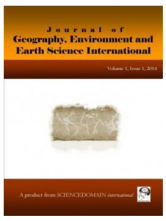

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Digital Earth in Enhanced Teaching Methods of Geography

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Authors' contributions

This work was carried out in collaboration between all authors. Author KV designed the study, performed the statistical analysis and mapping work, wrote the protocol and wrote the first draft of the manuscript. Author AKL guided and designed and edited the manuscript. Authors VSK and KJ helped in mapping and field study and collection of secondary data and tabulation. All authors read and approved the final manuscript.

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ABSTRACT

The scope of Geography expanded with changing trends in the world. 21st century is fast growing with modern trends in computer technology information systems and virtual world to obtain data about the physical and cultural worlds, and to use these data to do research or to solve practical problems as such. The use of traditional cartographic techniques in teaching terminology of Geography has turned with innovative teaching methods with computer aided Geo-informatic technologies. The current digital and analog electronic devices facilitate the inventory or resources and the rapid execution of arithmetic or logical operations. These information systems are undergoing much improvement and are able to create, manipulate, store and use spatial data much faster rate as compared to conventional methods.

The science of Geo-informatics is a cluster of information sciences like Geographic Information System (GIS), Remote Sensing (RS), Global Positioning System (GPS) and Photogrammetry. The GIS has roots in the analysis of information on maps, and overcomes many of the limitations of

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manual analysis. As a visual tool, maps are most effective in communicating spatial data. The vast majority of modern cartography is done with the help of computers, especially using GIS. With an advent of Remote sensing technology, satellite data is being increasingly used for mapping, monitoring and assessment of various spatial studies particularly in Geographic literature.
The teaching of Geography starts with the latitude and longitudes. The real-time information regarding lat-long and the elevation of the points established with the satellite-based radio-navigations system namely, Global Positioning System (GPS). The terrain models like DEM, DTM and DSM created with Photogrammetry and GIS, with advanced 3D models of spatial features of geographic literature are the real-time innovative teaching methods in Geography.

Keywords: Spatial data; geo-informatics; GIS; RS; GPS; photogrammetry; 3D models.

1. INTRODUCTION

The aim of education is to surge individual in right direction with rational thinking. The emerging trends in geo-spatial technologies like GIS, Remote sensing, Photogrammetry, GPS and LiDAR etc., have produced the scientific methods in teaching and learning in the field of geography. Since ancient to modern period, the scope of geography has undergone many changes. Presently, geography is in transition stage in conversion of social science approaches to scientific approach. The teaching methodology in geography also keeps changing from use of Globe, Charts, Models to Digital aid like Google Earth, Bhuvan (NRSC) etc., . The digital earth brings analog world into digital features and produce the easier method of understanding and bring changes in ideas and helps in planning and decision making.

The teaching of Geography subject is rooted in Greeks philosophical school and further it spread all over the Europe particularly Germans, French schools. According to Majid Husssain [1] the systematic description of earth explained by Greeks by using diagrammes, charts. Greek philosophers was come to known the locations of earth by extensive travelling. Hecataius, the father of Geography described whole earth centered with Mediterranean Sea. Aristotle – created a keen desire in his disciples to test theory by direct observation and he taught his pupils to ‘go and see’ and by that way Alexander the Great marched towards east and revealed beyond the Persian Empire. The systematic description of earth begin with Eratosthenes, he tried to measure the circumference of the earth. Hipparchus used instrument ‘astrolabe’ to measure latitudes and longitudes.

German schools of Geography developed the subject geography is enormous. They gave philosophical and scientific base. In starting stage of geography teaching in German universities was mostly general and monothetic and later converted to regionalist and idiographic in nature. The homogeneity of landscape was first explained by German geographers and particularly the Albercht Penck was leading German geographer explained the development of landscape and formulated the subject matter of ‘geomorphology’. Alexander von Humblodt led the way in the expansion of geography in and outside of Germany and he measured accurately the temperature of air and ground, pressure, winds, latitudes, longitudes, elevations above the sea level and nature of rocks and plants in relation with climate. Carl Ritter explained harmony of interactions of man and environment.

Mackinder’s [2] he was the first of a new generation of geographers and his work on 'The development of geography teaching out of nature study' opinion on the subject matter of geography concern it had to bridge the natural science and humanities and take as its core ‘the interaction of man in society and so much of environment as varies locally’.

Scarfe, N. James Fairgrieve [3], pointed out that regional paradigm recognized early on that systematization of the world’s natural regions and their climatic characteristics affected by human occurrence.

Jackson, E [4] of 'Only connect: approaches to human geography'explains effective teaching the subject geography in three aspects viz. 1. All pupils enjoy their geography, 2. Geography has a presence in whatever curriculum framework, 3. The geography curriculum is current, relevant and worthwhile.

The subject matter of geography has been redefining from locations of earth to interaction of human society on environment of particular space. The description of spatial differentiation of

earth also been changing from observation to mathematical calculation and further instrumental measurement of whole or part of earth. The spatial technologies are easy way to explain of spatial differentiation of earth are also been part of redefinition of geography.

According to department of education and employment (1991), Geography provokes and answers questions about the natural and the human worlds, using different scales of enquiry to view them from different perspectives. It develops knowledge of places and environments throughout the world, and understanding of maps, and a range of investigative and problem-solving skills both inside and outside the classroom. Geography is a focus within the curriculum for understanding and resolving issues about the environment and sustainable development. It is also an important link between the natural and social sciences. As pupils study geography, they encounter different societies and cultures. This helps them realise how nations rely on each other. It can inspire them to think about their own place in the world, their values, and their rights and responsibilities to other people and the environment. (Source: The School Curriculum and the National Curriculum: values, aims and purposes, 1999, DfES/QCA, page 154) [5].

The Commission on Geographical Education of the International Geographical Union [6]. The Commission suggests that students should develop attitudes and values" which are conducive to interest, appreciation, concern and understanding of the physical and human world (Bennetts, in Bailey and Fox, 1996, p.53).

Halford Mackinder esteemed Geikie's contributions to geographical education, as represented in The Teaching of Geography [7]. But he was also critical of that text, which he thought not tight enough in its definitions of the scope of the subject, accusing Geikie, in his wider environmental approach, of including topics which 'even the most grasping geographer would scarcely claim as his' (1887a, p. 506).

In the case of Mackinder, it was not so much the content of his 'good cause' that was the main problem, but the fact that he regarded instruction and special pleading as justified in its furtherance. Thus one of his articles was entitled 'The teaching of geography from the imperial point of view [8] and the use which could and should be made of visual instruction' (1911b).

Geikie's [9] credentials as an earth scientist and as a geographical educationist were impeccable. His The Teaching of Geography covered a broader field than the normal geography texts of the time, as befitted its environmental and local studies emphases.

James Fairgrieve [10] was better known as a geographical educator than as a geographer, in his work on 'Can we teach geography better?' Geography' helped to modernize geographical education and inspired more than one generation of teachers.

Walford and Haggett [11] see the future of geography in schools as resting on three variables "the effect of legal structures in the curriculum; the extent to which the subject continues to motivate students; and the future coherence and rationale for the subject" (Walford and Haggett, [13], p. 3).

Eleanor Rawling [12] highlights geography's wider curriculum contribution and leaves teachers considerable freedom to vary specific content and the emphasis given to particular aspects of geography and learning," also noted in Rawling (in Kent, 2000, p.103).

Dragos Simandan [13], in his book 'New ways of Geography' pointed out that the subject Geography is multifarious rather than so-called defined physical and human geography. Hence, the subject Geography presently is in condition of Cinderalla status where it struggle with other discipline lot. Simandan. D [14] also highlighted the subject will come out as rejuvenated Geography once it include the broad contents of Geography viz. a) human geography (population, settlements, economy, social, cultural, political geography, tourism), b) physical geography (geomorphology, climatology, hydrology, pedology, biogeography), c) regional geography (which includes the geography of landscapes, the regional study of continents, and territorial planning) and, d) environmental science (environmental geography, general geography, theory and methodology of geography). A fifth research group- on technical geography (GIS, remote sensing, topography, cartography).

The central theme of traditional Geography teaching is 'space' specific. The subject geographical space has been in dynamic in nature and presently with inclusion of technical space the content of geography subject elaborated with different technical contents like

GIS, Remote Sensing, Photogrammetry, GPS and Lidar analysis etc.

The geo-spatial technologies are applied in all the fields of geography. The raster data of landscape will obtain real time data with satellite networks, where GIS can be used in physical land cover patterns of the earth. The application of GIS is plenty in human geography. It starts from population studies to economic aspects of geography and also includes urban studies. Photogrammetry and LiDAR technologies built 3D landscape models that resemble the real world. Dragos Simandan described about how technical subject helpful for geographers in his book 'New ways of Geography' is the GIS geographer working on human geography topics has much more in common with a GIS geographer working on 'physical' issues, than with his non-GIS human geography colleagues.

The map, globe, toposheets, cadastral maps etc. are traditional teaching aids for teaching geography. Presently with advent of GIS, Remote Sensing, Aerial photography and Lidar imageries will helpful pupils to understand geographical spaces in class room where these spaces can only understandable with different field visits. Hence field visit is the compulsory for geography students as earlier due to some administrative constraints it could not possible all time. So that, these technical geography outputs are most effective and describe both physical and cultural aspect as well can understand earth effectively, for example the 'Google Earth' is an open source application explain earth most effectively. Considering with all these aspect the digital earth definitely will come as an enhanced teaching aid in geography subject.

2. OBJECTIVES

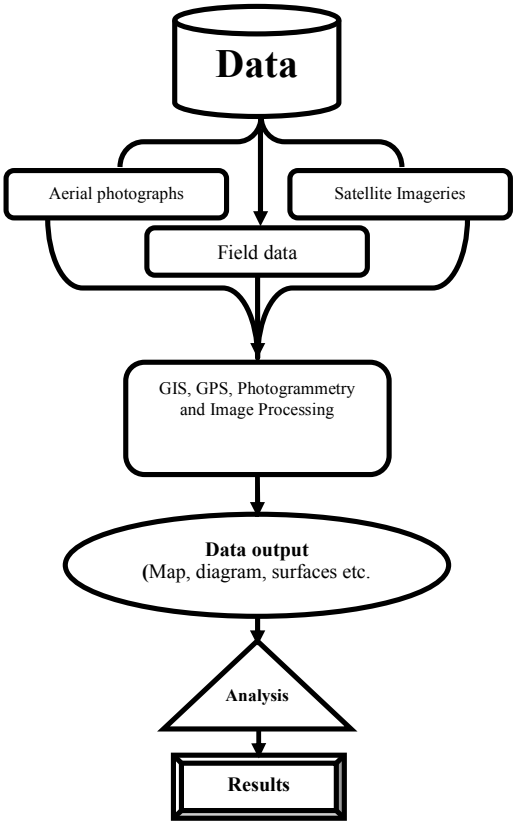
1. To study the concept and scope of Geography
2. To study the changes in the teaching methodology between the past and present.
3. To study the impact of the user friendly teaching methodology by using innovative teaching aids.
4. To study the applications of the innovative teaching aids for planning and development purpose.

3. HYPOTHESIS

It is assumed that the adoption of new teaching aids from time to time would help in proper application where by quick results can be drawn for better planning and understanding.

4. METHODOLOGY

In order to bring forth technical geography in teaching geography as digital earth in enhanced teaching models of geography, the geo-spatial technologies like GIS, Remote Sensing, Aerial Photography, Remote Sensing and GPS studies done in different case studies. Each case study has different study area and created spatial technical models by using geo-spatial technologies. The spatial data collected from various sources like Survey of India, NRSC, and Census of India etc. The secondary data like population figures obtained from Telangana state Census Operations of Census of India, 2011 enumerated data.



5. CASE STUDIES

A.M. Chandra, S.K. Ghosh [15] of 'Remote Sensing and Geographical Information System' explained large number of case studies providing a framework for carrying out various studies in different fields using remote sensing and GIS.

As the scope of geography is widened it is included with all geo-spatial technologies Along with GIS, Remote Sensing and other technologies of Light detection and Ranging (LiDAR), Photogrammetry and Global Positioning System (GPS). Digital earth widely uses in these geo-informatics. The fundamentals of geography can be divided into two branches; one is physical geography and another is human geography. Physical geography again consists of four branches with Geomorphology, Hydrology, Climatology and Ecology. The features of digital earth can be applied in these four branches of physical geography. The human geography studies the spatial aspects created by man. It includes Population geography, Economic geography and Urban and Settlement geography. The applications of spatial technologies also plays an wider role in human geography.

Geomorphology is defined as the scientific study of earth surface (landforms). There are three order of landforms existed on the earth surface. First order landforms consists continents and oceans, the second order landforms are Mountains, Plateaus and Plains, the third order landforms existed within the first and second order landform. The digital earth is an aid to represent whole earth, in this context the google has created the total data base of the earth that give a detail information of first and second order land forms.

Fig. 1. Digital Earth

The third order landforms are formed within the first and second order landforms. It is shown in the digital data form by digitization of toposheets. The toposheets in India are prepared by Survey of India, which shows physical and cultural features of earth surface at given scale with latitude and longitudinal reference. Generally, topsheet itself is the best teaching aid, where lots of information available to study which starts from conventional signs to spot heights.

5.1 Study Area

Nalgonda district in Telangana State has been taken to understand digital form of earth. The digital earth and its applications can use as the innovative teaching aids for planning and development purpose to achieve regional development. The Nalgonda district is Landlocked district of Telangana State. The District comprises of 4 Regional Divisions, 59 Mandals [Sub-Districts], 17 Towns (4 STs & 13 CTs) and 1,135 Villages. The altitude of the district minimum at 26m height while maximum range of 679m elevation. The main rivers Krishna, Dindi, Paleru, Musi, Aler and Peddavagu drain in all parts of the district. The average maximum temperature with 40℃ and minimum temperature with 15℃. The 40 years average rainfall 701 mm in that about 70% precipitates from SW Monsoon and remaining 30% comes from NE monsoon rainfall.

5.2 Case Study: (Digital Earth Vs Toposheets)

The entire Nalgonda district cover 38 toposheets with the scale of 1: 25,000 distributed in between 16°25’ to 17°50’ north latitudes and 78°40’ to 80°05’ east longitudes having an area of 14,240 Square Kilometres. By using Geographical Information System (GIS), the scanned toposheets converted into known coordinate system called as geo-referencing of toposheets. The mosaic of these toposheets has been done to extract single view of entire Nalgonda district. The raster file of mosaic image identifies the contours with 20 meter interval and they are converted into vector contour file, during in the conversion the onscreen digitisation methodology is used. Further contours are attached with the non spatial data. In this process the 3D conversion such as TIN & DEM created automatically by using GIS. The creation of raster TIN surface has been done by using Global mapper.

5.2.1 Analysis

Jeff S. Jenness [16] of Calculating landscape surface area from digital elevation models identified 3D TIN surface by using grids, cells and polygon and identified TIN-based to grid-based surface-area.

J. Hyyppa, U. Pyysalo [17] of Digital Terrain and Target models in Forest Environment identified DTM from laser scanning based distance measurement.

In this case study of Nalgonda district, Telangana state identified raster TIN surface indicates that the elevation or altitude of district, ranges at lowest 28 meters to highest 625 meters. The elevation range has been grouped into three categories, one is less than 125 m height, second one range from 125 m-250 m and third one with greater than 250 m height. Total 59 mandals of the Nalgonda district, has been

Raster TIN Surface of Nalgonda district: Extraction from Contours

Fig. 2. Mosaic of Toposheets in Nalgonda district

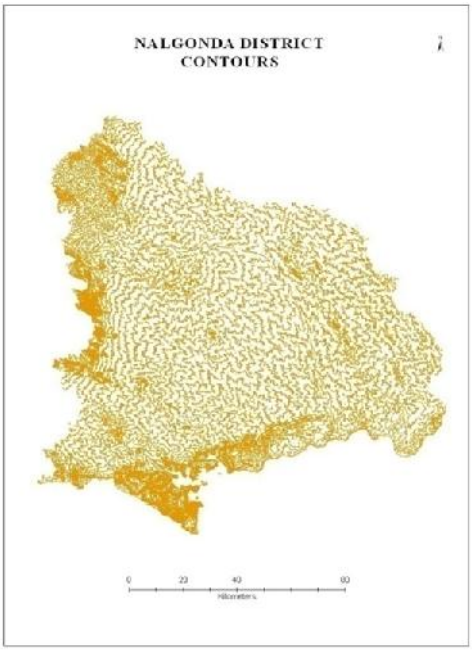


Fig. 3. Vector contour file of Nalgonda district

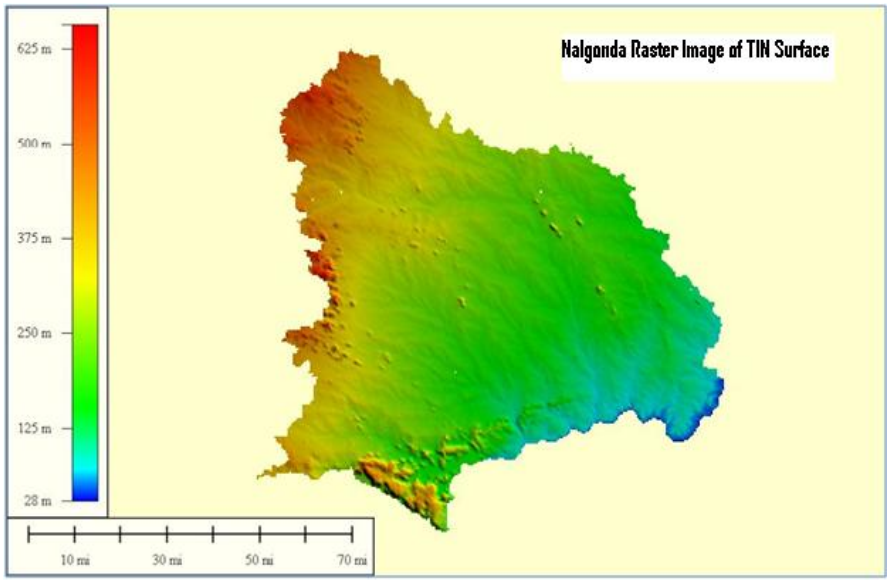


Fig. 4. TIN surface file of Nalgonda district

classified into three classes accordingly. In the first category 10 mandals felled and 150 mandals in the second category, while in third category there are 22 mandals (Fig. 4).

According to Census of India, during 2011 [18], the total population of Nalgonda district is 34,88,809. The distribution of population at mandal wise, the Nalgonda district occupies first in rank with 5.73%, followed by Miryalguda mandal with 5.04%, Suryapet (4.45%), Kodad (3.82%), Bhongir (2.97%). The least percentage of population existed in high latitude zone at Western part of Nalgonda district, namely Turkapalle mandal with 0.94% followed by Gundal with 1.04%, Marriguda (1.06%), Bommalaramaram (1.07%). The remaining mandals consists with 1.1% to 2.89% of total population of the districts (Fig. 5).

Regional development indicates that provision of special aid or assistance to develop one region. The improving of literacy rate is one solution for regional development. The Literacy rate in Nalgonda district is 64.2%. The distribution of literates with respect altitude, the 25.96% of total literates are above the altitude of 250m. The least number of literates of 17.45% are within the 125 m height and the remaining 56.59% of literates lies inbetween 125 m to 250 m height.

Mandal wise analysis of literacy rate indicates that the urban pockets in Nalgonda district recorded highest literacy rate. The Nalgonda mandal recorded highest literacy rate with 80.27%, followed by Suryapet (75.19%), Miryalaguda (73.29%), Bhongir (72.17%) and Huzurnagar with 72.03%. While the least literacy rate recorded at higher altitudes of the district, where Chandampet 47.66%, followed by Nampalle (51.2%), Pedda Adiserlapalle (51.86%), Mattampalle (55.98%) and Atmakur(s) with 56.31%. The remaining mandals fall in between above mandals (Fig. 6).

The total Scheduled Caste (SC) population in Nalgonda district is 6,37,385 constitutes 18.27% of total population of the district. The mandal wise distribution of SC population express that, the Khetepalle mandal ranks first with 27.39% of SC's, followed by Vemulapalle (26.26%), Nadigudem (25.72%), Shaligouraram (25.06%) and Thiparthi with 24.29%. The least percentage of SC population existed in Dameracherla with 10.19%, followed by Turkapalle (12.22%), Mellachervu (12.58%) and Devarakonda with

Maps: Population distribution of Nalgonda district-2011

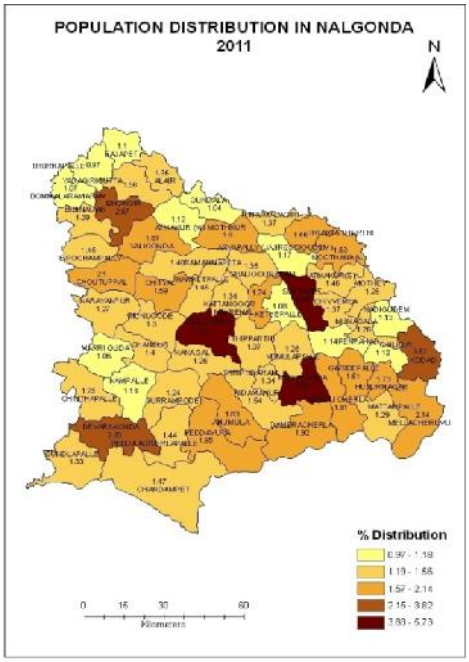


Fig. 5. Population distribution of Nalgonda district, 2011

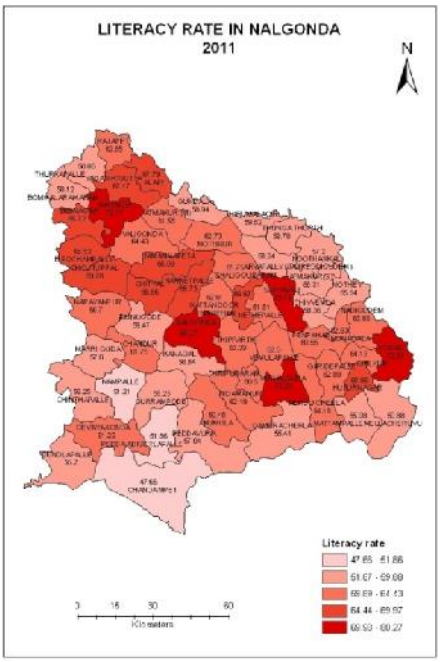


Fig. 6. Literacy rate in Nalgonda District, 2011

Graphs: Hypsographic demography in Nalgonda district during 2011

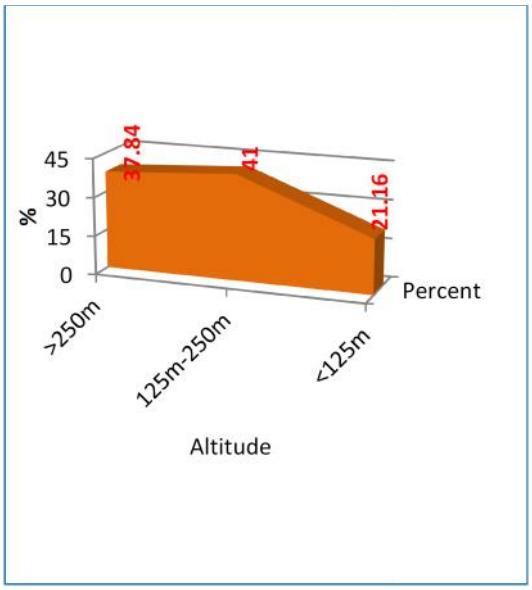


Fig. 7. Hypsographic representation of Population in Nalgonda District

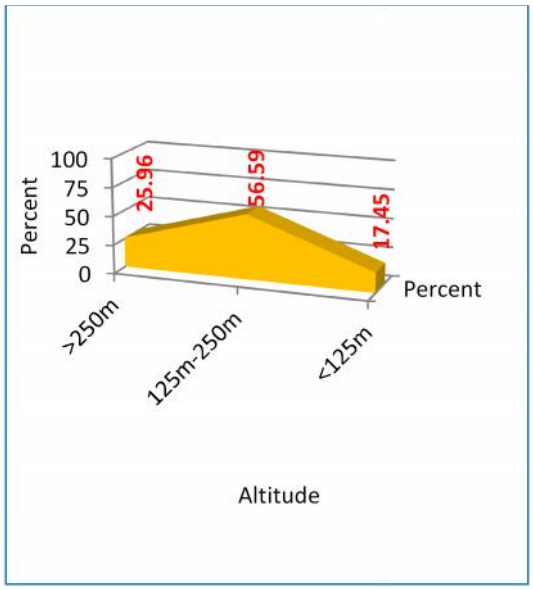


Fig. 8. Hypsographic curve of Literates in Nalgonda District

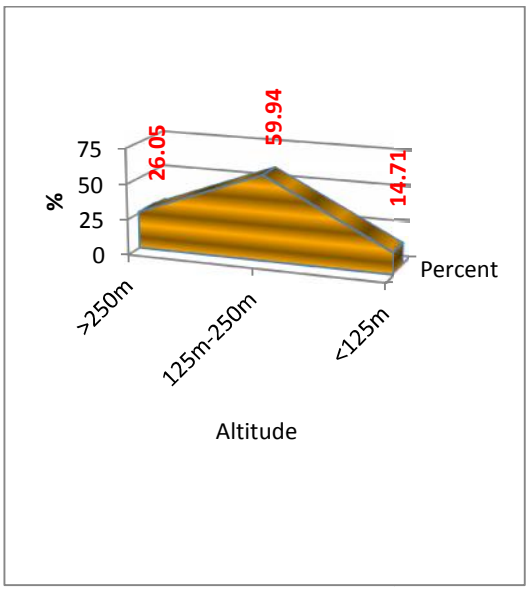


Fig. 9. Hypsographic curve of SC population in Nalgonda district

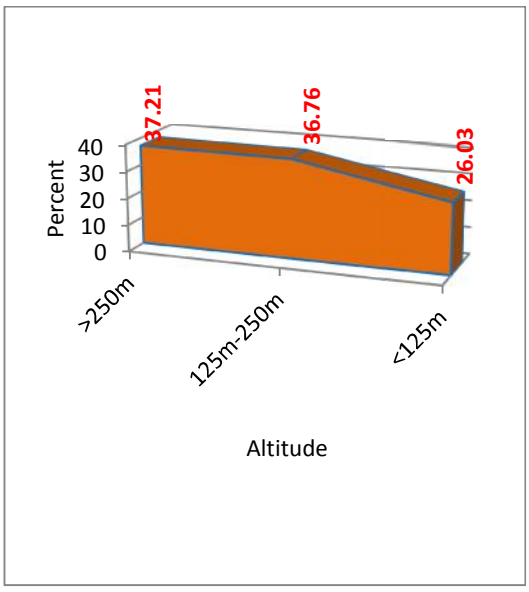


Fig. 10. Hypsographic curve of ST population in Nalgonda district

13.02%. The remaining mandal consists average proportion of SC population in total population of the mandals (Fig. 11).

The hypsographic curve of SC population in Nalgonda district indicates that 26.05% SC's living in the greater than 250m height and 59.84% of SC population existed in between 125m to 250 m altitudinal zone. While the 14.71% of SC's are within the altitude of 125m height.

The mandal wise analysis of ST population indicates that Chandampet mandal having

highest in ST population with 49.92% of population is with ST's only. However it is mentioned that the Chandampet mandal is located at highest altitude of the district with 625m above the sea level. Damarcherla mandal occupies second in rank with 42.1%, followed by Chevemla (34.93%), Peddavura (32.23%), Devarakonda (31.75%), Mattampalle (31.51%) and Pedda Adisapally with 30.62%. While the least ST population recorded in Valigonda mandal with 0.55% population are ST's, followed by Kettepalle & Mothkur are both having with 0.68% ST population, Chityal (0.92%), Atmakur (M) (0.95%) and Chandur (1.09%). The remaining mandals having proportional average ST population is there in almost all mandals (Fig. 12).

The Scheduled Tribe (ST) population in Nalgonda district is 3,94,279 contributes to 11.3% of total population of the district. The distribution of total ST population with respect to latitudinal wise, the 37.21% of ST population are above 250m height and 36.76% of ST population is in between 125 m to 250m. While the remaining 26.03% of ST population are living within the height of 125 m.

5.3 Case Study: (Digital earth Vs Aerial Photography)

Aerial photographs are taken from the air. Basically aerial photographs are of three types viz; vertical, oblique and very high oblique photographs. Interpretation of aerial photographs can be done with minimum of 60 percent overlap in any two adjacent photographs. The traditional interpretation of aerial photographs is basically done with stereo-pairs. The surface features like physical and culture features are identified on the earth surface. The on-screen interpretation of aerial photographs has been done with the software of Photogrammetry suites. The method that has been followed in these type of case study is, initially by knowing the flight height, aerial triangulation has been done, secondly that the DTM features like break-lines and mass points are placed, later the vector features like buildings, roads parks etc has been captured. Further, DEM and DSM is generated over rectified vector features. The Ortho photo of related aerial photographs has been created. It is a corrected and rectified photograph of given surface whereby, the interpretation of physical and cultural feature of the earth surface can be easily understand. The given figures clearly indicates the difference between raw aerial photograph to rectified photograph. The Ortho-photo is a best teaching aid when comparison to traditional interpretation of aerial photographs.

5.4 Case Study: (Digital Earth Vs Satellite Imageries)

According to Anji Reddy [19] of 'Remote Sensing and Geographical Information Systems', The collection of data about the spatial distribution of the significant features of the earth's surface has long been an important part of the activities of organized societies. Applications of Digital Elevation models of J.R. Sulebak, 2000 [20] states that modern aerial photography and satellite remote sensing started to provide continuos surface information by means of optical cameras, radar or laser beams, for example, and the derivation of terrain elevation was made possible by stereoscopy and interferometry, topography gained whole new meaning in spatial studies.

Satellite imageries are captured by using remote sensing technologies, in which satellite do not coming in contact with the objects or ground. The process of image capture can be done in visual or near infra-red wave lengths. The minimum capturable area on the ground is called as resolution which is very important to capture qualitative image. The highest resolution image with 0.5m resolution are ever captured with QuickBird satellites. The imageries normally are in false colour composition, hence the direct interpretation of these raster files are very difficult. However, the interpretation is done on the basis of tone, size, texture, shape and colour etc., where colour is important in terms of satellite imageries. A specific methodology has been followed in classification of satellite imageries by using ERDAS Imagine. The un-supervised and supervised classification has been made for easy interpretation and analysis purpose. It will also helpful in change detection.

5.5 Case Study: (Digital Earth Vs GPS)

GPS-Global Positioning System, is a satellite based navigational aid. Essentially it is a radio-positioning navigation and time transfer system. It provides accurate information on spot, such as velocity, time of an object or a platform at any moment, anywhere on the globe. GPS consists of 24 satellites each weighing 850Kg, these satellites are placed in six orbits, so that four satellites are accommodated in each orbit at an

altitude of 20,185km from the surface of the earth. Out of 24 satellites 21 are operational and remaining 3 are kept as active spares so that they can be inducted into the operational fleet immediately in case any one of the operational satellites becomes nonfunctional. GPS consists of three segments 1. Space Segment 2. Ground Control Segment and 3. User Segment.

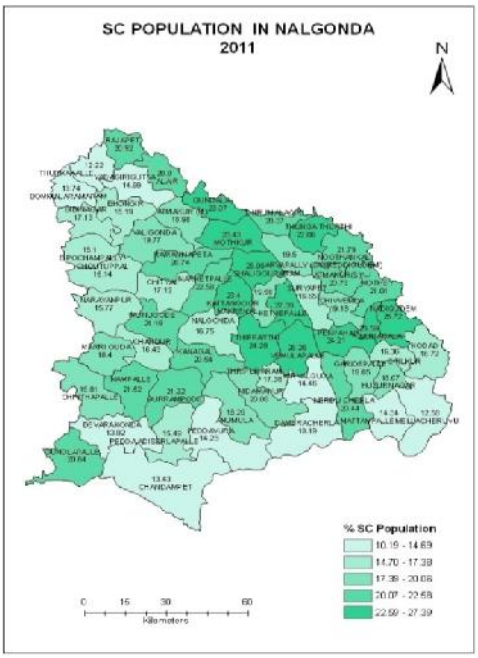


Fig. 11. SC Population distribution of Nalgonda district

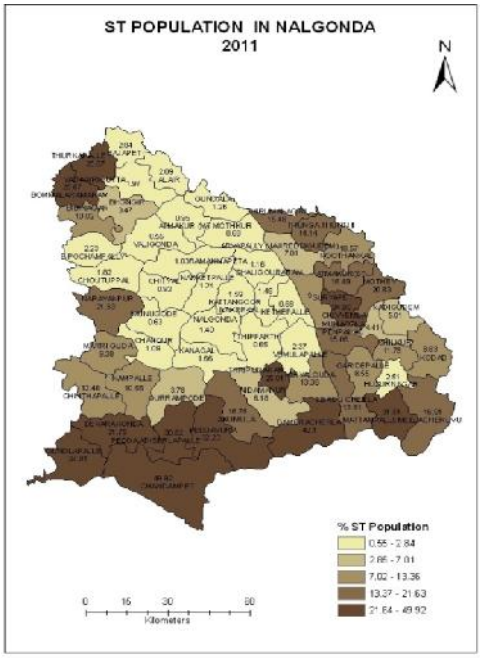


Fig. 12. ST Population distribution Nalgonda District

Fig. 13. Aerial photograph

Fig. 14. Ortho-photo of given aerial photograph

Fig. 15. Supervised Classification

Eg., GLONASS Global Positioning System, Galileo Global Positioning System,NAVSTAR Global Positioning System.

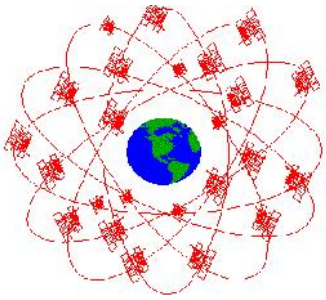


Fig. 16. GPS network

Applications of GPS are plenty, in military purpose; it has become important for nearly all military operations and weapons systems without any other reliable navigation system. U.S. forces could not have performed the maneuvers of Operation Desert Storm without GPS. With GPS, the soldiers were able to go to places and maneuver in sandstorms or at night. In Agriculture it is used for optimize water management with accurate topographic maps for land leveling, drainage or improved site-specific agronomy. It create a wide range of sampling regimes out in the field and quickly map and navigate around field boundaries, point, line, or area features, viewing all on-screen and accurately scout crops and navigate to weeds, pests and diseased areas. As asset management; GPS can manage the following assets. Whatever the asset, you need to know its current location, status or condition, and other information about it in order to effectively manage its contribution to your business or organization's performance. Assets take many forms. They can be mobile, such as: fleets of vehicles - taxis, trucks, emergency response vehicles and railroad cars, boats, airplanes and packages or other items being shipped or stored. The assets can be fixed in position, such as: utility hardware - telephone poles, fire hydrants, electric or radio towers, pipelines; natural resources - land, trees, bodies of

water, mineral deposits; public building inventories etc.

GPS is used to enhance the accuracy for environmental management; Species monitoring, ecological population density studies, soil run-off surveys, flood analysis, etc., In marine and hydrography; GPS is highly used in sea navigation, hydrographic survey, offshore piling and jetty construction- tidal height variations, currents, distance from land etc., GPS can use in oil and gas management like; mapping fixed assets such as pipelines and pipeline junctions and returning to them for maintenance. While in Surveying GPS can use in geodetic networks, precisely and continuously monitoring tectonic activity, garden design, environmental restoration, town or urban planning, recreation park planning, historic preservation etc.

Fig. 17. GPS tracking

6. CONCLUSION

Digital earth with respect to Toposheet digitization in extraction of elevation model determining the distribution of population in Nalgonda district reveals that at higher the altitudes showing lesser the population numbers and less literacy rate recorded. It indicates that increasing elevation indirectly impact in the literacy rate. The literacy rate is one of the main indicators for development. The low lying area maintain consistent population distribution with equal ratio of all communities except ST population. The ST people interested to stay at higher altitudes. It gives regional imbalance in the development of people. While in the low lying areas exhibits high literacy rate hence there is high development existed. The aerial photography interpretation, image analysis and GPS tracking will help learners to better understanding and improve decision making capacity. With context of interpretation and analysis of the spatial features of earth surface will be more appropriate in digital features as compare to conventional methods. In digital features the relative positioning modes of operation possible and hence high accuracies with respect to conventional surveying methods. In planning and development purpose, the digital earth is highly usable.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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