Land use and land cover change and sustainability assessment of Vijayawada city by RS&GIS

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Abstract. Land utilization is a key factor in the allocation and function of ecosystems. The limited available land is insufficient to satisfy the growing demand. Sustainable future depends on Human decisions on utilization of land. The landuse analysis between two time periods and their impact especially on sustainable development may leads to proper planning at different territorial levels. The present study examines spatiotemporal trends in modification of LULC (land use and land cover) changes in the Vijayawada area. Landsat 5 and 8 satellite imagery was used to produce change deduction maps over a sixteen year of time period (2005 and 2020). For the year 2005, 30 meter resolution Landsat 5 satellite image are used and for the year 2020 15 meter resolution Landsat 8 images are used to identify the changes in spatiotemporal trends. Maximum lielihood supervised classification techniques are used to estimate land use and land cover change. The dynamics of LULC modification for 16 year time period and its impact were discussed as key findings in this paper. This study reports that, by using geo-spatial techniques could reduce the main causes of LULC change detection that threaten ecosystems and biodiversity through timely and adequate monitoring.

Keywords: Sustainable development, Land use and Land cover, Remote sensing, Geographic information systems

1. Introduction
All the elements in the environment were surrounded by an organism, which consists of the chemical, physical and biotic conditions. In general for every day survival human beings interacts with biosphere, atmosphere, lithosphere and hydrosphere, however the man dominates and frequently destroys these components from environment, eventually these components become vulnerable [1].

To avoid vulnerability a better knowledge on ecological patterns and processes is required and the overlaying of sustainability plans for monitoring and managing LULC which helps to safe guard biodiversity, in case of fast growing cities [2].

The growth of a city in developing countries is expanding in a complex manner. The consequence of the sporadic expanding growth and development is reflected in issues such as depletion on various
resources and reduction of agro-ecological and rural lands. The corresponding changes on LULC data, especially by human activities can be controlled by suitable planning through GIS techniques [3].

The present and past land resources conditions can understand by satellite imageries. Detecting change detection in LULC is one of the ecological objectives of the landscape. These modifications may cause serious ecological impact challenging environmental sustainability on a local and global scale. In recent decades, there has been a threat potentially diminish the ability of ecosystems to manage and monitor forest, food production and freshwater resources etc. The human being facing the challenge to ensure the "sustainable development", which likely to have a control in between immediate man's need and maintaining the resources to provide long-term goods and services [4, 5].

Sustainable development is a primary objective for urban planning theory and practice; which relates monitor and managing natural resources and land use that are economically, socially advantageous and ecologically[6,7]. There are genuine concerns in literature with respect to ecological scope for planning of land use and ecosystems, combines both spatial and social dimension of the city ecosystems [3].

The sprawling city of Vijayawada reflects ineffective in land use planning and unsustainable decisions and actions in LULC planning, which may lead to physical, environmental and socio-economic problems. Reversing this trend requires a holistic understanding of activities on land use and long-term environmental issues. LULC change patterns for various time periods are collected to achieve sustainable urban growth by predicting the future behavior. In this article, remote sensing images were used to identify LULC modifications for 16-year time period for temporal resolutions and their consequences.

2. Study area
The geographical location of Vijayawada lies between 16°28'0"N to 16°34'0"N and 80°33'0"E to 80°44'0"E. Total geographical area of study area is 181.04 sq km. The city of Vijayawada is located in coastal region of Andhra Pradesh, India. The city is situated in Krishna district of Andhra Pradesh and lies on the banks of River Krishna on one side. The Krishna River separates the Vijayawada city from Guntur district and extends up to Bay of Bengal. The study area extends up to Guntur district on south and Nalgonda District, Telangana on west. The study area can be classified into three geological provinces. i) Khondalites rock types occupied by north and western part of study area, ii) Sandstones rocks are occupied by North-eastern and central part of Vijayawada and iii) Coastal alluvia rock type or occupied by eastern and southern part of study area. The study area has four types of soils, Viz., 58 % of black cotton soils, 23 % of sandy clay loams, 17 % of red loamy soils, and 2 % of sandy soils. The sandy soils form along the coastline. The western part of the city is covered by black cotton soil. The sandy clay loams are formed along Krishna river. The district is a major centre for agriculture, education and learning study area map was shown in Figure 1.

The population growth of Vijayawada city is increased drastically from 2001 to 2011 i.e from 10, 52,000 to 14, 94,000. Now at present the city will have a population approximately 20,00,000 [8]. The metro area population of Vijayawada from 2005 to 2021 is increase in the range between 3.0% to 3.5% every year approximately [8].
3. Methodology

LULC modification of Vijayawada city were obtained from LANDSAT satellite images was collected from USGS website for the year 2005 and 2020 respectively. The satellites Imagery were further pre-processed for geometrical and radiometric correction. Later the collected satellite imageries were imported into ArcGIS software and maximum likelihood supervised classification was carried out and further the review region was categorized into five different LULC patterns and suitable maps are generated and later the LULC change statistics was computed. The final output classes were: built up area, vegetation, fallow land, waste land, and water bodies. The methodology of the work was shown in Figure 2.
4. Results:
LULC is a major factor of climatic and environmental modification [9] and these modifications may induce directly or indirectly in the Earth atmosphere which guide to unsustainable environmental conditions such as loss of biodiversity, food insecurity, degradation of land, air and water pollution, etc. By comparing Figure 3 and Figure 4 land use patterns the urbanization increased significantly in Vijayawada. Table 1 represents that there was an 26.5% loss of vegetation land, with the built up areas rising from 13% to 53% within the study period. Figure 5 reveals the graph analysis of land use and land cover of Vijayawada city for the year 2005 and 2020.
Figure 3. Land use and land cover of Vijayawada city – 2005

4.1 Assessment of land use change between 2005 and 2020:
From Table 1, there was no appreciable change on water bodies during the study period. The major change includes the loss of vegetation and hilly area which decreased 46% approximately, i.e. nearly 40% of land was changed into built-up area and the remaining 6% of land was converted into fallow land. Comparing 2005 and 2020 satellite images there was an increase in settlement area on suburbs landscape of Vijayawada city, where land is cheaper and accessible. By RS and GIS government can easily monitor the growth of the city, and they can use this technique for site suitability analysis like constructing new Health centers, Schools, Park and etc..

Table 1. Land use and Land cover change analysis of vijayawada city for the year 2005 and 2020

| Land Use Land Cover classification | 2005 (%) | 2020 (%) | Rate of change (%) | Remarks   |
|-----------------------------------|----------|----------|--------------------|-----------|
| Water bodies                      | 3.49     | 4.28     | 0.79               | Increased |
| Vegetation                        | 53.09    | 26.51    | 26.58              | Decreased |
| Fallow land                       | 6.34     | 11.86    | 5.52               | Increased |
| Hills                             | 23.35    | 4.12     | 19.23              | Decreased |
| Build up area                     | 13.71    | 53.22    | 39.50              | Increased |
Figure 4. Land use and land cover of Vijayawada city – 2020

Figure 5. Graph analysis of Land use and land cover of Vijayawada city

5. Conclusion
This Research has established that Remote sensing and GIS is a viable tool for natural resource management in developing countries. By using RS and GIS the depletion of vegetation resources
clearly noticeable in Vijayawada city and government needs to addressed this issue before further depletion on vegetation resources. In-between 2005 and 2020 periods, more than 26% of the vegetation area was lost to settlement areas. It is obvious that if these patterns of land use change continue, upcoming era is left undesired. As compared to agriculture area, built up areas (industries, commercial areas,) are covering most of the land, but agricultural areas should not be considered for converting in to built-up areas. Only land unsuitable for agriculture should be taken into account for constructing build areas. By proper water and soil management the waste lands can be converted as agriculture fields. Fallow lands can also be converted into agriculture land by efficient utilization of organic matter to the soil. In addition to analyze changes in land use and land cover patterns, Remote Sensing and GIS provides information on the current trend of resource depletion, deforestation and loss of biodiversity in the constantly growing city and its helps the planners and policy makers to achieve sustainability now and in near future.

6. References
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