Application of Qgis in the Generation of Contour Map

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Abstract. Contour maps visually represent elevation information throughcontour lines, aiding in the interpretation of the landscape's features and characteristics. QGIS is introduced as a valuable tool for generating contour maps due to its accessibility, versatility, and extensive range of features. The step-by-step process of using QGIS for contour map generation, begins with data acquisition, encompassing the importation of elevation data from various sources and ensuring its quality. QGISsupports different data formats, facilitating seamless integration of data from diverse origins. further describes the process of contour line creation using QGIS's contouring algorithms, which extract elevation values and generate smooth and continuous contour lines. Adjusting parameters allows for the customization of contour intervals, offering control over the level of detail in the resulting maps. the application of QGIS in contour map generation provides significant advantages for researchers, professionals, and decision-makers in various disciplines. QGIS's user-friendly interface, broad range of tools, and efficient processing capabilities make it a valuable tool for generating precise and informative contour maps. The utilization of QGIS enhances spatial understanding and supportsinformed decision-making in fields that rely on accurate terrain analysis.

Keywords: QGIS, Digital contour, Terrain, Slope, contour, Aspects, Hill shade, Plugin pools

1 Introduction

1.1 Background

Contour maps, also known as topographic maps, are fundamental tools in geospatial analysis and decision-making processes across a range of disciplines. These maps represent the three-dimensional nature of the Earth's surface on a two-dimensional plane, providing visual representations of elevation information through contour lines. Contour lines connect points of

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equal elevation, allowing researchers, professionals, and decision-makers to understand the topography and landscape characteristics of a particular area.

The generation of accurate and detailed contour maps requires advanced tools and techniques that can handle large amounts of geospatial data and process it efficiently. In recent years, the availability of open-source software such as QGIS (Quantum Geographic Information System) has revolutionized the field of geospatial analysis. QGIS provides a comprehensiveplatform for managing and analyzing geospatial data, making it an ideal tool for contour mapgeneration.

1.2 Significant of contour map

Contour maps have significant importance in various fields and applications due to their ability to provide valuable insights into the topography and characteristics of a specific area.key significance of contour maps are Visualization of Elevation, Understanding Topographic Features, Planning and Development, Geological and Geophysical Studies etc.

1.3 Overview of QGIS Software as a Contour Map generation Tool

QGIS (Quantum Geographic Information System) is an open-source software that provides a powerful and versatile platform for geospatial data analysis, visualization, and mapping. It offers a wide range of features and tools, making it a valuable tool for generating contour maps. It provide a user-friendly interface that enables both novice and experienced users to easily navigate and perform complex spatial analyses. QGIS supports various data formats, including vector and raster data, enabling users to import and manage diverse geospatial datasets. This flexibility is crucial when working with elevation data sources, such as digitalelevation models (DEMs) or LiDAR data, which are essential for contour map generation.

2 Objective

The objectives of the application of QGIS in the generation of contour maps are as follows:

a. Primary objective is to utilize QGIS to generate accurate contour maps that effectively represent the elevation variations and topography of the study area.
b. Utilize QGIS's styling and symbology features to enhance the visual representation of contour lines, allowing users to customize line characteristics, label placement, and color palettes to improve map legibility and interpretation.
c. To leverage QGIS's geoprocessing capabilities to perform spatial analyses on contour maps, such as measuring slope gradients, identifying landforms, or assessing terrain characteristics.

3 Methodology

3.1 Study Area Definition:

The study area, one of the twelfth districts of Himachal Pradesh i.e. the district Kullu was probably the most ancient state next to Kashmir and Kangra. Kullu or Kulu is the capital townof

the Kullu district in the Indian state of Himachal Pradesh. It is located on the banks of theBeas River in the Kullu Valley about 10 kilometres (6.2 mi) north of the airport at Bhuntar. Kullu is a broad open valley formed by the Beas River between Manali and Largi. Kullu valley is sandwiched between the Pir Panjal, Lower Himalayan and Great Himalayan Ranges.The Chinese pilgrim, Hiuen Tsiang (AD 629-645) described the country of Kiulu-to(Kullu) situated at 117 miles to the north-east of Jalandhar which exactly corresponds with the position of Kulata. Identified and acquired elevation data in the form of raster and vector form to analyze the study.

3.2 Data Acquisition and Preparation:

a. Acquired the necessary elevation data sources for the Manali hills, ensuring dataquality and appropriate resolution for the desired level of detail.
b. Verified the accuracy and completeness of the elevation data, addressing any dataanomalies or inconsistencies.
c. Pre-processed the elevation data, fill data gaps, or conduct data interpolation fora smooth and continuous elevation surface.

3.3 Importing Elevation Data in QGIS:

a. Launched QGIS and created a new project.
b. Import the pre-processed elevation data into the QGIS project, ensuring that the data is properly georeferenced and aligned with the project's coordinate referencesystem (CRS).
c. Organize the elevation data layers within the QGIS project to facilitate analysisand visualization.

3.4 Contour Line Generation:

a. Accessed the contouring tools in QGIS through the toolbar or plugins menu.
b. Specified the appropriate contour interval based on the study's objectives, desiredlevel of detail, and the elevation range of the dataset.
c. Adjust other parameters, such as smoothing and label placement, to customizethe contouring process according to the project requirements.
d. Applying the contouring algorithm in QGIS to generate contour lines from theelevation data.

3.5 Terrain Analysis:

a. Utilized QGIS's geospatial analysis tools to derive valuable information from the contour map and elevation data.
b. Calculate slope and aspect using the generated contour lines to analyze the steepness and orientation of the terrain.
c. Conducted viewshed analysis to determine areas visible from specific viewpoints or analyze line-of-sight visibility across the terrain.
d. Performed terrain classification or landform identification based on the contour lines and elevation data, identifying ridges, valleys, plateaus, and other landforms.

3.6 Visualization and Interpretation:

a. Customized the appearance of the contour map, ensuring clear and informative visualization of the terrain.
b. Adjust line styles, thickness, and color to enhance the contrast and visibility ofcontour lines.
c. Utilized gradient shading or color ramps to represent elevation variations andterrain features effectively.
d. Add labels, legends, scale bars, and other necessary map elements to aidinterpretation and understanding of the terrain characteristics.

3.7 Data Analysis and Findings

3.7.1 Create Contours from Points

To create contour lines from points we can use the Contour tool in the Raster menu >> Extraction >> Contour. We use the Contour plugin to generate contour lines from points.The plugin can be accessed from the Manage >> install plugins menu under Plugins.

a. Make CSV file format of given data (**Figure 1**).

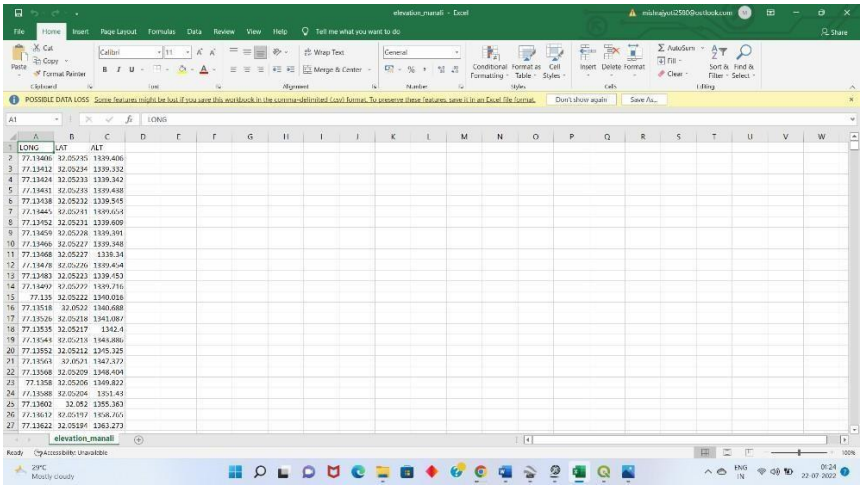

Fig. 1. Data in CSV file format

b. Install contour plugin in QGIS. The plugin can be accessed from the Manage >> install plugins menu under Plugins as shown in **Figure 2.**

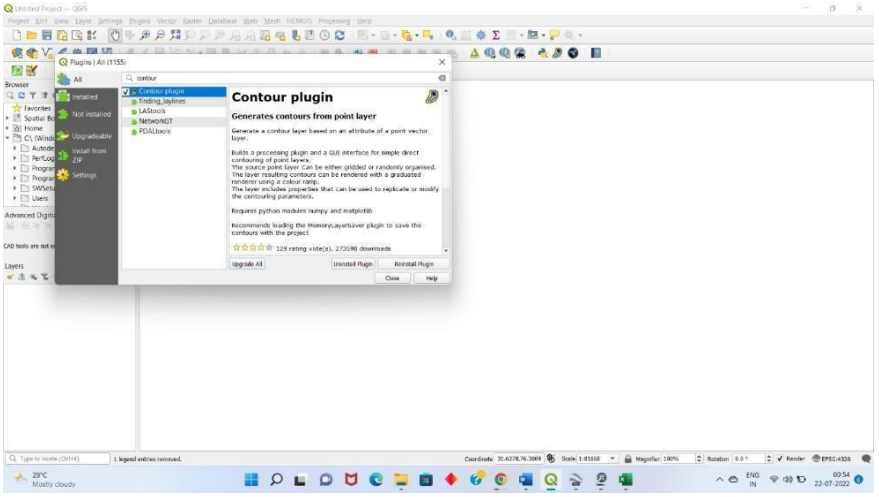

Fig. 2. Install contour plugin

c. Import the CSV file as shown in **Figure 3**. and create contour using plugin, we can use the tool from menu bar Layer>> Data source manager >> Delimited text.

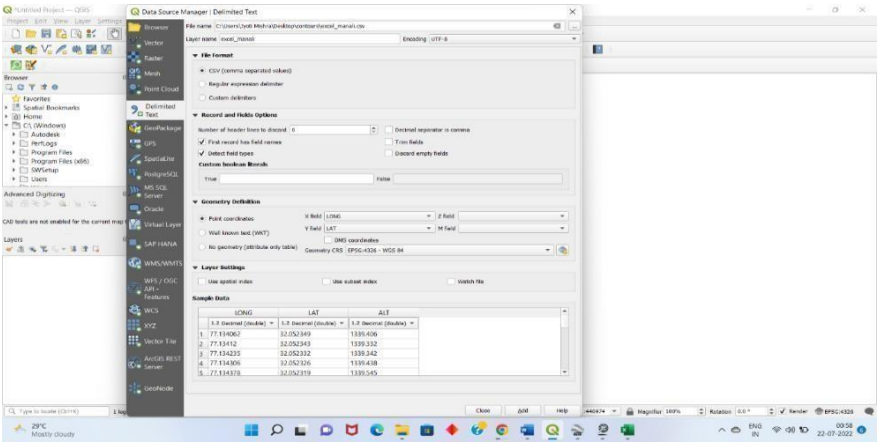

Fig. 3. Data source manager

d. Again, go to contour tool vector>> Contour (**Figure 4.**)

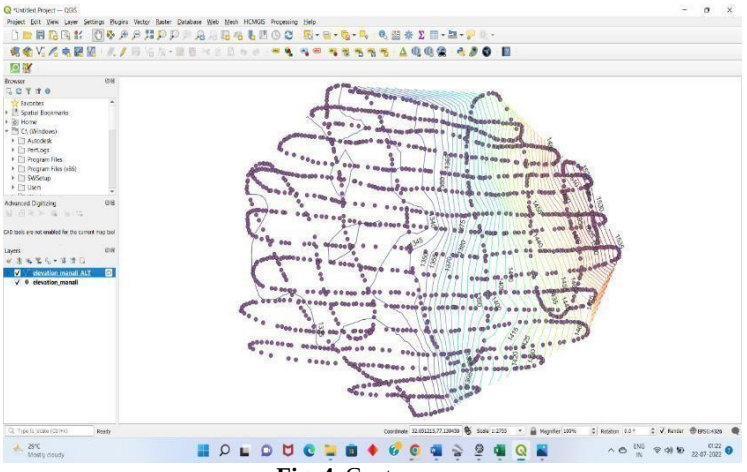

Fig. 4. Contour map

e. Choose other options like contour interval CI=1m. Fixed contour interval method shouldbe selected and in data value select elevation. (Refer **Figure 5.**)

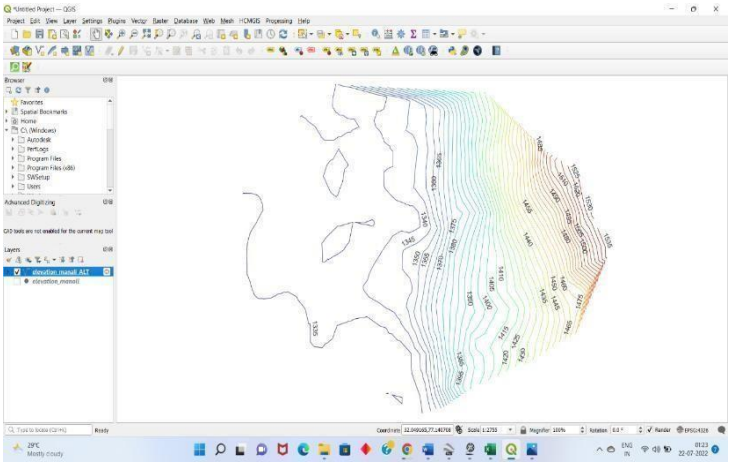

Fig. 5. Contour map by using point data

3.7.2 Create Contours from DEM

The Contour option in the Raster menu under Extraction >> Contour to producecontourlines from DEM.

There are numerous processes that can be taken to construct contour lines from DEM:

a. Fill the QGIS map canvas with DEM data.

b. Activate the Contour tool as shown in **Figure 6.**

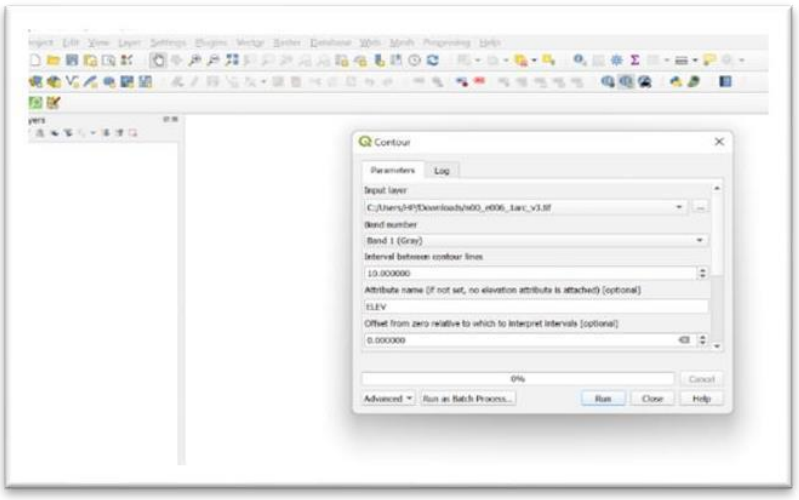

Fig. 6. Contour tool

c. Pick the DEM information. The contour interval is then set. We can provide thecontour outputs path or save it to a temporary file in the Contours option.
d. If all settings are already in place. Select "Run in Background" from the menu.Output is shown in **Figure 7.**

Fig. 7. Contour map

The DEM contour lines appear smoother than the points in the comparison as noticed in **Figure 8.** That is because of the DEM including more elevation data than the pointsdataset. Each pixel

in the DEM has information, therefore it may have thousands of pixels and elevation data.

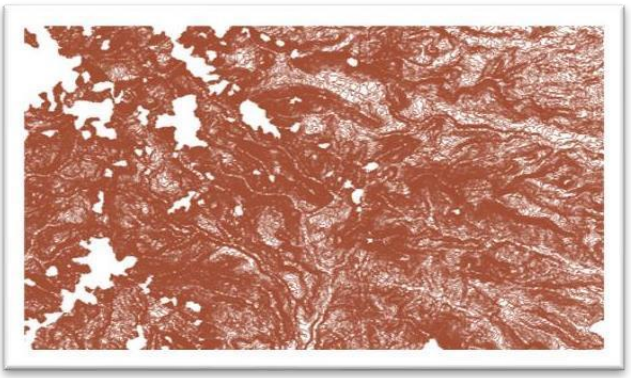

Fig. 8. Contour map by using DEM data

4 Terrain Analysis in Qgis

Terrain analysis is the use of geographic information systems to interpret topographicfeatures. Slope, viewshed, aspect, elevation, flow, contour lines and downslope and upslope flowlines are a few examples of these properties. It focuses on the connectionsbetween ecological systems and physical characteristics. The transverse and longitudinal dimensions of the land surface make to the concept of terrain.

For digital elevation models, the Raster Terrain Analysis Plugin could be used to determine the slope, hill shade, slope, roughness index, and relief from DEM. It is easytouse and offers a clear graphical interface for adding new raster layers.

4.1 Steps For Terrain Analysis

a. Step 1: - Collect data in DEM format with the help of google earth pro or earth explorer.
b. Step 2: - Import DEM data in QGIS map view. Go to menu bar and select layer, add layer, and add raster layer, respectively.
c. Step 3: - To terrain analysis, go to menu bar as shown in **Figure 9** and select raster and proceed with analyzing hill shade, slope, and aspects, respectively.

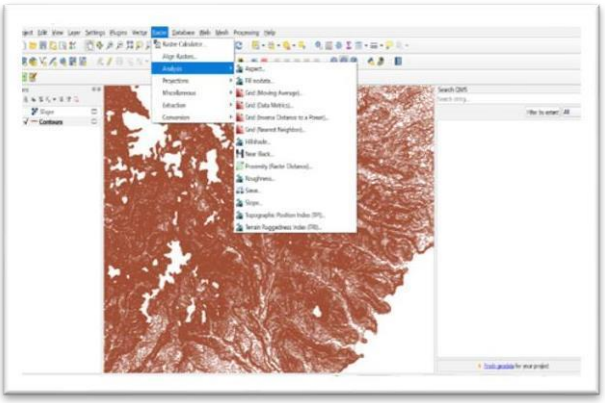

Fig. 9. Menu bar to analyse terrain

4.2 Slope

Slope is the angle of inclination to the horizontal. You have the option of specifying the type of slope value you want degrees or percent slope. Slope is the angle of inclination to the horizontal.

Step to analyse slope in terrain analyse:

a. Extract DEM data in QGIS layer with the help of data source manager
b. Open Slope, raster>Analysis> slope (**Figure 10.**)
c. Use information tool bar to collect information of slope

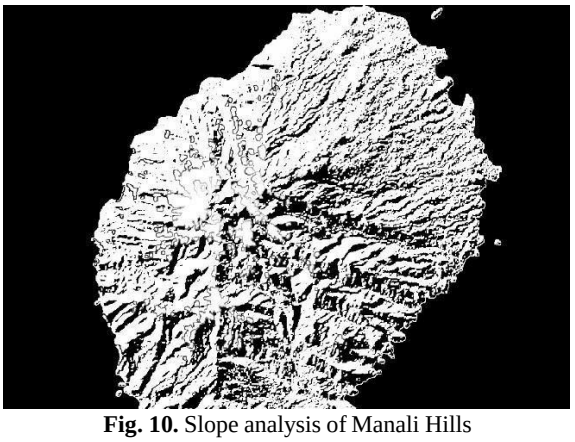

Fig. 10. Slope analysis of Manali Hills

4.3 Aspect

Aspect is defined as the horizontal direction of the slope of topographic feature. Aspectis the directional measure of slope. Aspect starts with 0° at the north, moves clockwise,and ends with 360° also at the north.

Steps to analyse aspects in terrain analysis: -

a. Extract DEM data
b. Open Raster>Analysis>aspects (refer **Figure 11.**)
c. Use information tool bar to get information.

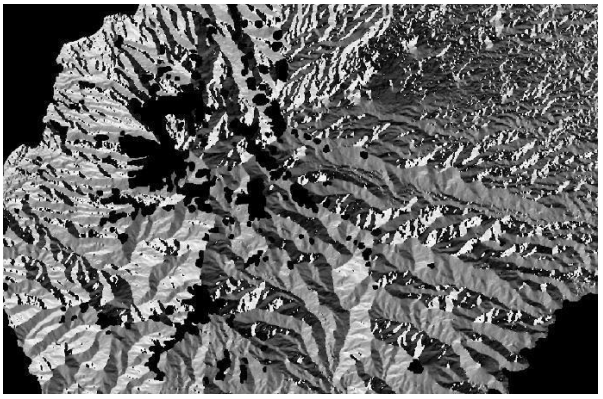

Fig. 11. Aspects analysis of Manali Hills

4.4 Hill shade

Although the DEM showing on map does show you the terrain's elevation, it occasionally seems a little abstract. It does not appear to be a 3D object, but it has all the necessary 3D landscape data. It is possible to calculate a hillshade, which is a rasterthat maps the terrain using light and shadow to produce an image that appears to be inthree dimensions, to gain a better view of the terrain.

a. Use QGIS' all-in-one DEM analysis tool to work with DEMs.
b. Select the menu item. DEM and raster analysis
c. Verify that the input file is the DEM layer in the dialogue box that appears.
d. Change the output file's directory setting to hillshade.
e. Ensure that hillshade is chosen under the mode choice.
f. Store the file under temporary files
g. You can choose to not modify any of the other choices.
h. To create the hillshade, click OK.
i. When it indicates that processing is finished, click OK to dismiss the notification and hillshade is generated as in **Figure 12.**

A hillshade can offer a lot of helpful data regarding the sunlight at a specific time of day. But it can also be utilized to improve the aesthetics of the map. Setting the hillshade to be primarily transparent is crucial in this situation.

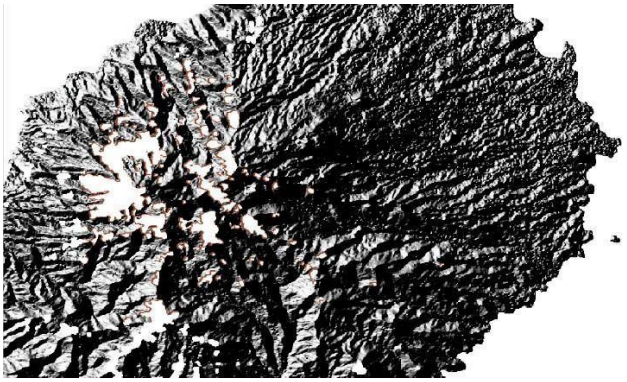

Fig. 12. Hill shade analysis of Manali Hills

4.5 Ruggedness Index

According to Riley et al., the ruggedness index is a quantitative way to assess terrain heterogeneity (1999). It is determined for each place by adding up the elevation changewithin the 3x3 pixels as depicted in **Figure 13.**

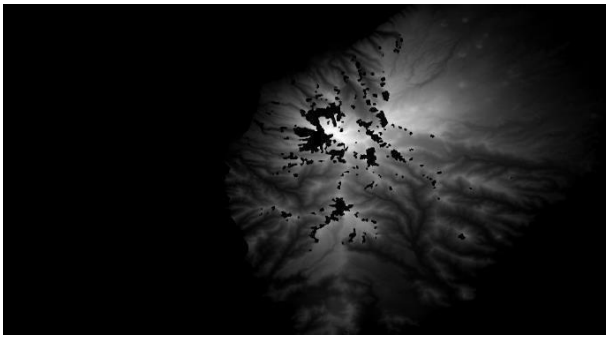

Fig. 13. Ruggedness Index analysis of Manali Hills

5 Conclusion

This study has demonstrated the valuable application of QGIS (Quantum Geographic Information System) in generating contour maps for terrain analysis. The study has shown that QGIS offers a user-friendly interface and a range of geoprocessing tools that enable efficient manipulation and analysis of terrain data. By utilizing QGIS, researchers can generate accurate and detailed contour maps, allowing for a deeper understanding of topographic characteristics and patterns within a given area. The software's customization options further enhance the visual representation of contour maps, aiding in effective communication of terrain features. QGIS's compatibility with various data formats facilitates data integration, enabling researchers to incorporate additional layers of information for comprehensive terrain analysis. Moreover, QGIS's cost-effectiveness as an open-source software makes it accessible to researchers with limited budgets. Overall, the findings of this research highlight QGIS as a valuable tool for terrain analysis, empowering researchers and professionals in making informed decisions in fields such as land management, and infrastructure planning.

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