Land Use/Land Cover and Change Detection Analysis of Upper Krishna River Sub Basin using GIS and Remote Sensing

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Abstract

Land use/land cover (LU/LC) changes were determined in an urban area, upper Krishna river sub-basin, from 2000 to 2010 by using Geographical Information Systems (GISs) and remote sensing technology. Present studies were employed by using the Survey of India topographic maps and the remote sensing data of Landsat Images. The study area was classified into six categories on the basis of field study, geographical conditions, and remote sensing data. The comparison of LU/LC in 2000 and 2010 derived from toposheet and satellite imagery interpretation indicates that there is a significant Built-up areas show increase of 538.45 hectares from 2000 to 2010. Area under agriculture has increased by 2095.88 hectare. Area under water bodies shows increase of 898.11 hectare. Areas under both medium dense and dense vegetation have decreased.

Keywords: Land use/land cover, GIS, Remote Sensing, Change Detection.

Introduction

"Land use is the human modification of natural environment or wilderness into built environment such as fields, pastures, and settlements". Land cover is the physical material at the surface of the earth. Land covers include grass, trees, bare ground, water, etc.

"Study of Land use and land cover change has become a central component in current strategies for managing natural resources and monitoring environmental changes. The advancement in the concept of vegetation mapping has greatly increased research on land use/land cover changes". It provides an accurate evaluation of the health and spread of the world's forest, grassland, and agricultural resources. In the present study attempt has been made to find out the status of land use/land cover of study area from 2000 to 2010.

Objectives of the Study

To Study land use land cover of upper Krishna river sub-basin.

To Study land use land cover and Change Detection of upper Krishna river sub-basin.

Study Region

The study area selected for the present study is upper Krishna sub basin in a part of Wai taluka. This basin drains Wai taluka of Satara district comprising 113 villages. Study region Comprise 554.20 Sq.km. Area and lies between 17^0 45' N to 18^0 05' N Latitude and

73^0 35' E to 74^0 05' E Longitude. The region has diversified physiography whose western border is demarcated by Western Ghats. Minimum elevation of the area is 942 meter and maximum is 1400 meter. A vast plain area of river Krishna valley sloping east ward and southeast ward is noted in the central part of the region. A western part, north and south border area is hilly with rugged topography. Climate of study region is subtropical monsoon type. There is rapid decrease in rainfall from west to east. Western part of study region receives average 2124 mm rainfall while eastern part receives only 300 mm rainfall.

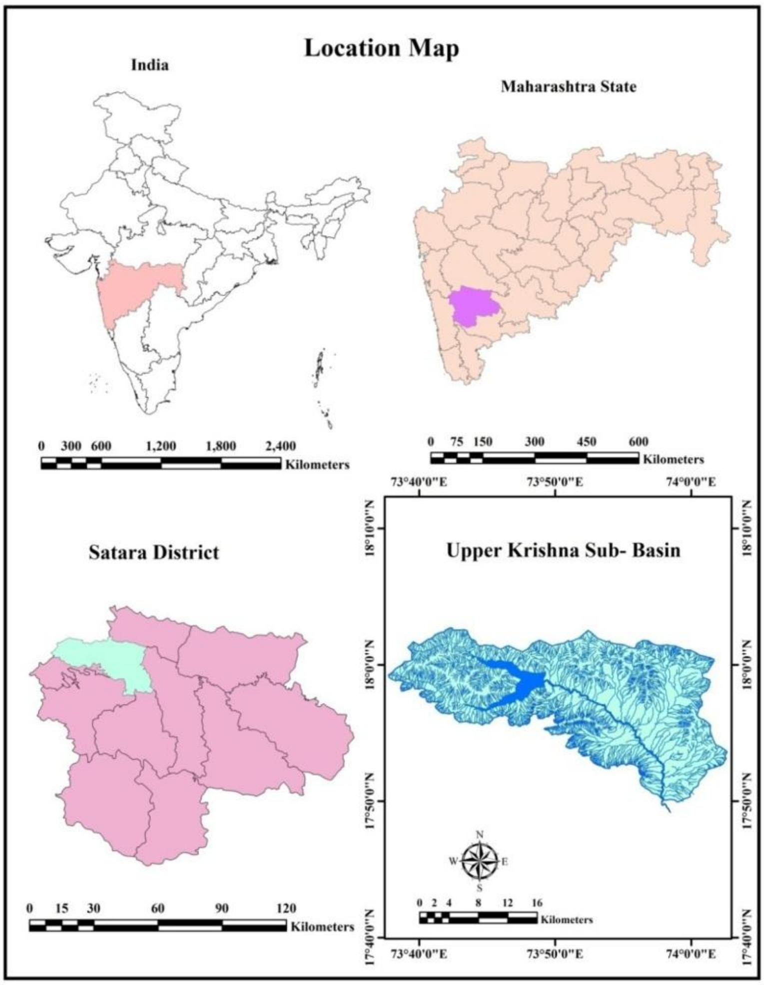

Fig: 1

Data Base

Methodology

Pre field phase: Different maps, Satellite imageries and non-spatial data were used for Preparation of different thematic layers.

Laboratory work: Digitization of various layers, preparation of maps and other GIS/RS techniques. I.e. Georeferencing, Digitization, Attribution, Data attachment, Overlay analysis, Supervise and Unsupervised classification, Final layouts of different maps were carried out in laboratory using ARC GIS 9.3 and ERADS IMAGINE 9.2 softwares.

Methodology for Image Classification

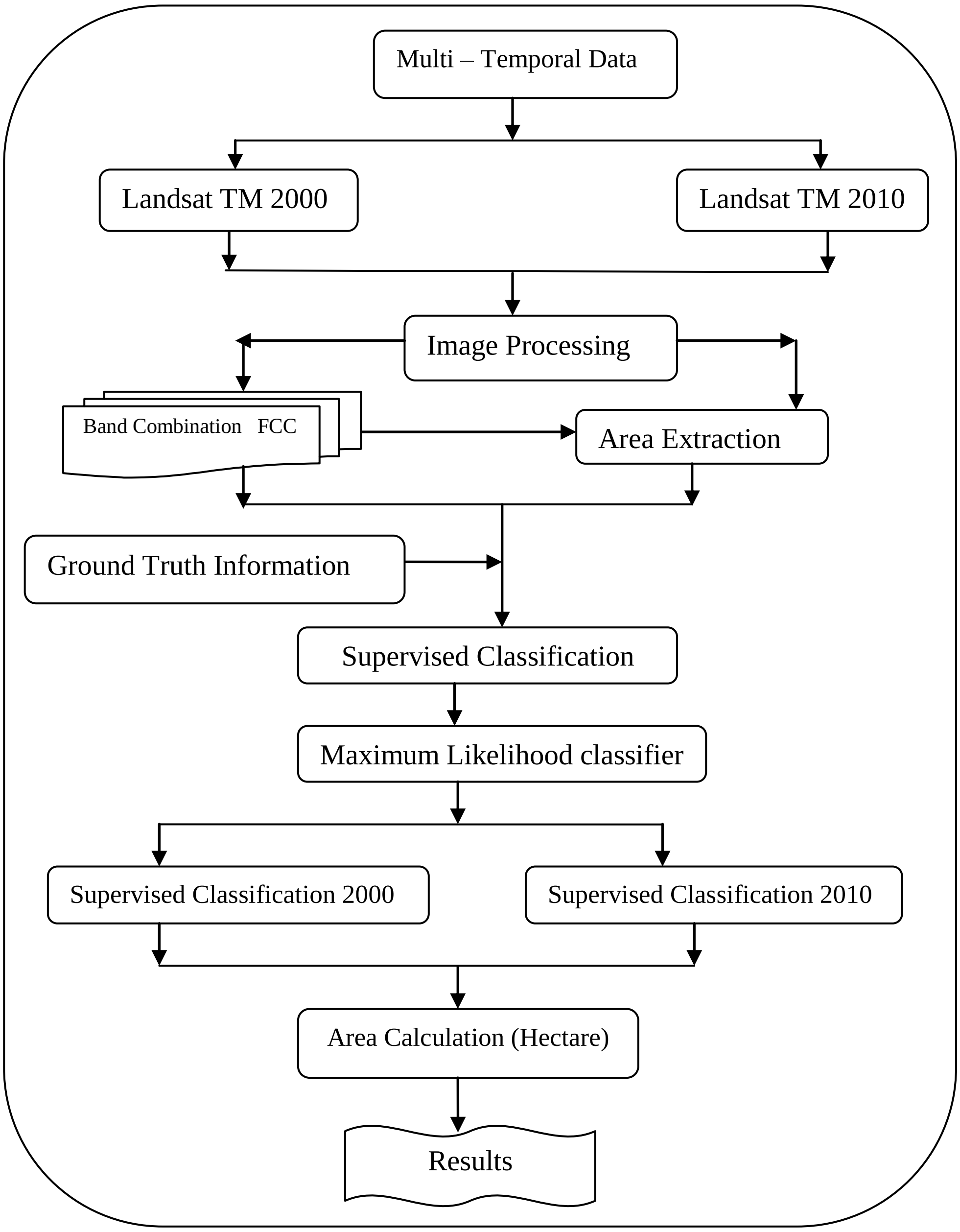

Image Processing

Image processing means study of any algorithm that takes an image as input and returns an image as output. It is a process of improving the quality of an image for the analysis and manipulation. Raw remotely sensed data have found lot of geometric as well as radiometric Errors. The geometric as well as radiometric corrections are mandatory before using raw remotely sensed data for analysis. By using Eardas Imagine it is possible to remove these errors. Image processing includes image restoration, enhancement, texture analysis, lossy and lossless data compression. Now a day's USGS, NASA and ISRO provide orthorectified data. For the present study, Land sat Tm satellite Images of 2000 and 2010 have been downloaded from glcf site.

Image Classification

By visual interpretation expert and experienced human interpreter extract thematic information from satellite image. Visual interpretation takes into account tonal differences, texture, size, shape, context etc. Though the visual analysis is extensively used for the interpreting remote sensing data; it has the limitation of not being able to provide quantitative information. When the volume of data is very large, the information extraction through visual analysis is very low. Visual analysis also makes it difficult to effectively use all spectral bands. So computer processing of remotely sensed data is essential to take full advantage of the capabilities of this data to identify and quantify features.

The objects are discriminated on the basis of reflectance/emittance variation of their EM radiation (Spectral signature) and other characteristic properties. A pixel is associated with a set of values i.e. a digital number (DN) for each spectral band. The task of digital classification is to assign a value or label to each pixel of the remote sensing image. If this labeling is done for all the pixels in the scene, we get a thematic map as in the case of visual interpretation. There is no unique value of the reflectance/emittance associated with each class (object). Spectral response pattern from various surface classes will generally have a mean value and a spread/variability around the mean. Number of factors likes atmospheric scattering, topography, class mixture, illumination and view angles etc. cause this spread or variability within a class.

Supervised Classification

"In supervised classification, the analyst, based on the prior information on the spectral characteristics of these classes, 'trains' the computer to generate boundaries in the feature space within which each class should lie. Then each pixel lying within a class boundary is assigned to that class".

Typical supervised classification involves three steps (T. M. Lillesand& R. W. Kiefer, 1987).

1. The training stage, where multi-spectral parameters are extracted for various classes from the training sites identified in the image.

2. The classification stage, wherein, each pixel is assigned to a class to which it most probably belong.
3. The output stage–the presentation of the data is in the form of maps, tables, graphs, etc.

Training Stage

In this step, pixels from the training samples are extracted to train the classifier to create discriminate functions which assigns each pixel to a class in the feature space. The selection of training samples is very crucial to the accuracy of the classification. The first step is to locate representative areas of each class in the image.

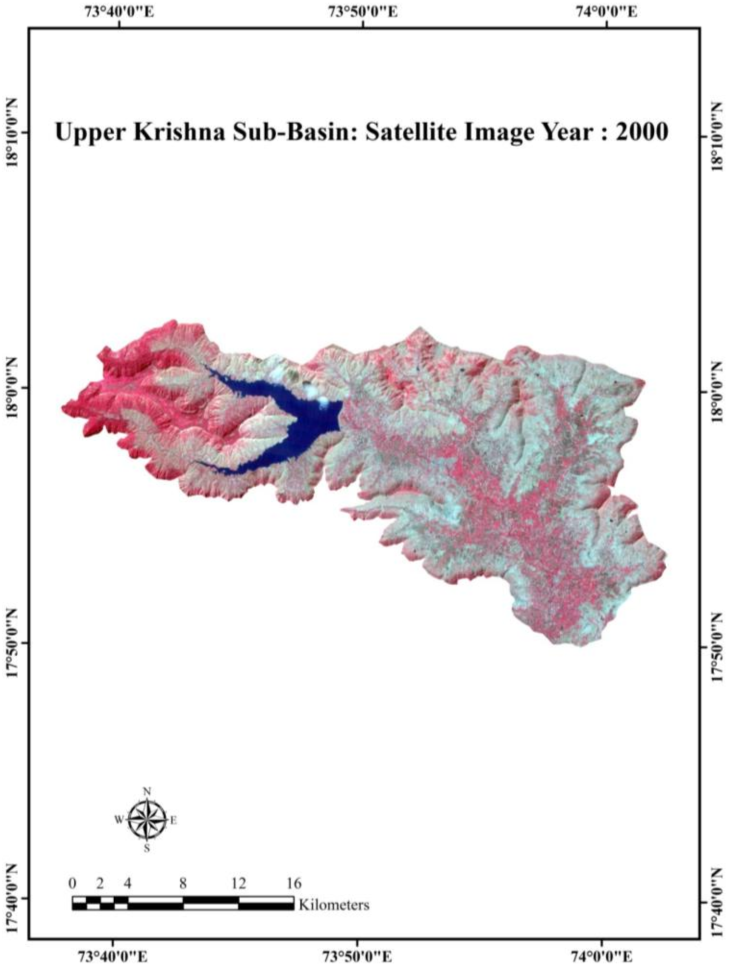

Fig: 2

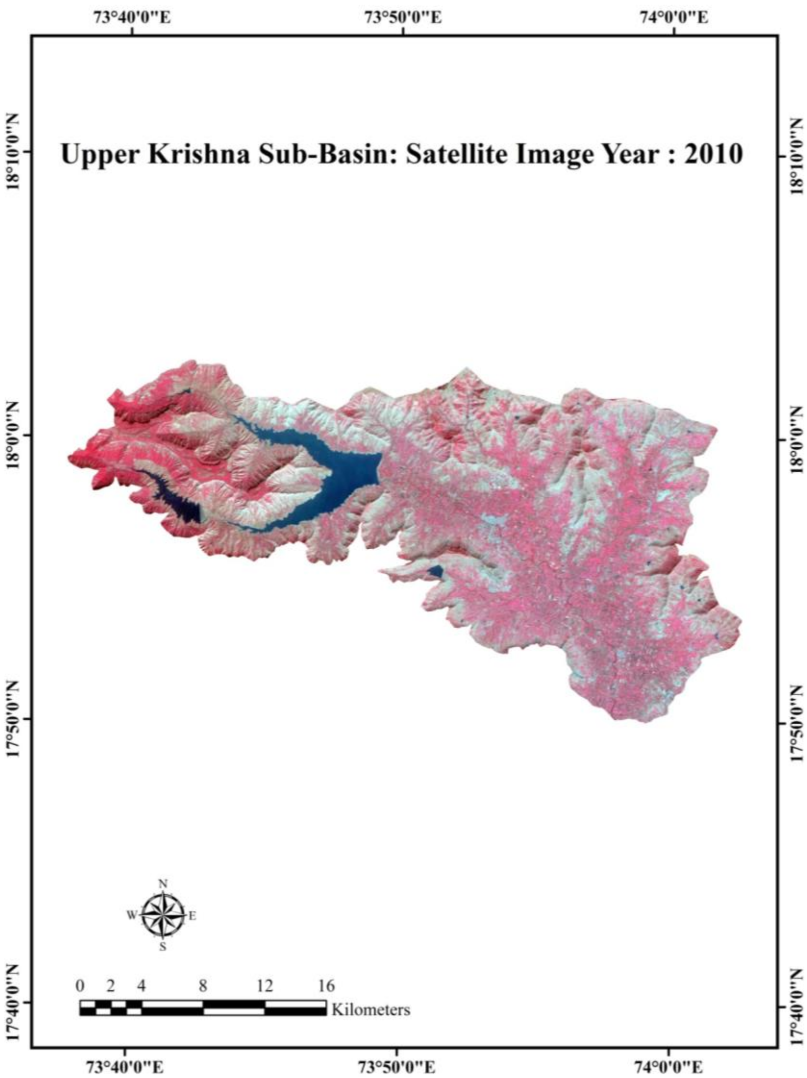

Fig: 3

These areas are called training sites. These training sites are selected on the basis of ground surveys.The training sites data for each class is used to calculate various statistical parameters such as mean, standard deviation, variance, covariance matrix, etc. to carry out classification.

Classification Stage

The classification algorithms can be broadly grouped into parametricand Non-parametric.

Parametric Classifier

Parametric Classifier assumes that samples from each class belong to a population modeled by a probability density function. Generally, a Gaussian distribution is assumed and requires estimates of the distribution parameters, such as the mean vector and the covariance matrix.

Non Parametric Technique

"Non Parametric Techniques are termed 'robust' because they can be applied with a wide variety of class distribution, if class signatures are distinct to begin with" (Robert A. Schowengerdt, 1997).

Maximum Likelihood Classifier (MXL)

MXL assumes that the DN value for each class has a Gaussian distribution. The necessary parameters for the model (mean and standard deviation) can be estimated from the training data. Each pixel from the class mean is associated with a probability of that pixel being a member of that class. For any pixel computer computes the probability for each class. The pixel is assigned to that class for which the probability is maximum and is above a threshold value set by the analyst. If the probability of all the classes is below the threshold, it may be labeled unclassified. A pixel close to the mean of the class will have highest probability for that class and as it moves away from the mean, the probability will decrease depending on the distribution function.

Output Stage

The classified information has to be presented suitably for further utilization of the information. A thematic image can be generated after classification. Here, each theme may assign a color or shade or symbols as in the case of visual interpretation. This gives a good pictorial display of the spatial extent of each theme.

Table 3 Land use/Land Cover Pattern of Study Area

Land use / Land Cover Classes	Hectares (2000)	Hectares (2010)
Built-up	101.33	639.78
Water body	1634.23	2532.34
Agriculture	18011.5	20107.38
Medium Dense Vegetation	8242.53	7145.87
Dense Vegetation	9022.31	6438.44
Open land/Sparse vegetation	18408.1	18556.19
Total Area of KRSB	55420	55420

Source: Classified Satellite Images and complied by Researcher (2000 and 2010)

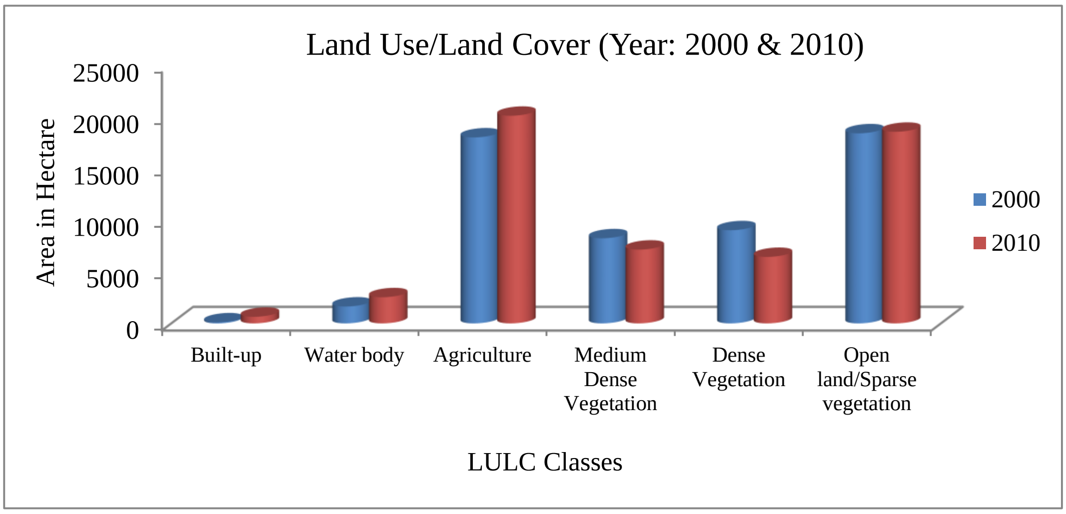

Fig: 4

For image classification images of 2000 and 2010 have been classified into six classes. Built-up area shows increase of 538.45 hectares from 2000 to 2010. Area under agriculture has increased by 2095.88 hectare. Area under water bodies shows increase of 898.11 hectare. Areas under both medium dense and dense vegetation have decreased.

Change Detection

Images of 2000 and 2010 have been classified into in six classes. "In change detection analysis, comparison of images with same spatial resolution is necessary for crucial result". (Jensen, J. R., 2005).

Table 3.10 Built-up area shows increase of 0.97 percent from 2000 to 2010. Area under agriculture has increased by 3.78 percent. Area under water bodies shows slight increase of 1.62 percent. Areas under medium dense vegetation decreased by 1.98 percent while dense vegetation have decreased by 4.66 percent.

Table 3 : Land use/Land Cover Pattern of Study Area

Land use/Land Cover Classes	Hectares (2000)	%	Hectares 2010	%	Area Increased and Decreased (In %)
Built-up	101.33	0.18	639.78	1.15	0.97
Water body	1634.23	2.95	2532.34	4.57	1.62
Agriculture	18011.5	32.50	20107.4	36.28	3.78
Medium Dense Vegetation	8242.53	14.87	7145.87	12.89	-1.98
Dense Vegetation	9022.31	16.28	6438.44	11.62	-4.66
Open land/Sparse vegetation	18408.1	33.22	18556.2	33.48	0.27
Total Area of KRSB	55420	100	55420	100.00	

Source: Classified Satellite Images and complied by Researcher (2000 and 2010)

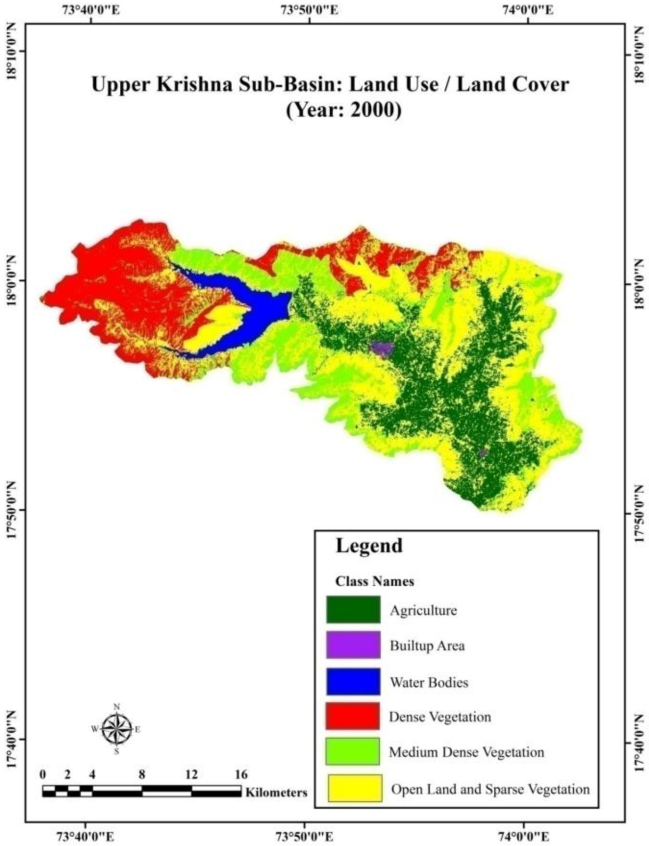
Upper Krishna Sub-Basin: Land Use / Land Cover
(Year: 2000)
73°40'0"E
73°50'0"E
74°0'0"E
18°10'0"N
18°0'0"N
17°50'0"N
17°40'0"N
Legend
Class Names
Agriculture
Builtup Area
Water Bodies
Dense Vegetation
Medium Dense Vegetation
Open Land and Sparse Vegetation
0 2 4 8 12 16
Kilometers

Fig: 5

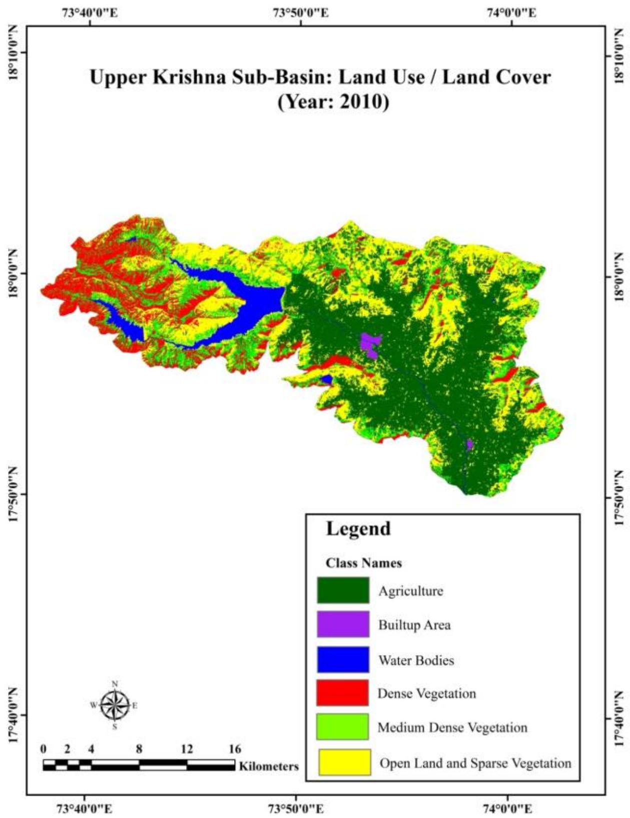
Upper Krishna Sub-Basin: Land Use / Land Cover
(Year: 2010)
73°40'0"E
73°50'0"E
74°0'0"E
18°10'0"N
18°0'0"N
17°50'0"N
17°40'0"N
Legend
Class Names
Agriculture
Builtup Area
Water Bodies
Dense Vegetation
Medium Dense Vegetation
Open Land and Sparse Vegetation
0 2 4 8 12 16
Kilometers

Fig: 6

Conclusion

Built-up areas show increase of 538.45 hectares from 2000 to 2010. Area under agriculture has increased by 2095.88 hectare. Area under water bodies shows increase of 898.11 hectare. Areas under both medium dense and dense vegetation have decreased.

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