SLOPE MAP GENERATION THROUGH DIGITAL ELEVATION MODEL OF KALABURAGI DISTRICT USING GIS

Dr Ramesh Londonkar [1]*, Basanti Patil [2]

[1]* *Professor Department of Biotechnology Gulbarga University Kalaburagi, Karnataka,India.585104(IN) Email:*londonkarramesh53@gmail.com
[2]*Ph.D Research Scholar Department of Environmental Science Gulbarga University, kalaburagi,Karnataka,India.-585104(IN)*Email Id: Patilbasantis@gmail.com

***Corresponding author: Dr Ramesh Londonkar**
Email: londonkarramesh53@gmail.com
Phone: +91-9880416391

Abstract:
A slope map is a representation of gradient of a surface in two dimensions. It shows how steep or gentle a slope is at any given point. Slope maps can be used to plan up construction projects and water resources etc. And also is a type of map that represents the gradient of the Earths terrain. It is created by analysing a Digital Elevation Model (DEM) and calculating the rate of change in neighbouring pixels.
The study area Kalaburagi is situated in Deccan Plateau which is located at 17.33°N 76.83°E and the general elevation ranges from 300 to 750 meters above mean sea level
A Digital Elevation Model (DEM) This can be highly useful in the project involving land suitability assessment for water conservation structures in Kalaburagi district. The DEM will provide crucial information on the topography of the region, which is an essential factor in determining the suitability of a site for water conservation structures. The DEM may be used for the Slope analysis, Drainage analysis, Elevation analysis, Hydrological modelling and more.
CartoDEM is a digital elevation model developed by the Indian Space Research Organization (ISRO) that covers the entire Indian landmass. It is based on the Shuttle Radar Topography Mission (SRTM) data with a spatial resolution of 30 meters.

Key Words- CartoDEM, DEM (Digital Elevation Model), GIS,Slope map.

INTRODUCTION

Kalaburagi District, situated within the state of Karnataka, India, is renowned for its diverse and varied landscapes, each characterized by unique topographical features. An in-depth comprehension of the district's terrain is indispensable for a multitude of purposes, ranging from land-use planning and infrastructure development to agricultural initiatives and environmental evaluations. The creation of a slope map for Kalaburagi District using a Digital Elevation Model (DEM) emerges as a crucial tool which proves to be an invaluable asset, shedding light on the degree of steepness throughout the region and thereby facilitating well-informed decision-making processes.

A slope map, often referred to as a gradient map or terrain slope map, serves as a visual representation of the land's incline in geographic areas. Utilizing elevation data and the capabilities of geographic information systems (GIS), this slope map delineates the varying slopes that characterize Kalaburagi District. This cartographic tool is of paramount importance to geographers, urban planners, environmentalists, and governmental authorities. It aids in the identification of areas featuring gentle slopes, rendering them suitable for agricultural or urban development purposes. Simultaneously, it highlights regions with steeper inclines, which may be more prone to issues like erosion, landslides, or other environmental challenges.

The introduction provided here serves as a preamble, emphasizing the critical role played by a slope map of Kalaburagi District. This tool addresses the specific regional needs, offering insights into the local topography and empowering informed decision-making, particularly concerning evolving land utilization and environmental considerations. Stakeholders within the region find in it a means to harness the potential of geographic information, allowing them to manage the land judiciously while maintaining ecological equilibrium.

KEY ASPECTS OF A SLOPE MAP:

Slope Measurement:

A slope map quantifies the steepness of the land by measuring the rate of change in elevation across a given distance. This measurement is often expressed as a percentage or degrees. A steeper slope will have a higher numerical value, while a flatter area will have a lower value.

Data Sources:

Slope maps are typically derived from digital elevation models (DEMs) or topographic data. These data sources provide detailed information about the elevation of the land at various points within a geographic area.

Color representation:

In slope maps, colors are commonly used to represent different slope categories. For example, a color scale may be employed to display gentle slopes in green, moderate slopes in yellow or orange, and steep slopes in red. This color-coding aids in visual interpretation.

Applications:

Slope maps have a wide range of applications. They are used in land-use planning to identify suitable areas for development, agriculture, or conservation. In geology, they help geologists to identify areas susceptible for landslides or erosion.

Hydrologists use slope maps to analyse the flow of water, identifying drainage patterns and potential flood-prone areas. Additionally, slope maps are valuable in terrain analysis and hiking route planning.

Interpretation:

By studying a slope map, you can gain insights into the landscape's characteristics. Steep slopes may indicate challenging terrain for construction or agriculture, while gentle slopes are more suitable for these purposes. Additionally, slope maps can highlight potential environmental concerns and hazards.

Accuracy and resolution:

The accuracy and resolution of a slope map depend on the quality of the underlying elevation data. High-resolution DEMs will provide more detailed and precise slope information, while lower-resolution data offer a broader overview of the terrain.

In summary, a slope map is a valuable tool for understanding and visualizing the topographical characteristics of a geographic area. It is widely used in various fields to make informed decisions regarding land use, conservation, and risk assessment, and it helps professionals and planners work with the natural landscape in a sustainable and informed manner.

Base map of the Study Area

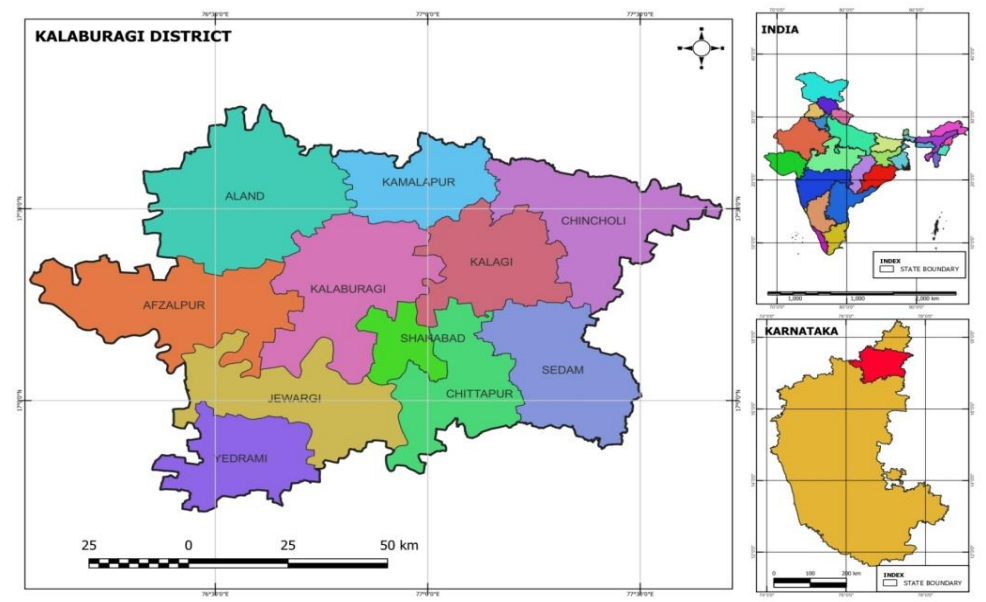

Figure 1: Location Map of kalaburagi District

The base map of the study area was created using toposheets obtained from the Survey of India. These toposheets provide detailed information about the natural and man-made features of the Kalaburagi district, including elevation, land use, roads, and other important landmarks. To create the base map, the toposheets were scanned into a digital format and imported into a Geographic Information System (GIS) software program.

The toposheets were georeferenced to ensure accurate positioning and scaling, and relevant features were digitized using the GIS software. Additional data layers, such as administrative boundaries and land use information, are also added to the map. The final base map was styled to make it visually appealing and easy to read, using different colors, line weights, and labels. The resulting map provided a detailed and accurate representation of the study area, which was essential for the research and analysis conducted in this study.
Kalaburagi (also known as Gulbarga) is a district headquarter located in the northern part of the Indian state of Karnataka.

This district is currently divided into 11 taluks, which are administrative subdivisions. The taluks of Kalaburagi district are: Afzalpur, Aland, Chincholi, Chitapur, Kalaburagi, Jevargi, Sedam, Shahabad, Kalagi, Kamalapur & Yedrami. Each taluk is further divided into several villages and towns. Kalaburagi taluk is the most populous and serves as the district headquarters.

Geographically, Kalaburagi district is situated in the Deccan plateau and is characterized by its flat terrain with occasional low hills. The district is spread over an area of 10,990 square kilometers and is bordered by the districts of Bidar in the north, Yadgir in the east, Raichur in the south, and Bijapur in the west.

The population of Kalaburagi district is approximately 25 lakhs people, according to the 2011 census. The major language spoken in the district is Kannada,Hindi although Urdu is spoken by a significant minority.

Agriculture is the main source of livelihood for the people of Kalaburagi district, with crops such as jowar, Tur, and cotton being the major ones.

Kalaburagi is a historical city and has been ruled by various dynasties such as the Chalukyas, the Bahmanis, and the Adil Shahis. It is home to several historic monuments, including the Sharana Basaveshwara Temple, the Khwaja Banda Nawaz Dargah, and the Gulbarga Fort. The district also has several wildlife sanctuaries, including the Great Indian Bustard Sanctuary and the Bhima River Wildlife Sanctuary.

Kalaburagi district of Karnataka state has a semi-arid to arid climate. The district experiences hot and dry summers, with temperatures ranging from 35°C to 45°C, and cool winters with temperatures ranging from 15°C to 30°C. The monsoon season lasts from June to September, with an average annual rainfall of around 600-800 mm.

The agro-climatic conditions in the district are suitable for the cultivation of crops such as pulses, oilseeds, and cotton. The predominant cropping systems in the region are rain fed agriculture and dry land farming. The soil in the district is mostly red to black cotton soil, which is suitable for the cultivation of these crops.However, water scarcity is a major challenge in the district, and the availability of water for agriculture is limited. The district is home to the Krishna river basin and the Bhima river basin, and irrigation facilities are mainly dependent on these river basins. The district also has a few small reservoirs and tanks, which are used for irrigation purposes.Overall, the agro-climatic conditions in Kalaburagi district are suitable for certain types of crops, but the limited availability of water is a major constraint for agricultural productivity in the region. Water conservation efforts and efficient use of available water resources are crucial for sustainable agriculture and livelihoods in the district.

DATA AND METHODOLOGY

ACQUIRE CARTODEM DATA: Obtained CartoDEM data from ISRO'S Bhuvan portal.CartoDEM is a digital elevation model (DEM) of India that was developed by the Indian Space Research Organization (ISRO) in collaboration with the Survey of India (SOI) and the National Remote Sensing Centre (NRSC). It is a raster dataset that provides topographic information for the entire country at a resolution of 30 meters.

The CartoDEM dataset is derived from a variety of data sources, including satellite imagery, airborne LiDAR, and ground-based surveys. It is processed using advanced algorithms to produce a high-quality DEM that accurately represents the topography of India. The dataset is updated regularly to reflect changes in the landscape due to natural and human factors.

CartoDEM is a valuable resource for a wide range of applications, including terrain analysis, hydrology, and natural resource management. It can also be used for urban planning, transportation infrastructure, and disaster management. The data is freely available to the public and can be downloaded from ISRO's website or other sources.

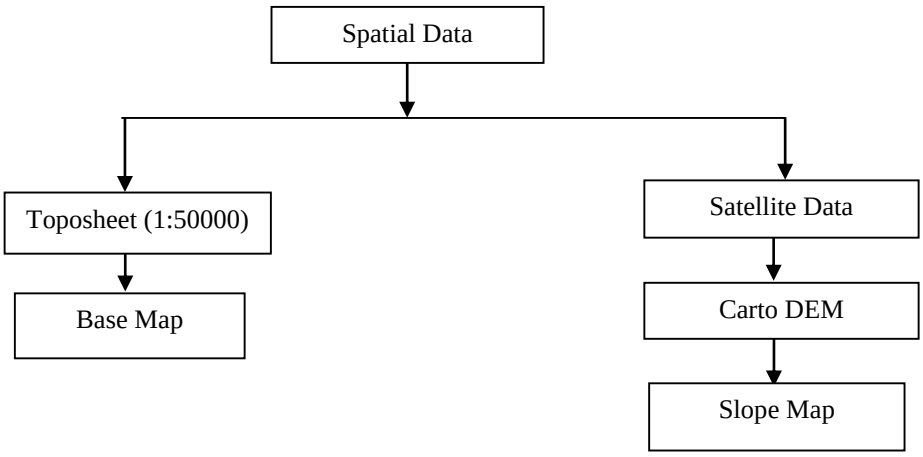

Chart: 1 Illustration of the Methodology

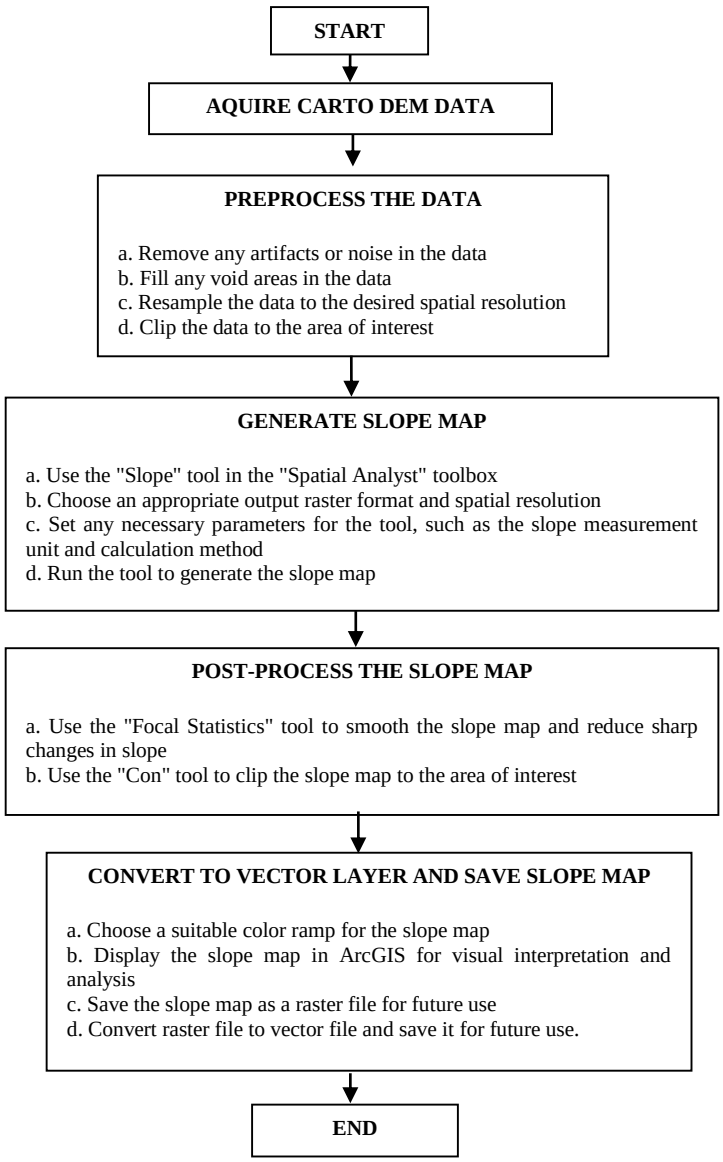

Chart 2: Illustrate generation of a slope map from Carto DEM using ArcGIS

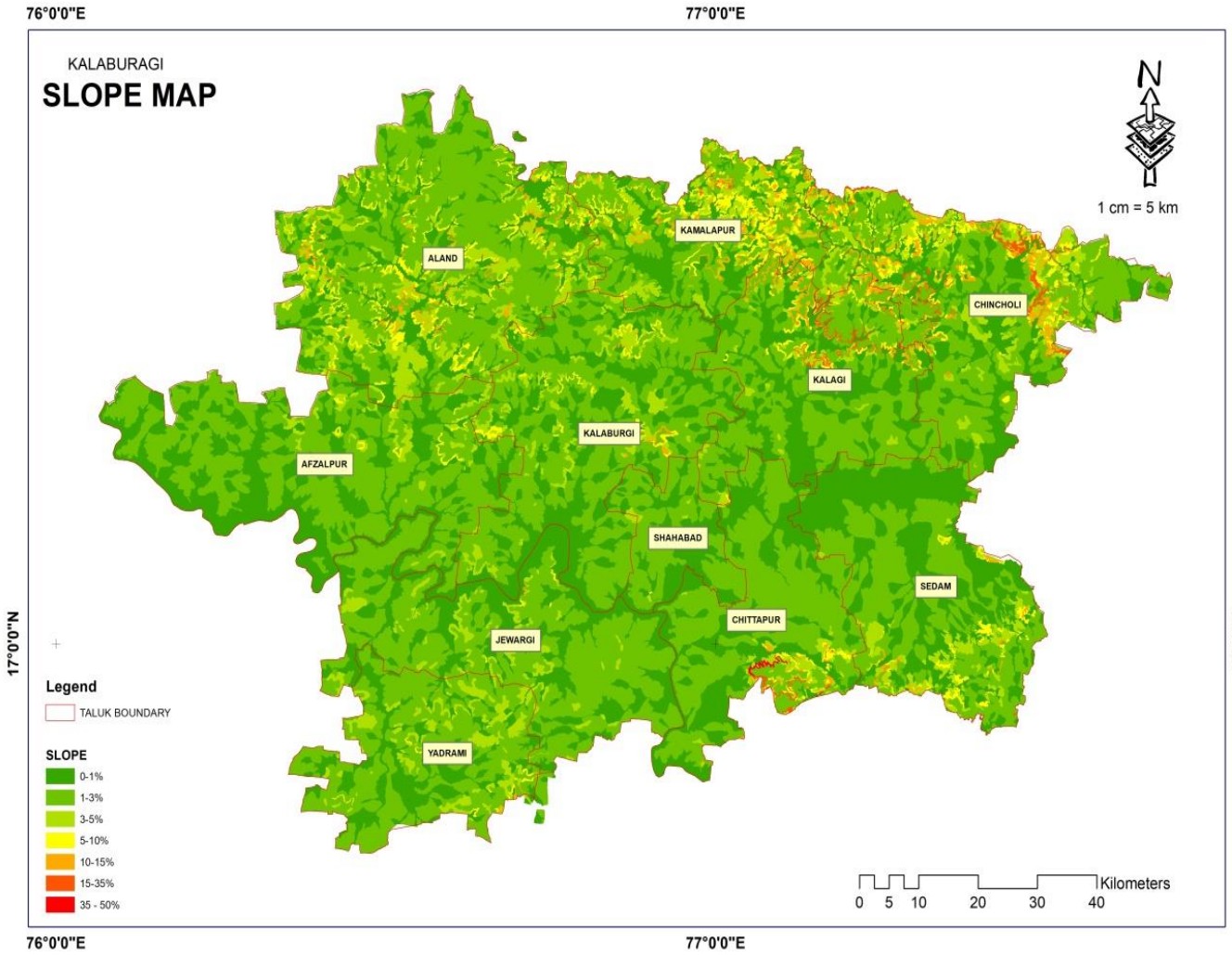

Figure 2:Illustratrate of the sloe map showing steepness or Gradient of the terrain in the study area

Results and Discussion

The categorization of slope types in Kalaburagi district, as determined through slope map, is as follows

Gentle Slope covers an area of 979.48 square kilometers, constituting approximately 9.78% of the district's total area.

Moderate Slope encompasses 326.16 square kilometers, making up around 3.26% of the district.

Moderately Steep Slope accounts for 49 square kilometers, approximately 0.49% of the total area.

Nearly Level terrain extends over 3,475.15 square kilometers, covering about 34.75% of the district.

Strong Slope encompasses an area of 176.82 square kilometers, contributing to approximately 1.77% of the district's area.

Very Gentle Slope covers a significant portion, totaling 5,932 square kilometers, which represents around 59.32% of the district.
Lastly, Very Steep Slope is found in a smaller area, totaling 3.97 square kilometers within the district, making up approximately 0.04% of the total area.

Table 1: Illustrate a clear and concise representation of the slope categories, their respective areas, and the percentage of each category concerning the total area of Kalaburagi District.

Slope Category	Area (in square kilometres)	Percentage of Total Area
Gentle Slope	979.48	9.78%
Moderate Slope	326.16	3.26%
Moderately Steep Slope	49.00	0.49%
Nearly Level	3,475.15	34.75%
Strong Slope	176.82	1.77%
Very Gentle Slope	5,932.00	59.32%
Very Steep Slope	3.97	0.04%

CONCLUSION

In conclusion, the analysis of the slope map in Kalaburagi District reveals a diverse range of slope categories. While the district predominantly consists of areas with Very Gentle and Nearly Level slopes, collectively covering a significant portion of approximately 94.07% of the total district area, it's essential to acknowledge the presence of other slope types.

Gentle Slope, Moderate Slope, and Strong Slope areas, though relatively smaller in comparison, still contribute to the district's topographical diversity. These slope categories, along with the Moderately Steep Slope and Very Steep Slope areas, highlight the existence of variations in land gradients.

It is noteworthy that the Moderately Steep Slope and Very Steep Slope areas are primarily concentrated in Chincholi Taluk, Kalagi Taluk, and a smaller portion of Chittapur Taluk. These regions present unique topographical challenges and opportunities for specific land-use planning and development. Additionally, it's important to mention that the steep and moderately steep slopes in Chincholi also includes significant forested areas, which further adds to the ecological significance of these regions. This information is invaluable for land-use planning, environmental assessment, and infrastructure development in Kalaburagi District, as it allows for informed decision-making that takes into account the region's diverse terrain characteristics and potential challenges posed by steeper slopes in these specific taluks.

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