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Analysis of Land Use/Land Cover Changes Using Remote Sensing Data and GIS at an Urban Area, Aurangabad, India

Kayte Jaypalsing Natthusing[1], Sumegh Shrikant Tharewal[2], Kayte Sangramsing Natthusing[3], Mohammed Waseem Ashfaque[4] and Professor. Chitra G Desai[5].

1.1 Abstract

Need and Significance of the research

This paper we are analysis of Land use/land cover (LU/LC) changes were determined in an urban area, **Aurangabad**, from 1990 to 2014 by using Geographical Information Systems (GISs) and remote sensing technology. These studies were employed by using the Survey of India topographic map 57 O/6 and the remote sensing data of LISS III and PAN of IRS ID of 2014. The study area was classified into eight categories on the basis of field study, geographical conditions, and remote sensing data. The comparison of LU/LC in 1990 and 2014 derived from toposheet and satellite imagery interpretation indicates that there is a significant increase in builtup area, open forest, plantation, and other lands. It is also noted that substantial amount of agriculture land, water spread area, and dense forest area vanished during the period of study which may be due to rapid urbanization of the study area. No mining activities were found in the study area in 1990, but a small addition of mining land was found in 2014.

Research Area: Remote Sensing and GIS.

Keyword: LISS III, RS, GIS, LU, LC.

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1. KAYTE JAYPALSING NATTHUSING.

(Department of Computer Science and Information Technology, Dr. Babasaheb Ambedkar Marathwada University, Aurangabad) jaypalsing@gmail.com

Contact No: +91 888 888 0624

1.2 Introduction

In an urban environment natural and human-induced environmental changes are of concern today because of deterioration of environment and human health [1]. The study of land use/land cover (LU/LC) changes is very important to have proper planning and utilization of natural resources and their management [2]. Traditional methods for gathering demographic data, censuses, and analysis of environmental samples are not adequate for multicomplex environmental studies [3], since many problems often presented in environmental issues and great complexity of handling the multidisciplinary data set; we require new technologies like satellite remote sensing and Geographical Information Systems (GISs). These technologies provide data to study and monitor the dynamics of natural resources for environmental management [4]. Remote sensing has become an important tool applicable to developing and understanding the global, physical processes affecting the earth [5]. Recent development in the use of satellite data is to take advantage of increasing amounts of geographical data available in conjunction with GIS to assist in interpretation [6]. GIS is an integrated system of computer hardware and software capable of capturing, storing, retrieving, manipulating, analyzing, and displaying geographically referenced (spatial) information for the purpose of aiding development-oriented management and decisionmaking processes [7]. Remote sensing and GIS have covered wide range of applications in the fields of agriculture [8], environments [9], and integrated eco-environment assessment [10]. Several researchers have focused on LU/LC studies because of their adverse effects on ecology of the area and vegetation [11–14]. Present study area witnessed rapid development during past decades in terms of urbanization, industrialization, and also population increase substantially.

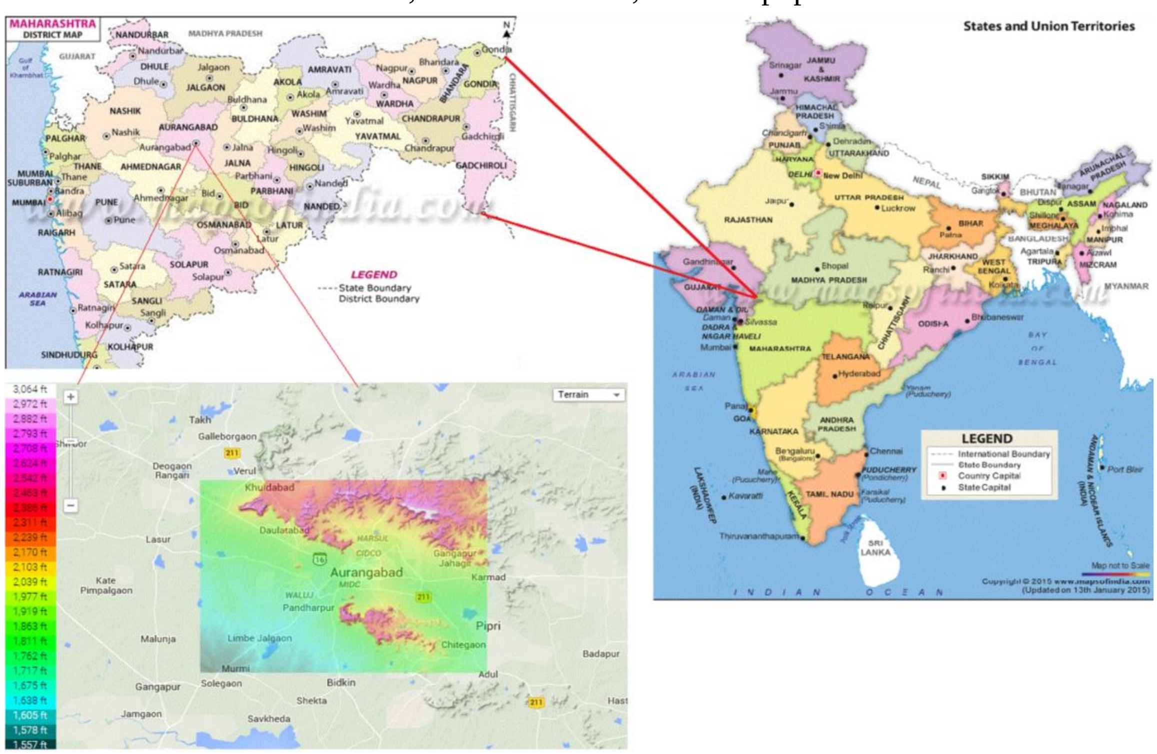

Figure 1: Location of the study area, Aurangabad.

1.2.1 Study area Description of Aurangabad

Latitude: 19.88° Nord
Longitude: 75.33° East
Elevation: 572 m
Total Area 123 km^2 (47 sq mi)

The study area, Aurangabad region (Figure 1), is located as the metropolitan city will making smart city in India. **Aurangabad** (Marathi: औरंगाबाद; pronunciation) is a city in the Aurangabad district of Maharashtra, India. Aurangabad ("Aurang City") is named after the Mughal emperor Aurangzeb. The city is a tourism hub, surrounded by many historical monuments, including the Ajanta Caves and Ellora Caves, which are UNESCO World Heritage Sites, as well as Bibi Ka Maqbara. The administrative headquarters of the Aurangabad Division or Marathwada region, Aurangabad is titled "The City of Gates" and the strong presence of these can be felt as one drives through the city. Recently, Aurangabad was declared "Tourism Capital of Maharashtra".[15] By population it is the 5th largest city in Maharashtra, after Mumbai, Pune, Nagpur and Nashik.

1.2.2 Geography and Climate

Temperature: Annual mean temperatures in Aurangabad range from 17 to 33 °C, with the most comfortable time to visit in the winter – October to February. The highest maximum temperature ever recorded was 46 °C (114 °F) on 25 May 1905. The lowest recorded temperature was 2 °C (36 °F) on 2 February 1911. In the cold season, the district is sometimes affected by cold waves in association with the eastward passage of western disturbances across north India, when the minimum temperature may drop down to about 2 °C to 4 °C (35.6 °F to 39.2 °F).[16]

Rainfall: Most of the rainfall occurs in the monsoon season from June to September. Thunderstorms occur between Novembers to April. Average annual rainfall is 710 mm. The city is often cloudy during the monsoon season and the cloud cover may remain together days. The daily maximum temperature in the city often drops to around 22 °C due to the cloud cover and heavy rains

1.3 Survey of Literature

1.3.1 Land Use/Cover Change

The terms Land use and Land cover are not technically synonymous; hence, we draw attention to their unique characteristics to differentiate between them. The terms land use and land cover will be clarified in this point. There are different definitions of land cover and land use among the relevant scientists. Therefore, a brief explanation about these two terms is provided in this section from the Encyclopaedia of Earth. In general, the term land use and land cover change (LULCC) identifies all kinds of human modification of the Earth's surface. Land cover refers to the physical and biological cover over the surface of land, including water, vegetation, bare soil, and/or artificial structures[21] Land use has a complicated expression with different views compared with the term land cover. In fact, social scientists and land managers characterise this term more general to involve the social and economic purposes. Natural science researchers classify the term land use in different aspects of human activities upon lands such as farming, forestry and man-made constructions.

[22] Believe Land use involves both the manner in which the biophysical attributes of the land are manipulated and the intent underlying that manipulation—the purpose for which the land is used. [23] Differentiate between land cover (i.e. whatever can be observed such as grass, building) and land use (i.e. the actual use of land types such as grassland for livestock grazing, residential area). In fact, the term land use/cover will be used chiefly in this thesis, referring to the land cover and the actual land use

1.3.2 Land Use/Cover Change Causes and Consequences:

LUCC can occur through the direct and indirect consequences of human activities to secure essential resources. This may first have occurred by means of burning of areas to develop the availability of wild game and it accelerated with the birth of agriculture, resulting in extensive clearing such as deforestation and earth's terrestrial surface management that takes place today[21]. Landuse/cover change is known as a complex process which is caused by the mutual interactions between environmental and social factors at different spatial and temporal [24,25]

More recently, industrial activities and developments, the so-called industrialisation, has encouraged the concentration of population within urban areas. This is called urbanization, which includes depopulation of rural regions along with intensive farming in the most productive lands and the abandonment of marginal lands [21]. Land use changes are increasingly known as the consequence of actors and factors' interactions [26].These conversions and their consequences are obvious around the world and it has been becoming a disaster around the metropolitan areas in developing countries.

1.4 Objectives of the research

1. The **main objective** of this study is to detect and quantify the LU/LC in an urban area, Aurangabad (Figure 1), from 1990 to 2014 using satellite imagery and topographic map.
2. To analyze and model the spatial distribution of earthquake epicenters as natural cause of LULC Change.
3. To detect the spatial distribution of selectively logged sites form remote sensing images.

4. To analyze and model the spatial distribution of selectively logged sites as human cause of LULC chance using spatial point pattern statistics.
5. To analyze spatial- temporal behavior of the distribution of selectively logged sites using spatial point pattern statistics.

1.5 Data, Methodology and tools (Approach)

In the present study we have used mainly two types of data. These are topographic map and remote sensing data. The remote sensing data of geo-referenced and merged data of LISS III and PAN of IRS ID of 2014 in the digital mode are obtained from the National Remote Sensing Agency (NRSA), Government of India and used. The spatial resolutions of LISS III and PAN are 23.5 and 5.8 meters, and spectral resolutions are 4 and 1 meters, respectively.

The topographic map 57 O/6 (1:50,000 scale) is obtained from the Survey of India, which was surveyed and prepared in 1990; it is converted to digital mode using scanning. The topographic map is geo-referenced with longitude and latitudes using the ArcGIS software and spatial analyst tools and demarcated the boundary of study area.

A supervised signature extraction with the maximum likelihood algorithm was employed to classify the digital data of IRS 1D geo-referenced and merged LISS III and PAN for land use/land cover mapping for the year 2012. Before the preprocessing and classification of satellite imagery began, an extensive field survey was performed throughout the study area using Global Positioning System (GPS) equipment. This survey was performed in order to obtain accurate location point data for each land use and land cover class included in the classification scheme as well as for the creation of training sites and for signature generation.

The satellite data was enhanced before classification using histogram equalization in ERDAS Imagine 8.7 to improve the image quality and to achieve better classification accuracy. In supervised classification, spectral signatures are developed from specified locations in the image. These specified locations are given the generic name "training sites" and are defined by the user. Generally a vector layer is digitized over the raster scene. The vector layer consists of various polygons overlaying different land use types. The training sites will help to develop spectral signatures for the outlined areas.

The land use maps pertaining of two different periods were used for post-classification comparison, which facilitated the estimation of changes in the land use category and dynamism with the changes. Post-classification comparison is the most commonly used quantitative method of change detection [17–19] with fairly good results. Postclassification comparison is sometimes referred to as "delta classification" [20]. It involves independently produced spectral classification results from different data sets, followed by a pixel-by-pixel or segment-bysegment comparison to detect changes in the classes. The detailed methodology adopted was given in Figure 2.

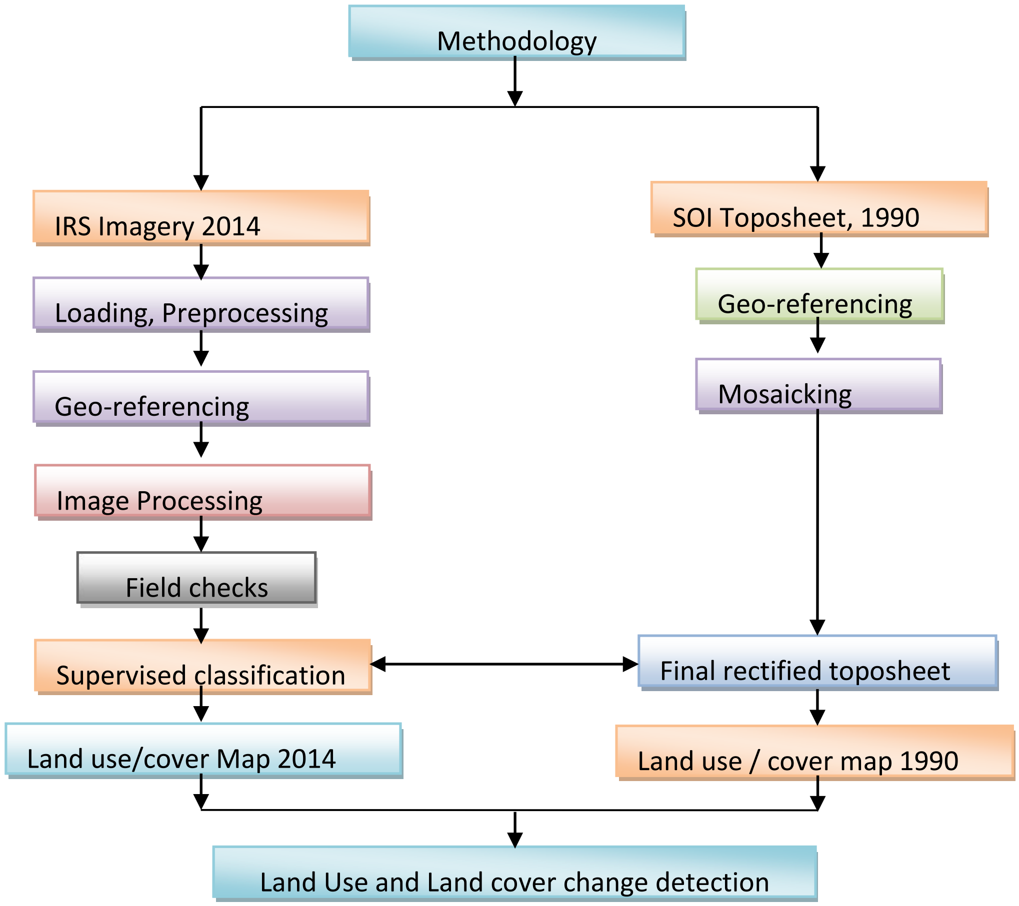

Figure 2: Flow chart of methodology for land use/land cover and change detection.

1.6 Conclusion

Land cover is defined as the biophysical state of the earth's surface and the immediate subsurface. Land cover changes are driven by natural forces or by land use by humans. Thus it involves both the natural and human dimensions. Locally, the land cover changes due to environmental or climatic factors determine the vulnerability of people to climatic perturbations and thus affect the decisions on land use by people. This synopsis is focuses on LU/LC changes in an urban area, Aurangabad, India, using remote sensing data and GIS technology. Our results clearly show that LU/LC changes were significant during the period from 1990 to 2014. There is significant expansion of built-up area noticed. On the other hand there is decrease in agricultural area; water spread area, and forest areas. This study clearly indicates the significant impact of population and its development activities on LU/LC change. This study proves that integration of GIS and remote sensing technologies is effective tool for urban planning and management. The quantification of LU/LC changes of Aurangabad area is very useful for environmental management groups, policy makers and for public to better understand the surrounding.

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