International Journal of Research in Advent Technology, Vol.5, No.8, August 2017
E-ISSN: 2321-9637
Available online at www.ijrat.org

Methodological Understanding of Land use and Land cover Change in Riverine Floodplain: A Remote Sensing and GIS based Approach

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Abstract- *Land use and land cover change in riverine floodplain is an exceptionally unavoidable continuous process. Root cause of the origin of this phenomenon is natural but with time human encroachment to this riverine fertile area has been increased manifolds. This encroachment leads to the transformations that question the sustainability of human development curve. With conceptual understanding it is also very important to understand the applied methodology used in study and analysis. There are two methods of studying the land use and land cover change one is traditional and other is modern. Both methods kept momentum and importance in the understanding, conceptualization, analysis, interpretation and representation of the subject. Traditional methods are absolutely field based with ancillary data input, whereas modern method of studying land use and land cover change includes Remote Sensing and GIS technique which enhanced the in depth understanding and paved the scope of critical result evaluations. This technique is highly conducive for acquisition of synoptic, repetitive, accurate, fast and efficient information about an area.*

Index Terms- ***Land use; Land cover; Floodplain; Remote Sensing; Geographic Information System.***

Introduction

Riverine floodplain area formed through the depositional work of river and changed naturally with the change in course of river. This area is attributed with fertile soil and ample water that attract the human brigade to live in periphery. This can be traced back to the dawn of human civilization. With even added human number and their requirements encroachment over riverine area has been increased many folds. Human activities on that area accentuates the process of land use and land cover that too with imbalanced land use to land cover ratio (Gill, 2016). This change affects the related phenomena which draws drastic ecological implications. Conceptually this process is engrossed in Man-Environment relationship and methodological in Geospatial Environment. Advancement in Geospatial technology boosts the researcher to add many more variables to understand this interlinked phenomena i.e. land use and land cover change.

1. Land use and land cover change in riparian flood plain

1.1. Conceptual Underpinnings

Land use and land cover change in flood plain area is the analytical overview of the changing Man-Environment relationship. This research theme includes two important components i.e. land use/ cover change and flood plain, which are having functional interlinkages, as any change in land use and land cover patterns gets affected and affects the floodplain environment. Changes in land resource utilization in flood plain domain results to the hazardous ecological implications, such as change in riparian vegetation, deforestation, disappearance of wetlands, soil degradation, ground water depletion, waterlogging and water pollution etc. (Omernik, 1977; Rabeni and Smale, 1995; Poff et al., 1997; Gergel, Turner, Miller, Melack and Stanley, 2002; Vache, Eilers and Santelmann, 2002; Zimmerman, Vondracek and Westra, 2003). These ecological implications will raise certain issues with regard to sustainability (Tariq, 2009, Kaur and Brar, 2013).

Conceptually there are two prevalent views of studying land use and land cover change i.e. oriental and western. *Oriental view*, reconstruct land use change through land cover and on the other hand *western view* reconstruct land cover change through land use change with passage of time. Land use and land cover of any area may be transformed and modified with time due to natural and anthropogenic factors operating directly or indirectly in the area. Among natural factors, availability of resources and climate change stimulate LULCC, whereas among

anthropogenic causes population, affluence, and technology (PAT) variables act as the dominant cause for this change (Turner and Meyer, 1991; Stern et al., 1992).

Flood plains offer great advantages for development, as these are characterized by low slope, fertile soil, and easy access to water. It provides the physical unity of resources, which makes these tracts attractive for regional development. But distinctiveness of that area lies in the special inputs of labor and capital needed to offset the hazard arising from the occasional inundation. These inputs are part of a series of human adjustments. These human adjustments occur through alterations of existing land use and land cover pattern. Flood plain is a fragile ecosystem which is vulnerable to the in-situ factors (such as inundation of water from the banks) and ex-situ factors (such as human interventions in the flood plain). For enhancing the resilience of flood plain and reduction of the vulnerability of population, it is necessary to see the present and past changing pattern of the land use and land cover. Thus, land use and land cover change in flood plain domain represents a critical intersection between human activities and environment (Gill , 2017).

1.2. Methodological Understanding

1.2.1. Traditional Methods

Absolute field based approach: In this method intensive field survey has been conducted for understanding the minute details of land use and land cover change of an area. Drawback of total dependency on this method is the lack of acquisition of data from those areas which are remote and inaccessible.

Ancillary data input: Secondary data sets further acquired from plots at Village level, Block level, Tehsil, District, State and Country level. Regular field surveys, census data sets, Survey of India Topographical sheets and various other documented material acts as important source of intensive and extensive information.

Absolute field based data requires more time and human power, that effects updation of data. This problem can be ruled out with the use of Remote Sensing and GIS technique at each possible spatial level. Continuous Research and Development (R&D) initiatives have been taken up for improving the quality, quantity and temporal aspects of data acquisition, analysis and representation.

1.2.2. Modern Methods

Role of Remote Sensing and GIS: Remote sensing is a viable source of gathering quality land use (human employment of the land) and land cover (physical and biotic character of the land surface) information at the local, regional and global scale. Land use and land cover is one of the important product generates from remote sensing data. Remote Sensing and GIS provides synoptic, repetitive, accurate, fast and efficient information and data analyses methods.

Methodology

Data Sources: Riverine floodplain domain covers the inter-state region. Depending upon the scale of study, we can use three season data from the following sensors:

Table 1: Spatial links between administrative hierarchy and Remote Sensing Data

ADMINISTRATIVE LEVELS	REMOTE SENSING SENSORS	SPATIAL RESOLUTION
VILLAGE	LISS IV	6m
MANDAL	LISS III	24m
DISTRICT	LISS III	24m
STATE	AWIFS	60m

Ancillary data input: It includes aerial photographs; Survey of India topographical sheets, field survey for ground truthing; various government offices including District Revenue offices; Water resource and Environment Directorate; Office of Economic Advisor to state Government; Soil Conservation Department; Meteorological Department; MODIS flood inundation maps etc.

Required thematic layers:

- Hydrological data set layer, it includes rainfall, surface water and ground water condition data.
- Digital Elevation Model (DEM) formulation: It helps in understanding the properties of drainage network and demarcation of floodplain. It is a valuable tool for the topographical parameterization of hydrological models.
- Political layer: It includes Administrative boundary layers and Government demarcated planning regions.
- Land capability layer: It exhibits soil texture, soil types and chemical composition etc.
- Ecological layer: That consist distribution pattern and characteristics of biota, which constitute natural cover, fauna and human population.
- Land use and land cover layer

All these layers can be generate and analyzed in GIS environment by using overlay analyses etc.

Data Processing

- Data acquisition and preprocessing: For studying change detection projects, multiple satellite scenes are required to provide complete area coverage. This could be done by using technique such as data mosaics, sub-setting and masking etc.

- Geometric and Radiometric correction: This analysis is performed on a pixel by pixel basis and misregistration greater than one pixel will provide anomalous result for that pixel.

- Data Normalization: Variation in solar illumination condition, atmospheric scattering, atmospheric absorption and detector performance results in differences in radiance values unrelated to the reflector of the land surface.

Radiometric data normalization represents a first order data transformation approach used to reduce the variability between multi- temporal data sets acquired over the same geographic area.

Land use and Land cover Classification

Classification criteria: Adopted from Anderson (1976);

- The minimum level of interpretation accuracy in the identification of LULC categories from Remote sensing data should be at least 85%.

- The accuracy of interpretation for the several categories should be about equal.

- Repetitive results should be obtainable from one interpreter to another and from one time of sensing to another.

- The classification system should be applicable over extensive areas.

- The classification system should be suitable for use with remote sensing data obtain at different times of the year.

- Effective use of sub categories that can be obtained from ground surveys or from the use of large scale or enhanced remote sensor data should be possible.

- Aggregation of categories and comparison with future land use data should be possible.

Change Detection Analysis

Change detection analysis approaches can be broadly divided into either post classification change methods or pre- classification spectral change detection method.

Post Classification Approach: This approach involves the analysis of difference between two independent categorization products. Application approached can include either visually imaged interpretation (pattern recognition), or computer data categorization. Application of this approach not required data normalization because two dates are classified separately.

Pre Classification Approach: This approach involves the transformation of two original images to a new single band or multi band image in which the areas of land cover change are detected.

The change enhanced data can be further processed by other analytical methods, such as a classifier for producing a labeled change detection output product; image differencing or image ratioing and vegetation indices etc. Techniques like band to band regressions and principal component analysis can be used to perform the image to image equalization and the detection of change areas.

Land use/ Cover Classification Accuracy Assessment

It can be done on the basis of insitu data or prior knowledge of that area. So, it is necessary to compare two classification maps i.e. Remote sensing (derived map) and assumed true map (It can be derived from in situ investigation or from the interpretation of remotely sensed data obtained at a larger scale or higher resolution). Accuracy test can be applied and accuracy can be calculated through Kappa co-efficient analysis.

Conclusion

Produced map of Land use and land cover change for a floodplain area with the merging of Remote sensing data coverage's with other spatial ancillary data type's resulted to the process of geospatial data integration, which is helpful in monitoring, mapping, evaluation and sustainable use of natural resources.

Provided information helps in the generation of land use and land cover change inventory that explains the changing patterns and trends. Such an inventory would be helpful in framing the historical overview of land use and land cover changes. It also estimates the vulnerability of floodplain area. Floodplain is highly vulnerable to the flood hazard or flood risk. Owing to factors of accessibility and high fertility this area is also more prone to human interference leading to large scale change in land use as well as land cover. The findings of such a study may helpful in estimating and reducing the vulnerability of that area to flood hazard. It also helps in understanding the issues that deal with sustainability in a particular region and provide inputs for framing policies for sustainable development. It

also shows the direction of changing human-environment interactions.

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