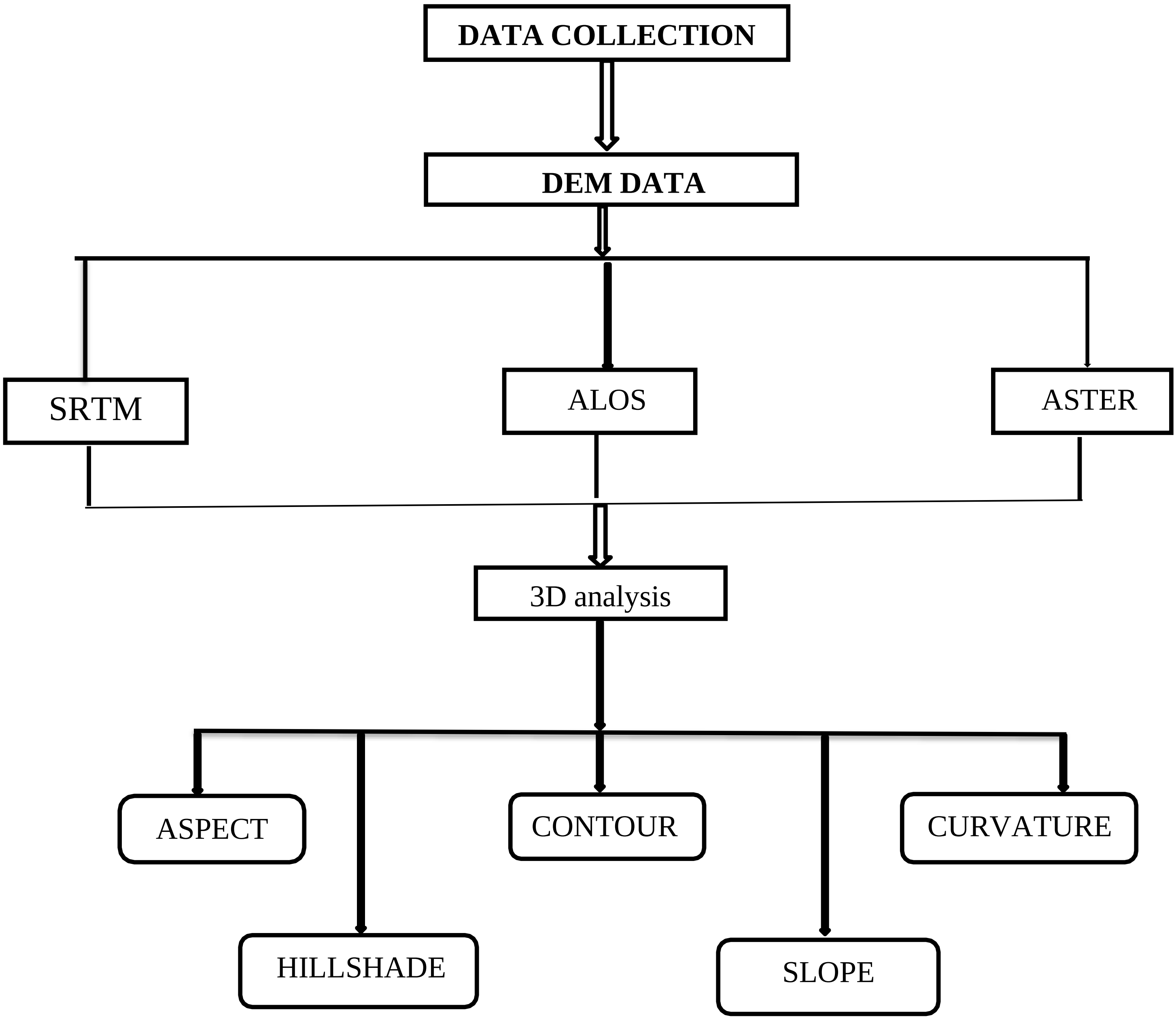
SOFTWARE REQUIRED: ARCGIS 10.8

AIM:

To Evaluate Diverse Topographic Feature using DEMAnalysis.

METHODOLOGY

FLOW CHART:



SHORT DESCRIPTION OF METHODOLOGY:

In order to effectively analyses the data in accordance with the specified requirements, it is imperative to commence by conducting a thorough search and subsequent download of the satellite derived DEM data. Afterward, it is essential to extract the ZIP file format within the same designated folder. The subsequent step entails the creation of shape files, which are indispensable for the successful integration of the data into the esteemed ARCGIS 10.8 software. To generate the diverse DEM outputs, we employ the utilization of 3D analysis tools. These tools enable us to effectively examine and evaluate significant terrain features, including Hill shade, Slope, Aspect, Curvature, and Contour. Also, it is crucial to highlight that the extraction of features from the DEM derived model has been accurately executed for the designated study area.

SPATIAL RESOLUTION'S OF ASTER -DEM, SRTM –DEM, ALOS - DEM

DATA TYPE	ALOS	ASTER	SRTM
SPATIAL RESOLUTION	30m	30m	30m

TABLE 2.1

Literature and review:

Schindler et al. (2011) have concluded that these digital elevation models (DEMs) can be utilized for various applications, including ecological risk assessment, 3D structure visualization, strategic military planning, flood and water flow simulation, identification of surface water bodies, and other hydrological purposes.

Study conducted by **Nikolakopoulos et al. (2006)** suggests that the observed issue was likely caused by the datum transformation process. To address this, a co-registration methodology was implemented, allowing for a comparison of the elevation distributions between the two datasets. Various descriptive statistical measures, such as aspect, slope, curvature, contour, contour barrier, and cut fill, were used to describe and analyze the datasets.

According to **Gajalakshmi (2015)** suggest the accuracy of Cartosat – DEM in utilizing elevation data was examined. The research involved the generation of sub watershed maps from both DEMs using ArcGIS 10. To further analyze the data, maximum elevation points were identified, and variance and standard deviation were calculated. Also, drainage maps were created for both DEMs using spatial analyst tools and a raster calculator. These drainage maps were then utilized to calculate stream length, mean stream length ratio, and bifurcation. The study area focused on comparing elevation data and terrain attributes obtained from Cartosat-DEM and SRTM-DEM, utilizing the capabilities of ArcGIS. It was observed that higher resolution DEMs produced a more realistic representation of the stream layer, resulting in consistent stream order and drainage density. Moreover, it was found that cartosat-DEM exhibited greater accuracy in analyzing terrain elements, while SRTM-DEM displayed higher elevation values.

Boulton et al. (2018) assessed the accuracy of four medium-resolution global Digital Elevation Models (DEMs) for fluvial geomorphic analysis and river long profile extraction. Two of the DEMs, SRTM30 and ASTER, are widely used datasets, while the other two, TanDEM-X and AW3D30, have recently become available to the scientific community. The analysis focuses on commonly used GIS tools.

According to **Sayantan Das et al. (2016),** the geographical guide and ASTER GDEM V2 information are considered to be more accurate and reliable in terms of overall precision compared to other created or available DEM data products, based on the extraction of terrain analysis boundaries from each.

STUDY AREA

(Vikkiramanglam Hills)

STUDY AREA

NAME OF THE HILL : Vikkiramanglam RF

STATE & DISTRICT : Tamil Nadu & Dindugal

ELEVATION:

- High Value - 1558
- Low Value - 249

LATITUDE :10.009517

LONGITUDE :77.92460

USES OF HILLS: Total sown / Agriculture area :658.36

Non-agriculture area uses : 201.34

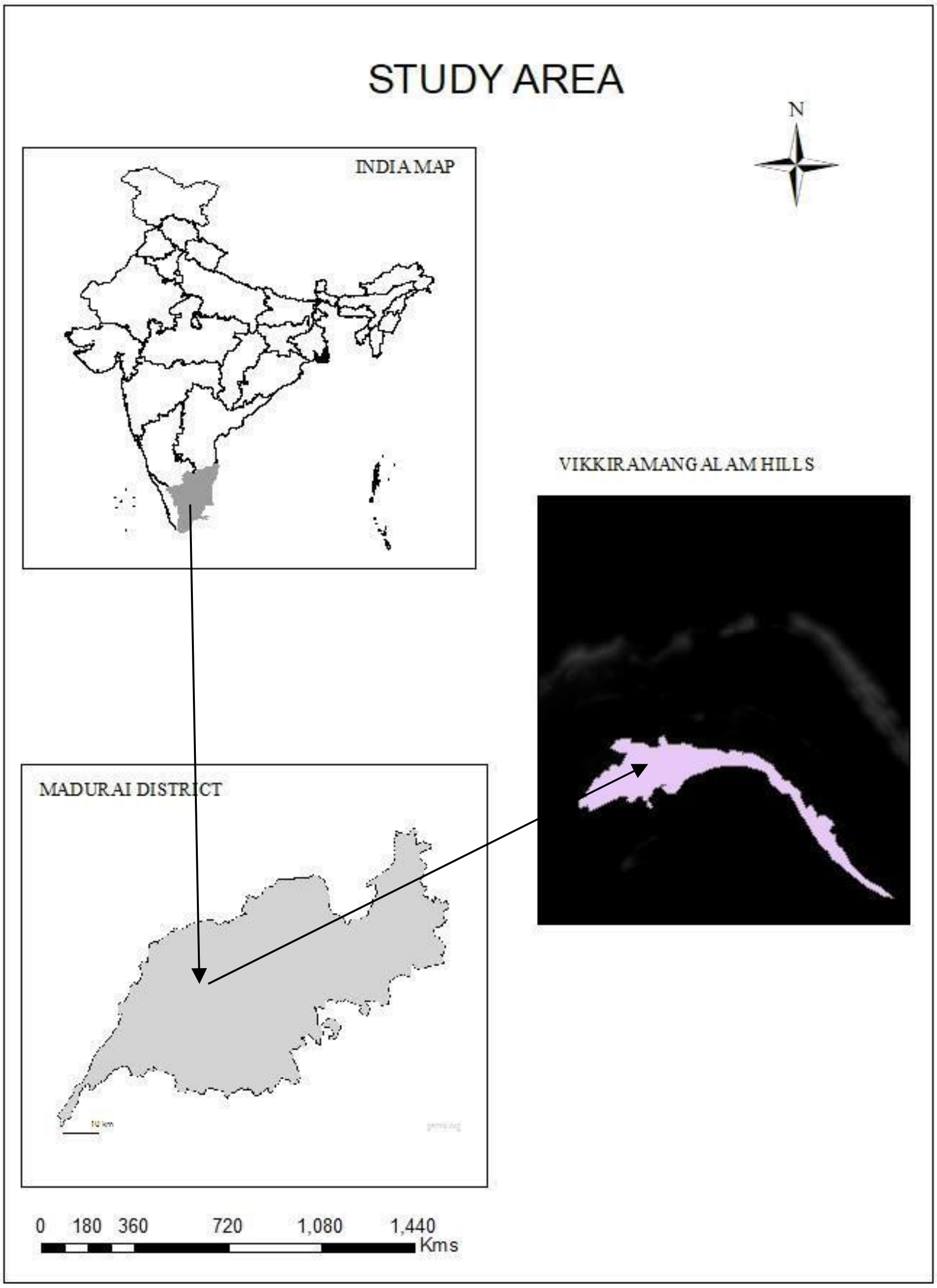
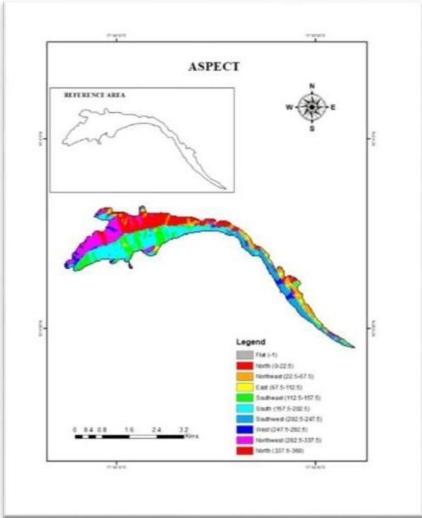
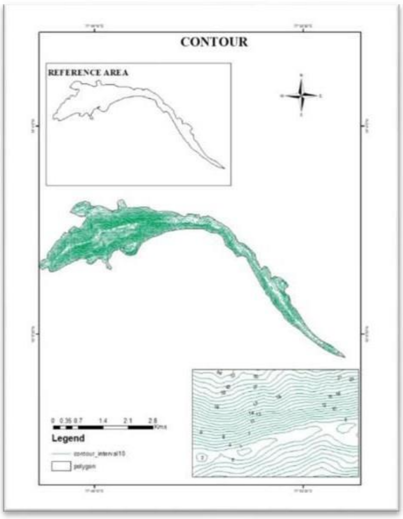

STUDY AREA
N
INDIA MAP
VIKKIRAMANGALAM HILLS
MADURAI DISTRICT
0 180 360 720 1,080 1,440
Kms

FIGURE 4.1

ALOS





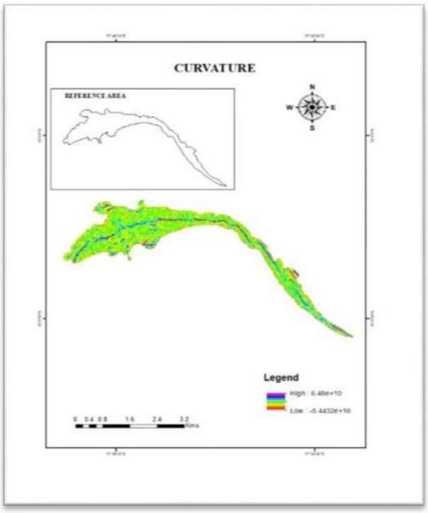


FIGURE 4.2,4.3,4.4

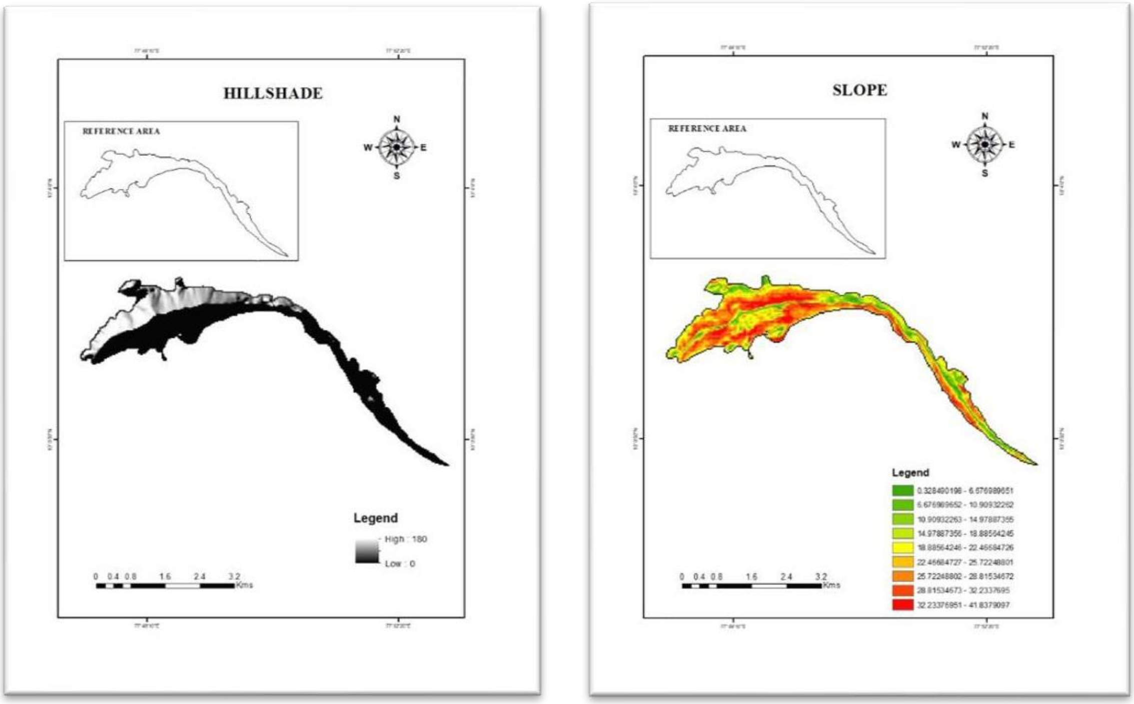


FIGURE 4.5,4.6

Aspect: Profile curvature is parallel to the slope and indicates the direction of the steepest slope. It significantly influences the acceleration and deceleration of flow across the surface. In our study area, we have successfully identified the prominent ridges by utilizing the curvature tool. The maximum height of the curvature measures 6.48, while the minimum height is recorded at 5.44.

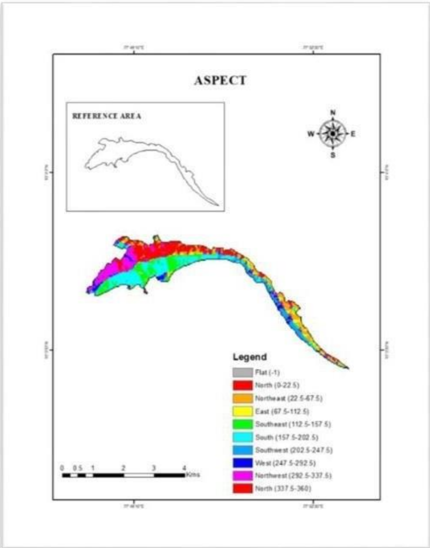
Slope: The slope is a measure of the rate of change of elevation for each cell in the digital elevation model (DEM). It represents the steepness, incline, or grade of a line. The absolute value of the slope is used to measure the steepness. A slope with a higher absolute value, such as (32.23-41.83), indicates a steeper line. On the other hand, a gentle slope line, like (0.32-6.67), indicates a lower value. In the realm of digital elevation models (DEMs), slope serves as a crucial indicator of elevation changes.

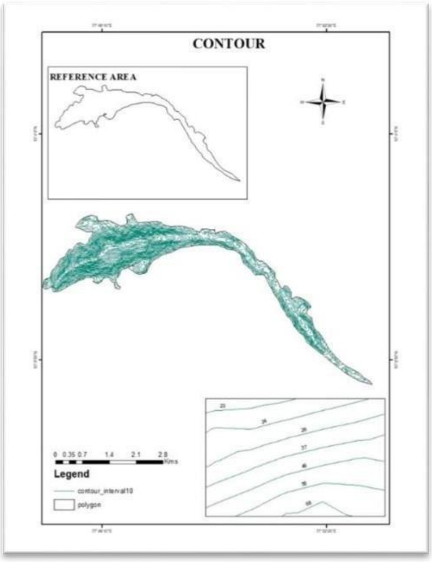
Contour: The base contour value represents the reference height from which all contours are generated, whether they are above or below the interval designated. To ensure accurate and precise contour representation, it is essential to establish the base contour value. This value serves as the starting point for the creation of contours, regardless of whether they are situated above or below the specified interval. The highest peak area will be represented by maximum values. The minimum allowable value is 261, while the maximum is 563. The contour interval is set at 10 meters.

Hillshade: Shaded relief, also known as hill shading, is a sophisticated technique employed in cartography to enhance maps by incorporating lighting effects based on variations in elevation across the landscape. By simulating the impact of sunlight on hills and canyons through illumination, shading, and shadows, shaded relief offers a more comprehensive depiction of the topography. This method generates a grayscale three-dimensional representation of the terrain surface, taking into consideration the sun's relative position to accurately shade the image. The hill shade function encompasses a total angle of 180 degrees, with our analysis covering up to 150 degrees to ensure comprehensive coverage of the shaded area. To modify the hill shade, it is necessary to adjust the angle of sun elevation. The North West areas topography is highlighted using this techniques.

Curvature: Profile curvature is parallel to the slope and indicates the direction of the steepest slope. It significantly influences the acceleration and deceleration of flow across the surface. In our study area, we have successfully identified the prominent ridges by utilizing the curvature tool. The maximum height of the curvature measures 6.48, while the minimum height is recorded at 5.44.

ASTER





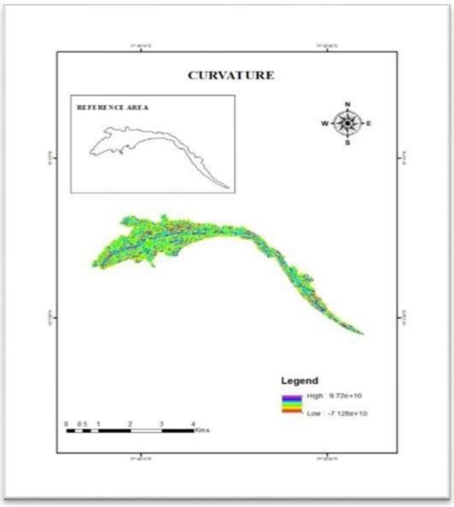


FIGURE 4.7,4.8,4.9

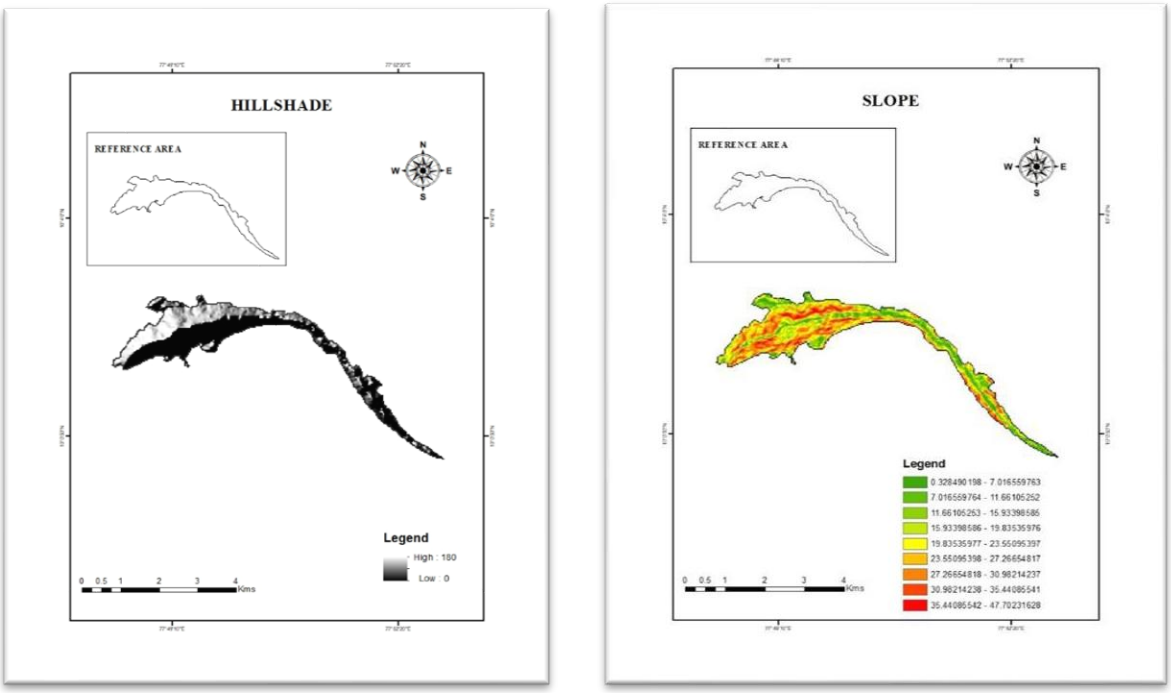


FIGURE 4.10

Aspect: Aspect refers to the downward direction of the steepest change in value between each cell and its neighbouring cells. It represents the orientation of the slope, measured in degrees from 0 to 360 in a clockwise manner. Specifically, 0 degrees corresponds to the north direction, while the range of 0-22.5 degrees represents an east-facing slope. Correspondingly, a range of 67.5-112.5 degrees indicates a south-facing slope, and 157.5-202.5 degrees representsa west-facing slope. Finally, a range of 247.5-292.5 degrees signifies a slope facing towards the west.

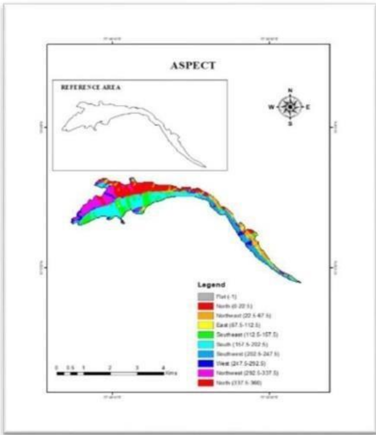
Slope: The slope is a measure of the rate of change of elevation for each cell in the digital elevation model (DEM). It represents the steepness, incline, orgrade of a line. The absolute value of the slope is used to measure the steepness.A slope with a higher absolute value, such as (32.23-41.83), indicates a steeper line. On the other hand, a gentle slope line, like (0.32-6.67), indicates a lower value. In the realm of digital elevation models (DEMs), slope serves as a crucialindicator of elevation changes.

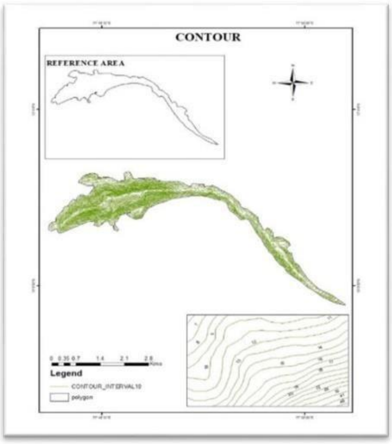
Contour: The base contour value represents the reference height from which all contours are generated, whether they are above or below the interval designated. To ensure accurate and precise contour representation, it is essential to establish the base contour value. This value serves as the starting point for the creation of contours, regardless of whether they are situated above or below the specified interval. The highest peak area will be represented by maximum values. The minimum allowable value is 261, while the maximum is 563. The contour interval is set at 10 meters.

Hill shade: Shaded relief, also known as hillshading, is a sophisticated technique employed in cartography to enhance maps by incorporating lighting effects based on variations in elevation across the landscape. By simulating the impact of sunlight on hills and canyons through illumination, shading, and shadows, shaded relief offers a more comprehensive depiction of the topography. This method generates a grayscale three-dimensional representation of the terrain surface, taking into consideration the sun's relative position to accurately shade the image. The hill shade function encompasses a total angle of 180 degrees, with our analysis covering up to 150 degrees to ensure comprehensive coverage of the shaded area. To modify the hill shade, it is necessary to adjust the angle of sun elevation. The North West areas topography is highlighted using these techniques.

Curvature: Profile curvature is parallel to the slope and indicates the direction of the steepest slope. It significantly influences the acceleration and deceleration of flow across the surface. In our study area, we have successfully identified the prominent ridges by utilizing the curvature tool. The maximum height of the curvature measures 6.48, while the minimum height is recorded at

SRTM





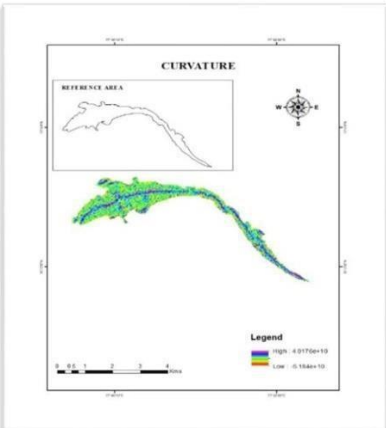


FIGURE 4.11,4.12,4.13

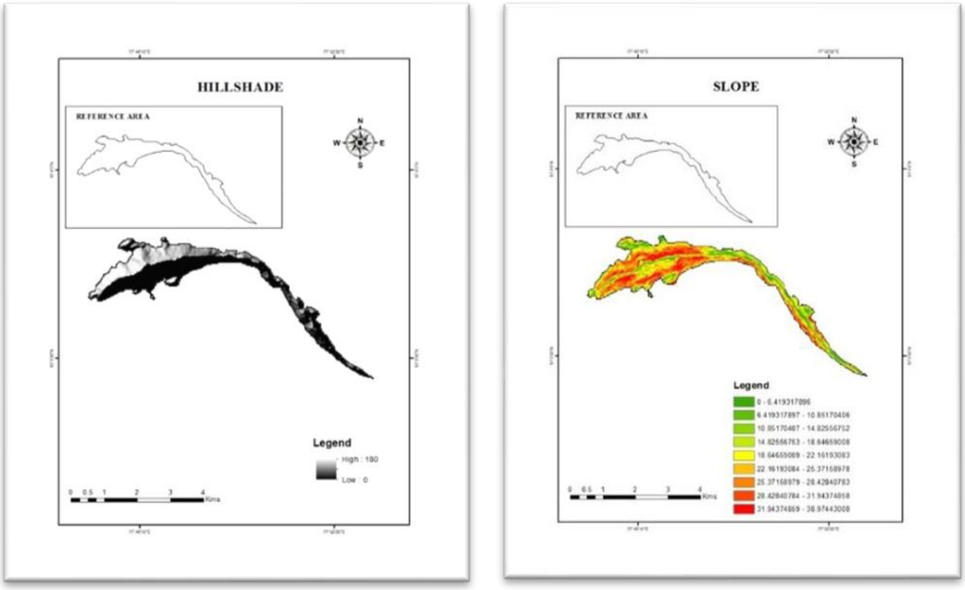


FIGURE 4.14,4.15

Aspect: Aspect refers to the downward direction of the steepest change in valuebetween each cell and its neighbouring cells. It represents the orientation of the slope, measured in degrees from 0 to 360 in a clockwise manner. Specifically, 0 degrees corresponds to the north direction, while the range of 0-22.5 degrees represents an east-facing slope. Correspondingly, a range of 67.5-112.5 degrees indicates a south-facing slope, and 157.5-202.5 degrees represents a west-facing slope. Finally, a range of 247.5-292.5 degrees signifies a slope facing towards the west.

Slope: The slope is a measure of the rate of change of elevation for each cell in the digital elevation model (DEM). It represents the steepness, incline, or grade of a line. The absolute value of the slope is used to measure the steepness. A slope with a higher absolute value, such as (31.9437-38.9744), indicates a steeper line. On the other hand, a gentle slope line, like (0-6.4193), indicates a lower value. In the realm of digital elevation models (DEMs), slope serves as a crucial indicator of elevation changes.

Contour: The base contour value represents the reference height from which all contours are generated, whether they are above or below the interval designated. To ensure accurate and precise contour representation, it is essential to establish the base contour value. This value serves as the starting point for the creation of contours, regardless of whether they are situated above or below the specified interval. The highest peak area will be represented by maximum values. The minimum allowable value is 117, while the maximum is 269. The contour interval is set at 10 meters.

Hillshade: Shaded relief, also known as hillshading, is a sophisticated technique employed in cartography to enhance maps by incorporating lighting effects based on variations in elevation across the landscape. By simulating the impact of sunlight on hills and canyons through illumination, shading, and shadows, shaded relief offers a more comprehensive depiction of the topography. This method generates a grayscale three-dimensional representation of the terrain surface, taking into consideration the sun's relative position to accurately shade the image. The hill shade function encompasses a total angle of 180 degrees, with our analysis covering up to 150 degrees to ensure comprehensive coverage of the shaded area. To modify the hill shade, it is necessary to adjust the angle of sun elevation. The North west areas topography is highlighted using these techniques.

Curvature: Profile curvature is parallel to the slope and indicates the direction of the steepest slope. It significantly influences the acceleration and deceleration of flow across the surface. In our study area, we have successfully identified the prominent ridges by utilizing the curvature tool. The maximum height of the curvature measures 5.18, while the minimum height is recorded at 4.01.

CONCLUSION:

This study focused on methods that can be used to assess the quality of a Digital Elevation Model (DEM) by evaluating various topographic features using DEM analysis. The researchers compared different quality assessment methods, such as visual, relative, and profile analysis, to determine their effectiveness in assessing the quality of DEMs for different applications. The choice of assessment method depends on the accuracy requirements of the specific application, availability of validation datasets, and knowledge of error assessment. Visual assessment may be sufficient for low quality applications, while absolute and relative quality assessment methods are necessary for high accuracy applications that require more thorough evaluation. Combining multiple assessment methods at different stages can be used for independent checks or verification purposes.

In this study, our primary objective is to provide a comprehensive evaluation of different DEMs, namely SRTM, ASTER, CARTOSAT, and ALOS. To acquire the essential data, we accessed USGS-Earth Explorer and Bhuvan satellite images. These resources allowed us to extract the specific study area using spatial reference tools. By employing advanced 3D analysis tools, we were able to generate a range of maps, including aspect, contour, hill shade, curvature, and slope. These maps serve as crucial indicators for assessing the suitability of each satellite image for our study area.

The ALOS satellite, with its advanced capabilities, offers unparalleled accuracy and precision in capturing land observations. Its exceptional performance in our study area is evident through its impressive range of values, from a remarkable high of 563 to a reliable low of 261. These values not only indicate the satellite's ability to capture a wide spectrum of land features but also highlight its suitability for our specific research needs. The well-defined results of the hillshade, slope, aspect, curvature, and contour further demonstrate its superiority over other Digital Elevation Models (DEMs).

In comparison, the ASTER (Advanced Spaceborne Thermal Emission and Reflection) satellite falls behind the other two in terms of visual interpretation. With a high value of 560 and a low value of 241, we have determined that ASTER is the First-best option for our study area. The well-defined results of the hillshade, slope and aspect, further demonstrate ASTER superiority over other Digital Elevation Models (DEMs).

Next, we evaluated the SRTM (Shuttle Radar Topography Mission) satellite andfound it to be superior to one of the others. Through visual interpretation, we assigned it the third position, considering its high value of 559 and low value of 262. The well-defined results of the hillshade, slope and curvature, further demonstrate SRTM superiority over other Digital Elevation Models (DEMs).

Lastly, we assessed the ASTER satellite. After careful visual interpretationand analysis of its high value of 269 and low value of 117, we concluded that it is the least suitable option for our study area. The well-defined results of the hillshade, contours and slope, further demonstrate ASTER superiority overother Digital Elevation Models (DEMs).

Finally, based on visual interpretation and the analysis of high and low values and comparing feature extraction techniques the ALOS satellite emerges as the most optimal choice for our study area, followed by ASTER and SRTM. CARTOSAT, with its respective values, is deemed the least favourable option.