International Journal of Remote Sensing & Geoscience (IJRSG)
www.ijrsg.com

IMPACTS OF DIGITAL ELEVATION MODEL IN LAND DEGRADATION ASSESSMENT – A CASE STUDY OF MUNNAR

Monica Praisy M[1]; Jayaprasad B K[2]; Karuppasamy S[3]
[1] Regional Office of Anna University, Tirunelveli
[2]Scientist E, National Centre for Earth Science Studies, Tiruvanthapuram.
[3]Assistant Proffessor, Regional Office of Anna University, Tirunelveli.

Abstract

This study addresses the assessment of land degradation using Remote sensing and Geographical Information System (GIS) in Munnar and its vicinity. Land degradation is slow and continual deterioration process mainly induced by human activities and equally catalysed by few natural parameters also. Until they grew in their full vigor it couldn't be seen by naked eyes, its tropical identification takes several years while its consequences sometimes remains forever. Hilly regions are much prone to this land degradation and serves as a caricature to witness its global consequence. This study area in recent times welcomes huge increase in population as well as tourists in equal measures which indirectly promote an emerging urbanization; this project also involves working on its population data in order to arrive at a prediction, to unveil the alarming status of this region. Munnar is bejewelled by its beautiful chain of mountains and this region usually receives more rainfall and usually its watershed is generally controlled by its dense trees but because of the recent unhealthy agricultural practices and urbanization the torrent ends up with water erosion which eventually contributed to the number of recent landslides it encountered and recorded. The recent time cultivators are not giving thought on the changes they make to the agricultural practices which lead to the top soil characteristic changes henceforth land degradation assessment here is carried out considering parameters like land use/land cover changes, hydrographical and topographical parameters. The landuse/landcover changes imply that there are various irregularities and most of the changes occur in medium slope area. Through weighted overlay analysis the land degradation assessment result is obtained and multiple analysis were carried out on highly risky areas which could be affected early by soil erosion, landslides and gullies are figured out. Throughout the paper, the exclusion of conservative approach rather an endorsement here and there about the essential and strategical utilization of DEM and Remote sensing which would end up in exponential land degradation management for the coming age.

Key words: Land degradation, landuse/landcover, gullies, e, landslides, DEM, Remote sensing.

Introduction

When there is an environmental commotion some Nation devise schemes before it occurs and many doesn't mind about it even after some natural imbalance with a catastrophe. India never fits inside these two categories rather it is a nation where the entire government meddle with the measure that it shouldn't collapse the traditional approach and the culture leaven, not most of the proposed schemes according to global thereat have successfully implemented these in India, but when it comes to Remote sensing and GIS it is one of the prominent technology which never surpasses the Indian limitation rather provides a medium to provide control measures over the posing problem. The major problem which India faces in addition to the existing thing is Land degradation, world nation acknowledges land degradation as an global issue, because its prevalent in every community available, it is not only induced by manmade machineries nor activities it is also because of the nature in itself and by animals with its major contribution by human beings. Land degradation is often compared with cancer by many naturalists; these two words are capable of deteriorating the land of any minerals without hesitation. Unlike cancer land degradation can be managed at will through many established methodologies. Land degradation is an alarming threat that now haunts India. Environmental statistics board declared that change in terrain characteristics is the very thing which aggravates land degradation; Idukki District in kerala seems to appear as green meadows embracing it but when dug deep there is a degrading land devouring the entire slopes. Remote sensing addresses the very need of the hour, top soil removal in general is found to be an act of ignorance amongst cultivators. Remote sensing offers both scientific and statistical solution which can replace some traditionally carried out failure methodologies which has been counted to aid cultivation alone and conventionally ruins that entire region for cultivation by deteriorating it. This study area is an apt example of demolition in disguise but the very recent news reproves that it's the hour not for cure but a better time to manage and make up. As a lending hand to this initiative, throughout this paper the entire above stated glimpses has been addressed.

Study Area

Munnar is a hill station lies between the 76º52' 30" and 77º15' East longitudes and between 10º52' and 10º10' North latitudes(Figure1 Study Area). Munnar is in Devikulam taluk of Idukki district in south-western Indian state of Kerala. The name Munnar is believed to mean "three rivers", referring to its location at the confluence of the Mudhirapuzha, Nallathanni and Kundaly rivers. It is the largest panchayat in the Idukki district covering an area of nearly 557 square kilometres. In Munnar tea plantation occupies most of the area and different plantation like cardamom, eucalyptus, gum trees. The clay soil is most dominanat soil type in this region and this region receives rainfall from both monsoons. In recent years several English vegetables like carrot, potato etc are cultivated in Munnar. Most of the forest in this area is announced as reserved forest to protect the endemic species. The Kurinjimala Sanctuary which is the core habitat of the endangered Neelakurinji plant. It is the well known place in Kerala for tourism. In recent years the open forest and agricultural land are changed into settlements because of increase in population and tourism.

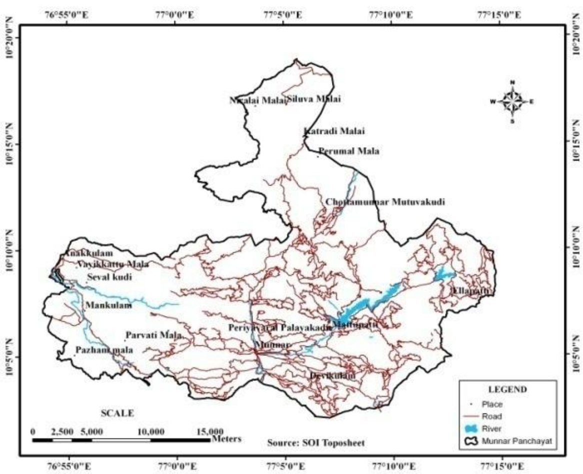


Figure1 Study Area

Materials and Methodology

Cartosat I stereo-pair was used here to generate DEM with spatial resolution of 10 meter. This DEM was generated using an Imagine photogrammetric tool in ERDAS Imagine 15 and the DEM was subsetted using the boundary of study area. LISS IV and LISS III are used for the year of 2007, these images are geo-referenced and in order to derive information with superior scalability, image consisting of PAN with 5.8m meter resolution and 4 band multi-spectral with 23.5 metre resolution were PAN sharpened. Figure 2 depicts the methodology flow chart of the study. Satellite data are geometrically and radiometrically corrected for the study area in order to avoid the distortion of satellite during the acquisition of image. The Survey of India Topographic map for the year 1986 with scale 1:25000 was scanned first and then registered. Georeferencing of topographic map, the intersection of latitude and longitude in the topographic map were taken and then image to map registration process is done. The satellite images are georeferenced by identifying the common points in the toposheet and in satellite images.

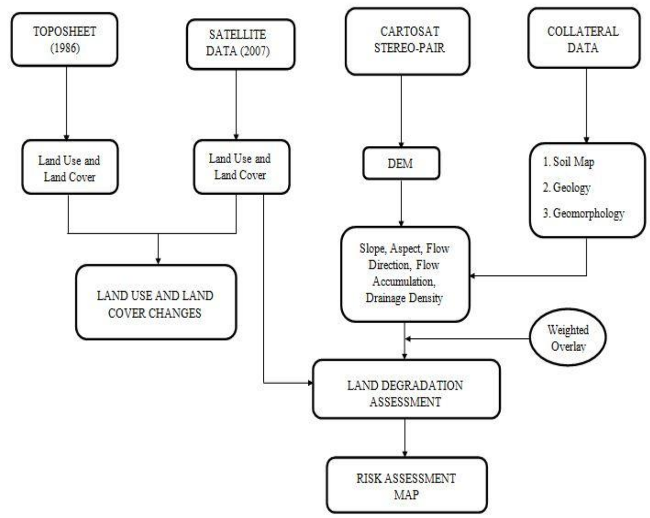


Figure 2 Methodology Flow Chart of Study

The soil, geology and geomorphology maps were prepared based on existing maps, ground survey and other ancillary data. The satellite image was visually interpreted and classified using ArcGIS 10.3 in order to prepare landuse/landcover for the year of 2007(Figure3). The classified image has been verified using ground survey reports and other original photographs of the study area. The topographic map was digitised and landuse/landcover map for the year 1986 was then prepared. The classified image for the year 1986 was validated using the ground survey reports (Figure 3). The two images were converted into vector and integrated using ArcGIS overlay tool and the landuse/landcover changes between the year 1986 and 2007 was prepared. The changes are noted in the attribute table and the image for changes was prepared.

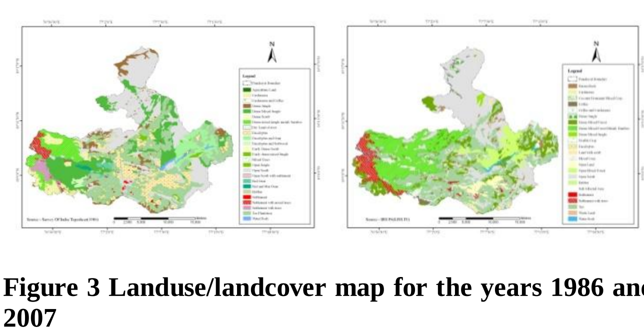
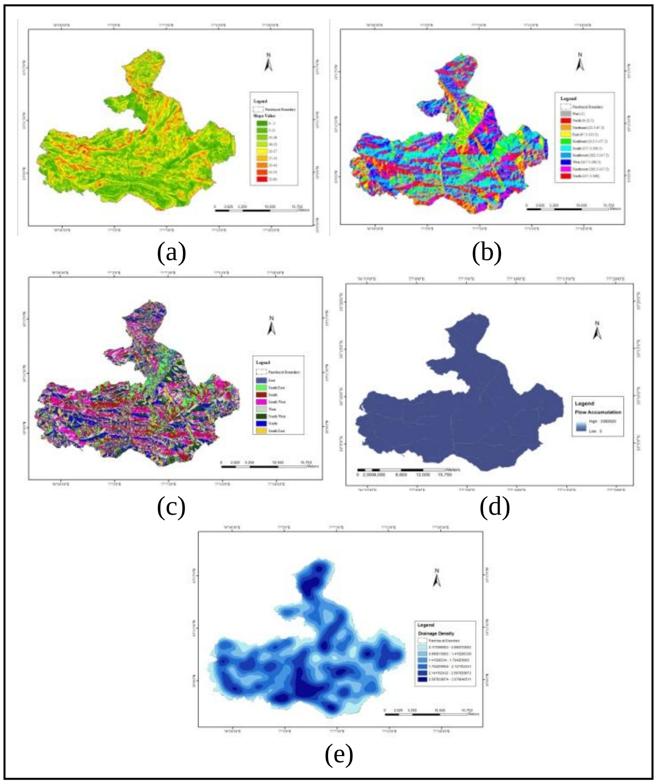


Figure 3 Landuse/landcover map for the years 1986 and 2007

The slope and aspect were derived from DEM of the study area.(Figure 4 (a) & (b)) The flow direction, flow accumulation and drainage density for the study area were derived from Archydro extension in ArcGIS software. Flow direction should only be performed on grids that are free of sink so the very first step in hydrological modeling is to fill DEM (elevation grid) and then its flow direction was generated. In order to generate drainage network, flow accumulation was generated from flow direction and DEM. Then streams were generated from flow direction and DEM, these generated streams were converted later into vector files and density of the stream was generated from kernal density tool in spatial analyst module from ArcGIS.(Figure 4 (c),(d) &(e)).



(a) (b) (c) (d) (e)

Figure 4(a) Slope(b) Aspect (c) Flow Direction Map (d) Flow Accumulation(e) Drainage density Maps of Study Area.

To determine the land degradation and its causes its themes like slope, aspect, flow direction, flow accumulation, drainage density, soil, geology, landform and landuse /landcover were integrated with ArcGIS. The weight value were assigned for each theme and its individual classes by considering the work of Moe Myint et al[9] and other experts words. The slope map and landuse/landcover changes were integrated; and most of the changes were found in its medium slope of the study area. The weight for soil, geology and landform were given based on the characteristics of each class. All themes were converted into raster and reclassified using reclassify tool. The weighted overlay methodology was done using model builder, the resultant image were classified as stable, very low, low, medium, high, very high and extremely high. The resultant was compared to drainage network of the study area and its slope, population data. The places were erosion, gullies and landslide are possible is figured based on their respective ranking in first order streams and slope class. Highly urbanised areas were also marked based on the population data and then risk assessment map is prepared based on these above analysis altogether.

Results and Discussion

1. Landuse/Landcover changes

Land use involves the management and modification of natural environment and wilderness into a built environment like settlements and semi-natural habitats such as arable fields, pastures, and managed woods. Land cover is the observed (bio) physical cover on the earth's surface. In the year of 1986 Munnar has more landcover classification; Its forest had wide spread of rich species hence it is declared as a reserved forest. In 1986 there was paddy cultivation in Munnar day after day the paddy cultivation area got vanished instead settlement got increased due to deposition of erosion in that area. Eucalyptus and cardamom cultivation area percentage fall from 11% to 2%. Most of the forest lands had become waste lands and open scrub. The settlement area increased to 5% to 10% because of the increase in population. The other reason was due to the advent of large domestic and international tourists in Munnar. Vast area was being utilized just to construct hotels, restaurants. Large forest area was demolished for the plantation of tea. Their slope and changes were compared, most of the changes occur only in medium slopes because there will be no vegetation area possible in steep slopes farmers had to only plough the medium slope areas and flat areas for agricultural purposes. Some of the land became barren rocks because of the soil erosion; these areas were under steep slopes. Eucalyptus field had replacements like some mixed crop like coconuts, carrot etc., from the bar chart it has been clearly understood that agriculture and forest area got drastically decreased. The main reason for these changes is soil erosion and increase in settlement areas, due to soil erosion the characteristics of soil got changed and which totally collapses and ruins the vegetation. Not only spoiled vegetation even landslides were an unavoidable consequence of soil erosion. This changes also affects the climate of the region which was already stated by E.Kunihikrishnan[11]. This holistic approach on land degradation would be incomplete with the involvement of its huge contributor urbanization, which plays the key role behind all these issues.

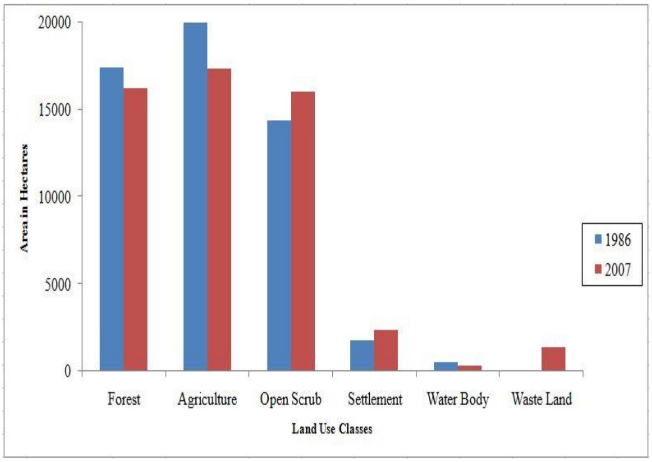


Figure 5 Bar Chart on landuse/landcover changes

2. Land Degradation Assessment

The hydrological, topographical, slope, aspect and landuse/landcover themes were integrated by a weighted overlay analysis. Slope and flow direction were given high preference because slope is the major factor responsible for land degradation. Inside slope class the first preference is given to the medium slope areas because in this study area most of the changes occurred in the medium slopes. In soil class loamy sand was given highest weight value because of water holding capacity. Denudation hill was given the highest rank in the landform theme. N, NE, SW, W and NW values were given higher values because in the study these areas were wet and affected mostly. The highest flow accumulation was given low rank because when the flow accumulation is high the flow of water is low. NW, W, N, SE and SW classes were given the higher weight value. Similarly Landuse/landcover classes of the wasteland and open scrub were given highest weight value. All these themes are integrated using model builder. These themes were converted into raster and reclassified. The preference values were given based on the literature and expert's advice and its land degradation map was prepared. The resultant image were classified as stable, very low, low, medium, high, very high and extremely high. The 16.44% of area falls under stable. 0.11% of land is under very low degradation. Low degradation class is under 5.39%. Medium and high falls under 24.31% and 33.24%. These areas mostly comprises of medium slopes and steep slope area. The landuse type is waste land and some agriculture land. In steep slope area there is a possibility of soil erosion and formation of gullies and this part again verifies with the drainage network of the study area which clearly shows that the areas with high group of first order have enormous possibility of gullies. In some areas the land which is close to the road and drainage has rich possibility of landslides. The land which is having possibilities of increases in settlement is marked as urbanised areas. Based on these factors the risk assessment map is formed.

Conclusion

In order to bring out the ferocious impact that land degradation would bring unto the farmers and the civilians of this particular district and this Munnar region has to be thoroughly monitored in order to arrive at a summarization with the adequate help provided by GIS and remote sensing alone. In this study, the region is found to have enormous changes; due to those changes there the land is degraded intensely. The main type of land degradation here is soil erosion, through the inference available after research it is said that eucalyptus plantation region is more eroding than any other plantation. This quickly emerged technology is an added advantage which can provide tremendous results in the days to come, The ringing theme of this paper projects over the agricultural and constructional dysfunction which played a vital role in bringing out a worst case scenario and suggest methodologies to preserve the agricultural practices for the future betterment then a suggested construction methods than preferred practices to bring out an orientation of nature as well as better living that ensures the harmony of that town. Now it's the role of not only government but also the role of every civilian to beseech and promotes the boon this technology provides which won't short live but with stability provides a consistent solution over this hazard for lifetime, Syndication of this technology not only needs cooperation but few conformity and an adhering mindset to keep moving towards any efficient budding methods that approaches their community.

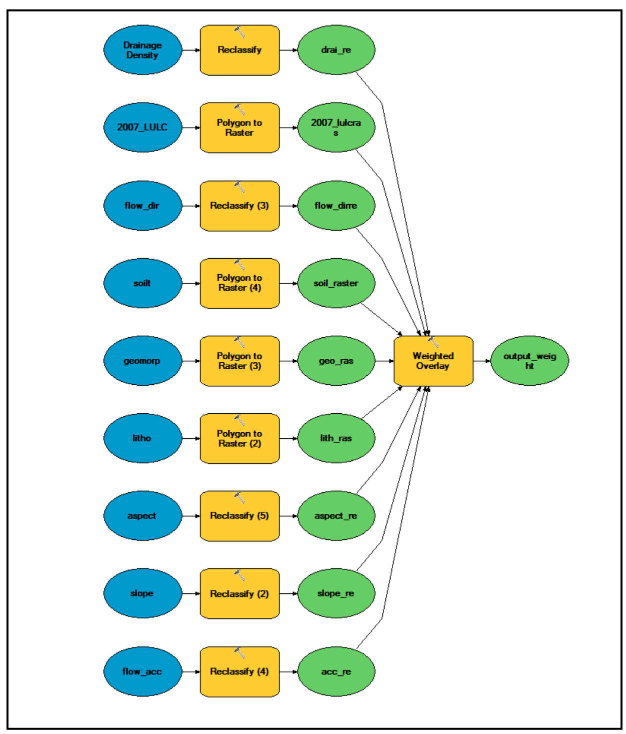


Figure 6 Model Builder for Weighted Overlay Analysis

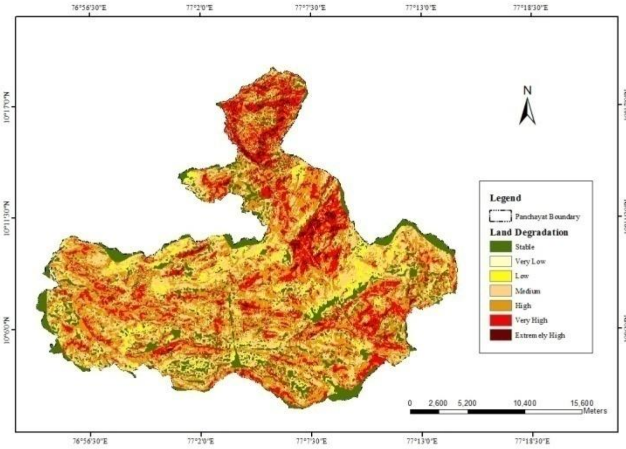


Figure 7 Land Degradation Map

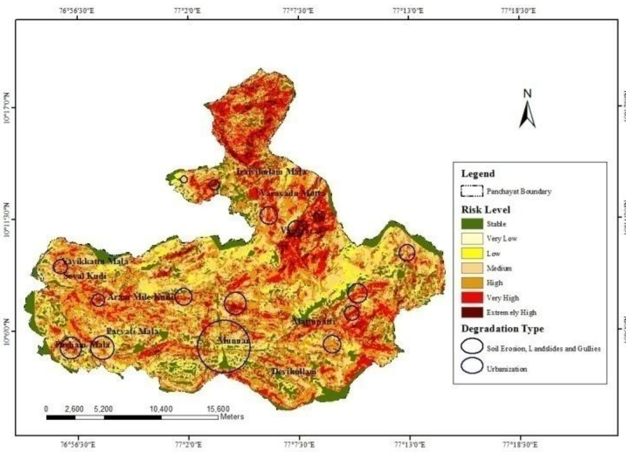


Figure 8 Risk Assessment Map

Table 1 Land Degradation Class Area extent

Sl.No	Land Degradation Class	Area in Hectares	Area in Percentage
1	Stable	9153.49	16.44
2	Very low	58.70	0.11
3	Low	2996.17	5.38
4	Medium	13535.50	24.31
5	High	18506.40	33.24
6	Very high	9714.80	17.45
7	Extremely high	1716.02	3.08

Acknowledgments

The author is thankful to the Director of National Centre for Earth Science Studies, Tiruvanthapuram, Kerala, India for granting permission to publish the paper.

References

[1] Thomas P. Higginbottom, Elias Symeonakis(2014), “Assessing Land Degradation and Desertification Using Vegetation Index Data: Current Frameworks and Future Directions”, Remote Sensing ISSN 2072-4292, 9552-9575.

[2] Denis M. K. Amara, Parameshgouda L. Patil , Edwin J. J. Momoh (2014), “Land Degradation Mapping in Singhanhalli-Bogur Micro-watershed in Northern Transition Zone of Karnataka through Remote Sensing and GIS Techniques” International Journal of Interdisciplinary and Multidisciplinary Studies (IJIMS), Vol 1, No.10, 161-166.

[3] Maurice O. Kodiwo, Francis A. Okere (2013), “Analysis of Spatial Variations of Agricultural Land Use Intensity and Land Degradation in different Physiographic Regions” Asian Journal of Humanities and Social Sciences (AJHSS) Volume 1 - Issue 1, May 2013.

[4] Olena Dubovyk, Gunter Menz, Christopher Conrad, Asia Khamzina(2012), “Object-based cropland degradation identification: a case study in Uzbekistan” Earth Resources and Environmental Remote Sensing/GIS Applications III, Proc. of SPIE Vol. 8538, 85380W.

[5] Mehnaz Rashid, Mahjoor Ahmad Lone, Shakil Ahmad Romshoo(2011), “Geospatial tools for assessing land degradation in Budgam district, Kashmir Himalaya, India” J. Earth Syst. Sci. 120, No. 3, June 2011, pp. 423–433.

[6] Mani. K, “Land use and land cover changes detection using multi temporal satellite data Taluk, Idukki district Devikulam, Kerala”, International Journal Of Geomatics And Geosciences,Volume 3, No 1, 2012.

[7] Fadhil, A. M. (2009). "Land Degradation Detection Using Geo-Information Technology for Some Sites in Iraq". Journal of Al Nahrain University-Science (JNUS), Vol. 12(3):94-108.

[8] Julia Mambo and Emma Archer (2007), “An assessment of land degradation in the Save catchment of Zimbabwe” Area Vol. 39 No. 3, pp. 380–391, 2007.

[9] Moe Myint, Pema Thinley, “Mapping Potential Land Degradation in Bhutan”, ASPRS 2006 Annual Conference Reno, Nevada.

[10] Symeonakis E and Drake N, "Monitoring desertification and land degradation over sub-Saharan Africa", International Journal of Remote Sensing, Vol. 25, NO. 3, 573–592.

[11] E Kunhikrishnan, "Impact Of Human Activities On Weather And Climate", National Children's Science Congress,Activity Guidebook For 2014 & 2015.

Biographies

MONICA PRAISY M received the B.E degree in Civil Engineering from the Periyar Maniammai University, Thanjavur, Tamil Nadu, in 2013, currently she is pursuing her M.Tech degree in Remote Sensing from the Regional Office of Anna University, Tirunelveli.

JAYAPRASAD B K received the B.A degree in Geography from the University of Kerala, Tiruvanthapuram, Kerala, in 1979, Completed Masters Degree in Cartography from University of Madras, Chennai, Tamil Nadu in 1989. Currently he is working as a Scientist in Natinal Centre for Earth Science Studies, Tiruvanthapuram.

KARUPPASAMY S received the B.E degree in Geoinformatics Engineering from the Anna University, Chennai, Tamil Nadu, in 2001, Completed Masters Degree in Photogrammetry and Geoinformatics from Stuttgart University of Applied Sciences, Germany, in 2006. Currently he is working as Assistant Professor in Regional Office of Anna University, Tirunelveli.