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Application of GIS in determination and mapping of topographic characteristics of temperate Himalaya

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Abstract
For the understanding and management of physical environment the mapping and visualization of topographic information is of great importance. Researchers all over the world are using GIS software in their investigation because it has proved to be a successful tool for sustainable development. In view to contemporary cartographic output the application of GIS in landscape mapping and visualization has increased many folds. The main objective of this paper is to determine the application of GIS software to analyze the topographical data. The application of GIS in mapping and visualization has occurred due to advances in computer technology. For the perceived user needs and the technology that allows faster visual display, GIS uses the idea of visualization through maps. For manipulation and extraction of terrain features DEM based topographic data of the study region was entered in the GIS softwares. Some important topographic features were generated and extracted that built GIS assisted topographical data such as contour and spot height, slope and relief direction, drainage and hill shade. For the analysis of this database important landscape features were classified. For investigation, planning and policy making these digital derivatives are essential for understanding regions landscape.

Keywords: GIS, spatial information, topography landscape mapping visualization

Introduction
Spatial information about the topography of an area is essential for the sustainable agricultural development. Spatial information pattern assessment is one of the fundamental characters of GIS for visualization (Comber *et al* 2008, Murad 2008, Papadimitriou 2009, Gao *et al* 2016, Mushonga *et al* 2017) [9, 20, 26, 13, 21]. The use of GIS technology facilitate the management of topography more efficiently and effectively so as to enable the spatial information within predefined space scale. The GIS enables the pedologists geologists, geographers and landscape researchers to investigate the spatial pattern and determine the correlation between human activity and physical environment. (Armitage *et al* 2000, Davydov & Timoshok 2010, Nichols *et al* 2014, Capizzi *et al* 2016) [3, 10, 22, 5]. Land physical characteristic information is one of the important parameter in geomorphic mapping which is derived from landform mapping and classification at regional and global level. The landform or topography is characteristic element in geomorphic mapping which divides earth's surface and includes relief slope, elevation and other land activities (Pankaj ans Kumar 2009, Alobeid *et al* 2010 Challis *et al* 2011, Kanth *et al* 2102, Pingale *et al* 2012) [25, 2, 6, 15, 27]. Researchers use the GIS and DEM in their data for increasing the quality of landform mapping because it includes 3d relief features and elevation information (Sandeep *et al* 2013, Vinoth 2014, Shaikh and Farjana 2015, Mayoral *et al* 2017, Orengo and Petrie 2017, Zamora 2017) [30, 33, 31, 17, 24, 34]. Today the GIS and DEM is one of the basic research domains in digital terrain analysis of landform classification. Before the advancement of GIS and Dem the cartographers faced difficulty in mapping the landscape and displaying results. These cartographers were exploring data from the conventional methods and surveys. The topographical maps produced by these methods were largely interpolated with contour lines. These methods are not being followed due to less cost effective, time consumption tediousness and less accuracy (Ganpatrao and Ghosh 2014, Liu *et al* 2015) [12, 16] The manual method of topographic mapping and visualization cannot be used for planning in the present time because of low quality and quantity of spatial information. Earlier the GIS was not considered efficient tool for making map and Clarke *et al* 1996 redefined it as a tool from the perspective of its

Functional capabilities that brings certain elements together for analyzing and solving the problem. GIS is the state of art technology beginning with automated modeling of landscape captured by cameras, digitizers, and scanners (Ajami *et al* 2016) [1] In the advanced cases of GIS the data is being collected from satellite and then integrated with high tech computers so that the data can be visualized, analysed, manipulated, enhanced and stored as data reference to earth. The GIS is capable of generating extremely high detailed 3D models of the earth surface by use of sensors in the space satellite and revolutionized topographical map generation (Pradhananga and Teizer 2013, Mert and dag 2017) [28, 18] The application of GIS software to map and visualize high resolution space derived data such as DEM eradicates the problem related with its high cost of producing relief maps, better visualization platform, increased level of accuracy and reduce topographic map revisions and also simplifies for planners and policy makers the complex topographic data through revisualization platform. The DEM when properly integrated by GIS can not only display 3d attributes and non-attribute data of landscape but can also define flow direction, river networks watersheds nodes, and other hydrological and topographic features (Nijzink *et al* 2016, Fenicia *et al* 2016) [23, 11]. GIS technology has made topographical mapping faster and accurate by its power to visualize geographic data by allowing its users to integrate various data sources. The GIS is also a powerful platform for multilevel decision making because of its capability to visualize and determine spatial and non-spatial data. The GIS enables large volume of geographic data to be summarized into a map without any interpretation. Fundamentally the current study was done to map the topographical area of the temperate Himalaya. In our study the topography mapping using GIS in the temperate Himalaya involved visual interpretation technique to obtain landform features instead of digital. Generally the visual image interpretation technique for the landform application utilize multispectral imageries from the land sat images combined with the DEM. The role of topographic mapping at the regional and national level was recognized in many developing countries and is also the reason for the investment in the technology for data collection manipulation and geo-visualization The application of DEM in applying digital technique is more pronounced on hydrology, land cover changes, natural disaster and general land physiographic changes using multi temporal data. The feature element of landform are diversely complex and requires high understanding and experience in interpreting them. The study area is the temperate Himalaya with high vegetative cover and the landform identification with visual interpretation could not be easily done. The current research provides concept of map landform in the rapid and easy way.

Table 1: Previous study of topographic mapping using GIS softwares

Name of topics	Country	Authors
Topographic mapping from satellite images: How feasible in developing countries	Germany	Ajayi, G. E. 1992
A comparison of prediction methods for the creation of field-extent soil property maps	Australia	Bishop and Mcbratney 2001[4]
Analyzing digital terrain attributes to predict soil attributes for a relatively large area	Jordan Amman	Feras M. Ziadat 2005
Red relief image map: New visualization method for three dimensional data.	Australia	Chiba *et al* 2008 [7]
Application of remote sensing and GIS in environmental monitoring in the Hindu Kush Himalayan region	India and Nepal	Shrestha *et al* 2016 [32]
Analysis of Digital Elevation Model and LNDSAT Data Using Geographic Information System for Soil Mapping in Urban Areas	Berlin Germany	Mohamed Ali Mohamed 2017 [19]
Generating Topographic Map Data from Classification Results	Denmark	Joachim Höhle 2017 [14]
Influence of relief and vegetation on soil properties in a disturbed chernozem soil landscape	Germany	Raab *et al* 2017 [29]
Research on the application of rapid surveying and mapping for large scare topographic map by aerial photography system	China	Goa *et al* 2017

Material and Methods

Study area

The study area is located in the temperate Himalaya of the North–Western part of India between the latitude 34º12′ to 34º20′ North latitude and 74º20′ to 74º34′ East longitude with an elevation of 1584 meters and an area of 3353 km^2. The region has the high, mid and low altitudes consisting of mountains, hills and valleys. The region has an annual rainfall of 1270 mm and an average temperature of 24° C. The highland is separated by a wide valley which is stretched by the river Jhelum in the eastern and western direction. In the north western part is the Jhelum and in the southern part is Pakistan. The topography of the area steep slopy to moderately slopy with some plain area as well.

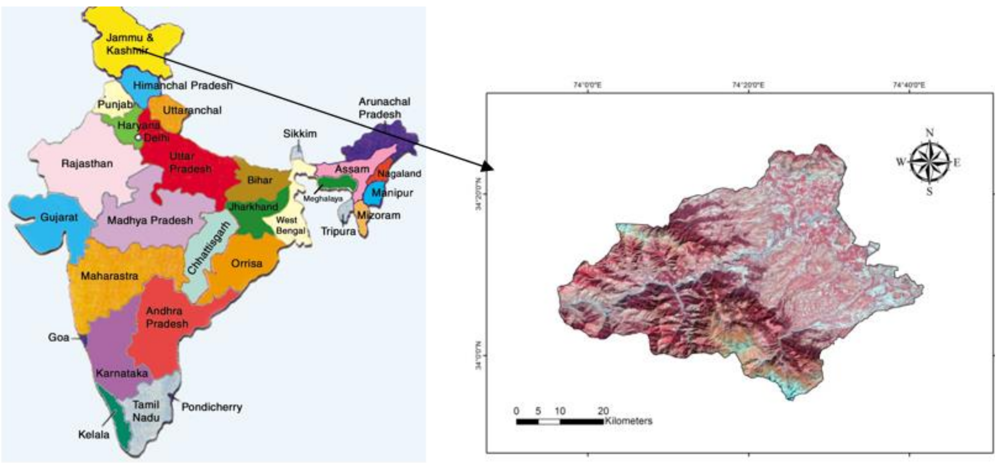

Fig 1: Shows the satellite image of the study area

Data

In the geographic and pedological survey the use of GIS has become an intensive, reliable and well developed tool. The current study focuses on the development of topographical maps using arc GIS. The Arc-GIS with high resolution DEM was produced using 1 degree by 1 degree tiles for the entire study area. The DEM developed was converted to various raster formats. The dataset produced was processed early in the 10.1 version of Arc-GIS to fill voids and to produce geographic coordinate system. The Arc-GIS using dual antennae, single pass interferometric synthetic aperture radar processing at a wavelength of 5.6 cm has generated most global DEM covering all the study area.

Method

For ensuring the maximum accuracy in topographic mapping various sophisticated and recent GIS softwares and algorithms were developed including Arc- GIS and global mapper version---. These tools were designed specifically to develop terrain information. For the analysis using DEM requires the merging of SRTM DEM tiles of one raster grid and then it's processing with Arc- map or Arc-Info GIS. Using the DEM assembly tool the elevation data of tiles of 1 degree were merged to produce terrain features. This one degree tiles were used to creat more accurate data and more visualization although certain other degree tiles can also have been used. The spatially created DEM were used in the current study. The actual shape and size of the study region was produced by resampling DEM in grid format using the mask tool of spatial analyst tool-box of Arc- GIS.

Result and Discussion

For visualization and mapping of the topographic information the GIS software having automatic extract surface features were used. The GIS software gives the reliable result which is easy to understand and is also more precise. The parameters that were recorded included contour line and spot height, Aspect and slope direction and 3-dimensional simulation model of the region's terrain.

Contour line and spot height

Before the advancement of DEM based analysis the use of contour line and spot height were most effective method for mapping topographical characteristics. The contour line and spot height represented land slope gradient and elevation simultaneously. The density or spatial clustering of contour lines along the strip determines the slope gradient of an area. The height value of the lines meters above the sea level represents the elevation of an area. In the mapping of an area flat surfaces and fine topography contour lines does not produce sufficient information and are to be integrated with the spot height. The reason for making contour maps are collecting data which is highly interpolated. Based on the high accuracy and precision the use of DEM to generate contour map is gaining wide acceptability and popularity. The value of particular spot height within the terrain determine the spot height and fits integration with the contour map improves its accuracy.

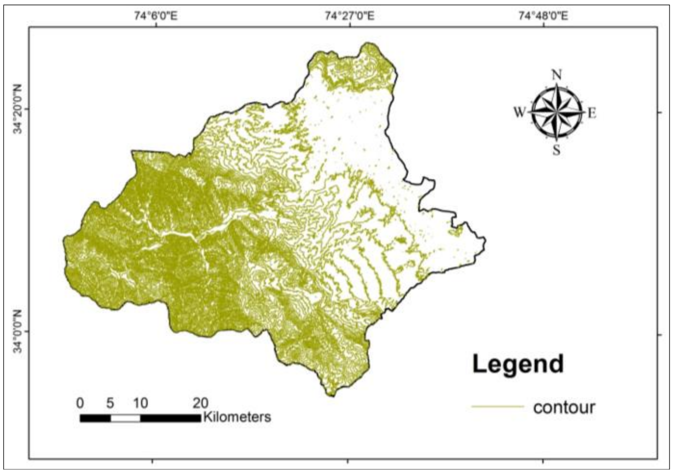

Fig 2: Showing contour map of the area –contour intervals is set to 50 meters

The density of the contour lines determine the ruggedness of an area. The results in the figure show hierarchy in topography with reference to height and ruggedness of relief. The north of the area generally represents the upland area and the south represents the low land area. A distint area between the northern and southern relief reveals wide valley in the contour map. The highest and lowest points are generally represented by spot height. At the highest point the spot height was 2473m and at lowest point it was 1298 m above sea level.

Aspect and slope direction

Slope is the degree of incline or steepness of an area and is computed by raster or Tin surfaces but cannot be computed directly from Lidar points. The maximum rate of change of elevation between the location and its surrounding determine the slope of an area and is expressed in degree or percentage. Aspect on the other hand determine slope in clockwise from 0-360^0. Where 0^0 is north facing, 90^0 is east facing, 180^0 and 270^0 are south and west facing directions. The aspect determine maximum rate of change in the values of cells from its neighboring cells and also detects downslope and downhill direction. The slope is also referred as slope direction. For a cell a particular value represents the compass direction of the slope at a particular location. The slope facing north to northwest are represented in dark shade and the slope facing north to north east are represented in the light shade. The flat areas having no downslope direction are represented by the darkest shades. The slope direction of grid are also used for topographical modeling such as locating and characterizing area of landslide, high water runoff and the areas receiving high and low solar intensity and illumination. The results also revealed that majority of flat areas are found in south and South west part of the region. In the terrain model of the northern aspect the slope is directed towards northwest and in southern direction it is facing northeast.

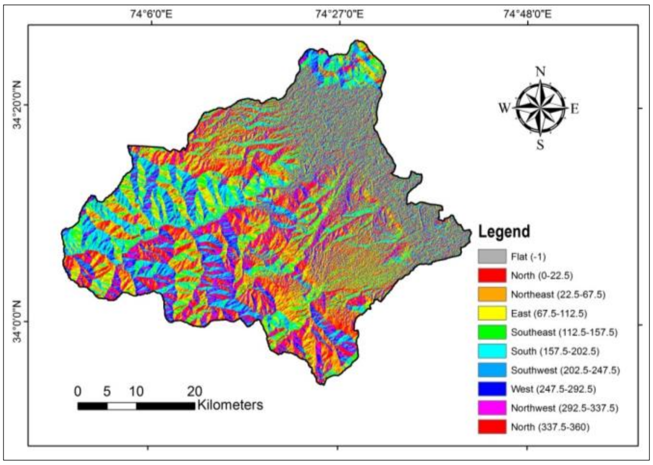

Fig 3: Aspect map showing the slope direction of the region

The slope of an area are determined as gradient of plane formed by the vector connecting from left to right cells and also from vectors connecting upper and lower neighbors. The magnitude of level of steepness or the value of surface structure inclination is displayed by the slope of that area. The slope values in an elevation grid of an area ranges from 0^0 that is flat surface to 90^0 that is perfect vertical slope.

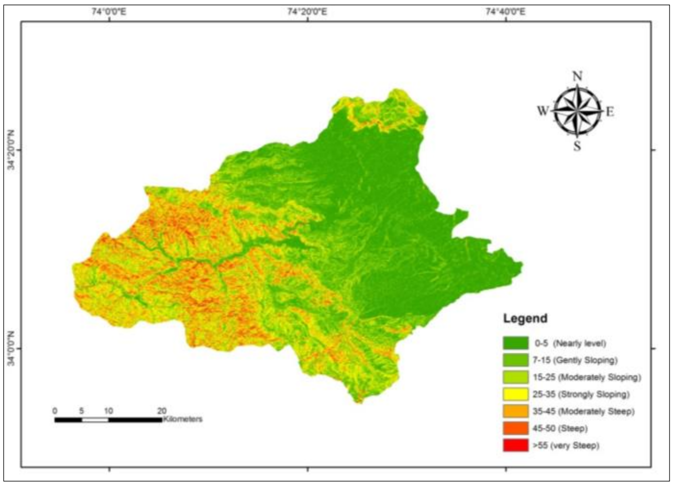

Fig 4: Shows that slope gradient of study area

The figure shows that slope decreases from north to south. The linear breaks in the slope angle determine large valley running from east to west. The slope of the region ranges from 0- 30 ^{0}. The steeper slopes are represented by black color and less steep slopes by the white color. The slope gradient and slope aspect when combined together are important source of information for erosion modeling and overall landscape.

Drainage network

Drainage network is one the important aspect determining rainfall runoff, managing water resources and predicting flood levels. The drainage network extraction from the Arc GIS Using DEM has received considerable attention and the most commonly followed method is deployment of a model for surface water flow accumulation. The extraction of drainage network of the study area was carried out from Arc- GIS in the raster format with 30x 30m grid size. These drainage networks are derived from DEM using GIS through the following steps; (a) depression filling of that area (b) flow direction of that area (c) calculating the flow accumulation values (d) deriving the drainage network according to flow according to flow accumulation values. The drainage networks extracted from DEM are shown in the figure

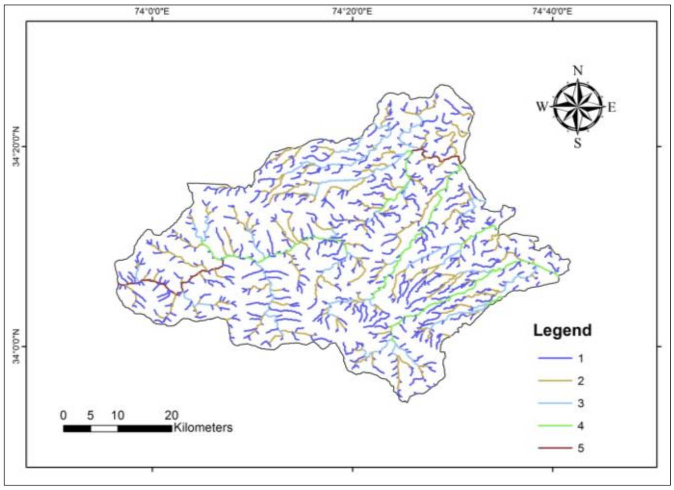

Fig 5: Shows the drainage network of the study area

The drainage networks in the figure demonstrates that the area is at headwaters of a number of drainage system or stream threshold. The stream threshold from the study area flows in all direction and gets collected in the Wular Lake in the North east direction, and in Jehlum River in the south east and south west direction. The stream threshold of an area was determined by the Dem resolution. The density of the derived drainage network increases with the decrease of the threshold value. The drainage density is the other critical parameter of drainage network composition, which measures the degree of drainage development within a region. The drainage density indicates the rugged texture of an area by providing useful numerical values of dissection and runoff potential of an area.

Hill shade

Hill-shade is a method to represent the two dimensional (2D) map of terrain and three dimensional (3D) appearance. This is generally achieved using a single point source of illumination and with the advent of computer mapping. For gridded terrain data the cosine of angle between vector of illumination and the surface normal vector defines the gray value (0-180) of each surface unit. Hill shade maps gives a richly textured appearance of the area and it is most critical for the mountainous areas due to rapid variation in the orientation of the terrain element. The hill shade technique varies with the luminosity of color based on the aspect of terrain. Colors are preferred in an elliptical pattern in hue-saturation-value (HSV) color space such that terrain facing opposite directions will show variations in luminosity. The highest hill shade was in a direction of North West and lowest in the North East and South East.

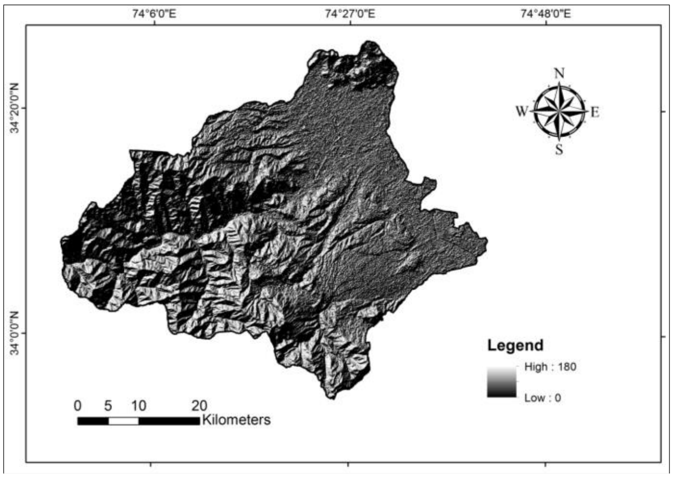

Fig 6: Hill shade

3-D analysis

Global mapper GIS/ ARC Scene application was used for 3-D mapping and visualization of the study area. The Global mapper GIS/ ARC Scene application produced the shade free 3-D image of the landscape thus giving the visual impression of that area in any direction. In this technique the surface of an area is not generated by the sun direction or the aspect but by the DEM information. The 3-D model of GIS is powerful tool for geographic analysis and also provides the quick understanding of landscape and the physical environment of that area.

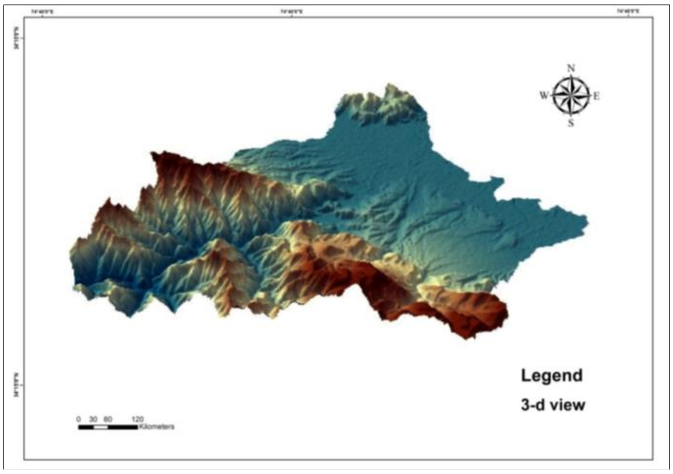

Fig 7: showing 3-d profile of study area

Arc Scene allows to overlay many layers of data in a 3D space. The Features are put in 3D by providing height information from layer properties, feature attributes, feature geometry, or a defined 3D surface, and every layer in the 3D view can be handled differently. Data with varied spatial references will be projected to a common projection, or even it can be displayed using relative coordinates only. Arc Scene is also fully processed with the geo processing environment, providing access to many analysis tools and functions. The figure clearly revealed the terrain of a region by underlying suspicious structure. The 3-D image of an area provide open research frontier for the pedologists and geologists to determine the development of that area.

Conclusion

This paper has demonstrated that GIS can effectively be used for mapping and visualization of the topographic features with regard to DEM based models. The application of GIS softwares over the last years in landscape modeling has been embraced by the researchers in the physical environment disciplines. The geomorphic visual model developed for any topography is a complicated work that needs complex state of art technology for accurate results. The GIS provides very extensive study of large scale topography of all the area of the world in a less time and cost effective manner. The maps derived in this paper clearly proves that using GIS algoriths is a better substitute for visualization technique than conventional mapping. The study also demonstrates that several topographic information can be extracted from a single DEM data, while in conventional mapping technique numerous land survey data and aerial photographs were needed to generate spatial information. In addition to this it also became possible to produce a large scale contour map of the study area using the prescribed methodology. The 3d mapping and geovisualization technique further strengthened the topographic mapping procedure. Using the Dem data and geovisualization algorithms it was easy to view and display the landscape of the region from multi perspective without losing any information or distorting the map.

From this study it is evident that manipulation and visualization of the data using GIS software is far reliable, less cost and time consuming as compared to traditional and conventional surveys and mapping methods. The numerous maps generated made it easier to understand and interpret topographical data. This quality information and the data provided is very explorative for spatial planning and will contribute significantly to solving agricultural, geomorphologic and environmental problems.

References

1. Ajami H, Khan U, Tuteja NK, Sharma A. Development of a computationally efficient semi-distributed hydrologic modeling application for soil moisture, lateral flow and runoff simulation, Environ. Modell. Softw. 2016; 85:319-331.
2. Alobeid A, Jacobsen K, Heipke C. Comparison of matching algorithms for DSM generation in urban areas from Ikonos imagery. Photogram. Eng. Remote Sensing. 2010; 76(9):1041-1050.
3. Armitage RP, Weaver RE, Kent M. Remote sensing of semi-natural upland vegetation: the relationship between species composition and spectral response. In: Alexander, R. and Millington, A., (eds) Vegetation mapping: from patch to planet. John Wiley and Sons, Chichester, 2000, 83-102.
4. Bishop TFA, McBratney AB. A comparison of prediction methods for the creation of field-extent soil property maps. Geoderma. 2001; 103:149-160.
5. Capizzi G, Grazia Lo Sciuto, Wozniak M, Robertas Damasevicius. A Clustering Based System for Automated Oil Spill Detection by Satellite Remote Sensing. ICAISC. 2016; 2:613-623.
6. Challis K, Forlin P, Kincey M. A generic toolkit for the visualization of archaeological features on airborne lidar elevation data. Archaeological Prospection. 2011; 18(4):279-289.
7. Chiba T, Kaneta S, Suzuki Y. Red relief image map: new visualization method for three dimensional data. "The International Archives of the Photogrammetry, Remote Sensing and Spatial Information Sciences. Beijing. 2008; 37(B2):1071-1076.

8. Clarke KC, McLafferty SL, Tempalski BJ. On Epidemiology and Geographic Information Systems: A Review and Discussion of Future Directions. Emerging Infectious Diseases. 1996; 2(2):85-92.
9. Comber A, Brunsdon C, Green E. Using a GIS-based network analysis to determine urban greenspace accessibility for different ethnic and religious groups. Landsc. Urban Plan. 2008; 86:103-114.
10. Davydov VV, Timoshok EE. Forming of soils on young moraines in the basin of the Aktru Glacier (Central Altai, North-Chuya Ridge). Contemporary Problems of Ecology. 2010; 3(3):356-362.
11. Fenicia F, Kavetski D, Savenije HHG, Pfister L. From spatially variable stream flow to distributed hydrological models: Analysis of key modeling decisions, Water Resour. Res. 2016; 52:954-989.
12. Ganpatrao NG, Ghosh JK. Information extraction from topographic map using colour and shape analysis. Sadhana. 2014; 39(5):1095-1117.
13. Gao F, Kihal W, Meur N Le, Souris M, Deguen S. Assessment of the spatial accessibility to health professionals at French census block level. Int. J. Equity Health. 2016; 15:125.
14. Joachim Höhle. Generating Topographic Map Data from Classification Results. *Remote Sens.* Journal of Scientific Research and Reports. 2017; 9(3):224.
15. Kanth TA. Morphometric analysis and prioritization of watersheds for soil and water resource management in Wular catchment using Geo-spatial tools. Inter. J of Geo, Earth and Environ. Sci. 2012; 2(1):30-41.
16. Liu TG, Miao QG, Xu PF, Song JF, Quan YN. Color topographical map segmentation algorithm based on linear element features. Multimedia Tools and Applications, 2015, 1-22.
17. Mayoral A, Toumazet JP, Simon FX, Vautier F, Peiry JL. The highest gradient model: a new method for analytical assessment of the efficiency of LiDAR-derived visualization techniques for landform detection and mapping. Remote Sensing. 2017; 9(2):120.
18. Mert BA, Dag A. A Computer Program for Practical Semivariogram Modeling and Ordinary Kriging: A Case Study of Porosity Distribution in an Oil Field, Open Geosciences. 2017; 9:663-674.
19. Mohamed Ali Mohamed. Analysis of Digital Elevation Model and LNDSAT Data Using Geographic Information System for Soil Mapping in Urban Areas. Scientific Research an Academic Publisher. 2017; 8(12):767-787
20. Murad A. Defining health catchment areas in Jeddah city, Saudi Arabia: An example demonstrating the utility of Geographical Information Systems. Geospat. Health 2008; 2:151-160.
21. Mushonga HT, Banda F, Mulolwa A. Development of a web based GIS for health facilities mapping, monitoring and reporting: A case study of the Zambian Ministry of health. S. Afr. J. Geomat. 2017; 6:321-332.
22. Nichols EN, Bradley DL, Zhang X, Faruque F, Duhé RJ. The geographic distribution of mammography resources in Mississippi. Online J. Public Health Inform. 2014; 5:226.
23. Nijzink RC, Samaniego L, Mai J, Kumar R, Thober S, Zink M *et al.* The importance of topography-controlled sub-grid process heterogeneity and semi-quantitative prior constraints in distributed hydrological models, Hydrol. Earth Syst. Sci. 2016; 20:1151-1176.
24. Orengo HA, Petrie CA. Large-scale, multi-temporal remote sensing of palaeo-river networks: a case study from northwest India and its implications for the Indus Civilisation. Remote Sensing. 2017; 9(7):735.
25. Pankaj A, Kumar P. GIS-based Morphometric Analysis of Five Major Sub-watersheds of Song River, Dehradun District, Uttarakhand with Special Reference to Landslide Incidences. Journal of Indian Society of Remote Sensing. 2009; 37(1):157-166
26. Papadimitriou F. Modelling spatial landscape complexity using the Levenshtein algorithm. Ecol. Inform. 2009; 4:48-55.
27. Pingale Santosh M, Harish Chandra, Sharma HC, Sangita Mishra S. Morphometric analysis of Maun watershed in Tehri-Garhwal district of Uttarakhand using GIS. International Journal of Geomatics and Geosciences. 2012; 3(2):373-784.
28. Pradhananga N, Teizer J. Automatic spatio-temporal analysis of construction site equipment operations using GPS data, Automation in Construction. 2013; 29:107-122.
29. Raab T, Hirsch F, Vasserman O, Raab A, Naeth N. Influence of relief and vegetation on soil properties in a disturbed chernozem soil landscape. Geophysical Research Abstracts. EGU General Assembly. 2017; 19:EGU2017-2332.
30. Sandeep S, Tripathi S, Maurya AK. GIS Based Morphometric Characterization of Mini Watershed - RachharNala of Anuppur District Madhya Pradesh. International Journal of Advanced Technology & Engineering Research (IJATER). 2013; 3(3):32-38.
31. Shaikh M, Farjana B. Analysis of Watershed Characteristics Using Remote Sensing and GIS Techniques. International Journal of Innovative Research in Science, Engineering and Technology. 2015; 4(4):1971-1976.
32. Shrestha F, Uddin K, Maharjan SB, Bajracharya SR. Application of Remote Sensing and Gis in Environmental Monitoring in the Hindu Kush Himalayan Region. In: AIMS Environmental Science. 2016; 3:2372-0352.
33. Vinoth M. Characteristics of Drainage Morphological Studies Using GIS in Kolli Hills, Central of Tamil Nadu, India. International Journal of Remote Sensing & Geoscience (IJRSG). 2014; 3(3):10-15
34. Zamora A. A model for the geomorphology of the Carolina Bays. Geomorphology. 2017; 282:209-216.
35. Ziadat FM. Analyzing Digital Terrain Attributes to Predict Soil Attributes for a Relatively Large Area. Soil Science Society of America Journal. 2005; 69:1590-1599.