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LAND USE AND LAND COVER CHANGE DETECTION IN MOGRAL RIVER BASIN, KASARAGOD DISTRICT, KERALA USING REMOTE SENSING AND GIS

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ABSTRACT

Land cover of an area is undergoing various transformations due to natural and man-made processes. Information about land use change is needed for planning and development of an area. This study is proposed with an objective for the inventory of various land cover classes in Mogral river basin of Kasaragod district, Kerala. The higher value of NDVI is seen along the eastern portion of the study area and also along the banks of stream course. The eastern part of the basin was having comparatively higher NDVI value due to the Karadka reserve forest. Compared to the NDVI value of 2009, the NDVI value of the basin in 2016 was decreased. This decrease in value indicated the loss of vegetation due to human encroachment. The changes were identified, in which the decrease of agricultural land, natural vegetation, and water body and increase of urban land and laterite exposure were observed. About 7.75 % decrease in area under forest land, had been noticed. The area under water bodies was also found to be depleting over the years. About 0.11 % of decrease in area under water bodies have been found out. Quarrying, agriculture expansions, deforestation have a crucial role in the reduction of this land cover.

Key words: Remote sensing, GIS, Mogral river basin, NDVI, Laterite.

INTRODUCTION

Land is one of the most valuable and constant natural resource of a nation. The land surface is undergoing slow or fast changes, naturally or due to anthroprogenic activities with time. Land Use Land Cover change detection is the process of detecting the changes in the physical features and identifying the effects on the environment. It is an important component to understand the global land status. It can show the present and past status of the earth's surface. Land cover is a natural basic parameter which evaluates the content of earth's surface on the ecosystem. Land Use and Land Cover studies are playing important role in environment, ecological studies and natural resource management. Land Use refers to utilization of land by human beings. The changes in land use and land cover have intense consequences for the biodiversity and economic rise of the people (Binutha and Somashekar, 2014). Land Use and Land Cover changes provide a relation between anthropogenic and natural activities in earth. The land use and land cover of an area varies with its various geological and geomorphological features (Ansari et al., 2013). At present, fresh water resources in most parts of the world, is facing severe crisis in demand due to contamination and unsustainable water use aggravated by the unpredictable and unforeseen climatic changes caused by deforestation. The climate change along with urbanization and adverse alterations in land use made most of the world's fresh water resources under severe pressure and change. River banks and its associated landforms act as prominent sites of human settlements all over the world, and now they were among the important natural systems receiving the impact of pressures of development. Degradation of river basins concomitant to depletion of resource is one of the serious environmental issues of Kerala that require quick attention and corrective measures (Krishnakumar et al., 2017).

Location

The river Mogral is a west flowing river in Kerala having a length of 34 km. It is lying between Chandragiri river basin in the south and Shiriya river basin in the north. The catchment area of the river basin is 113 sq.km. It lies in between N12^{0}29 00"toN12^0 36 00" and E74^0 57' 00" to75^0 09 30" (Figure.1).

Figure 1. Location of Mogral river basin.

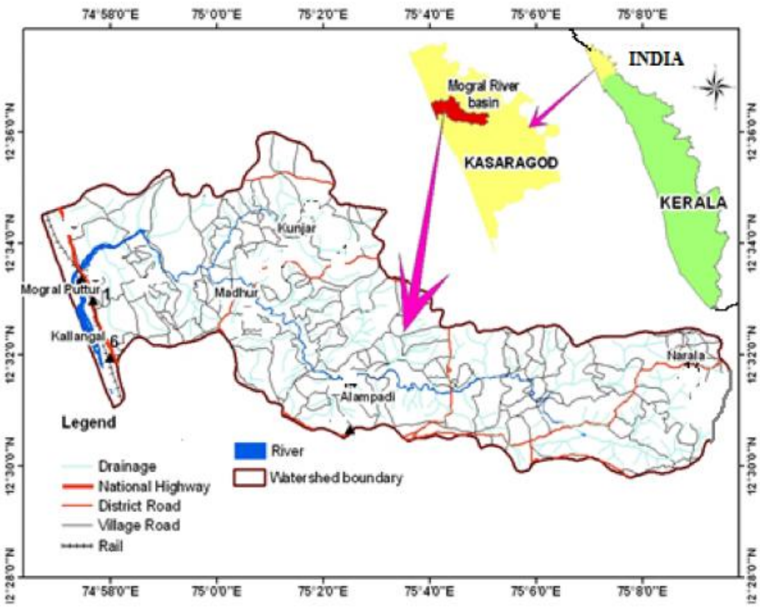


Figure 2. Satellite imagery of Mogral river basin in the year 2009.

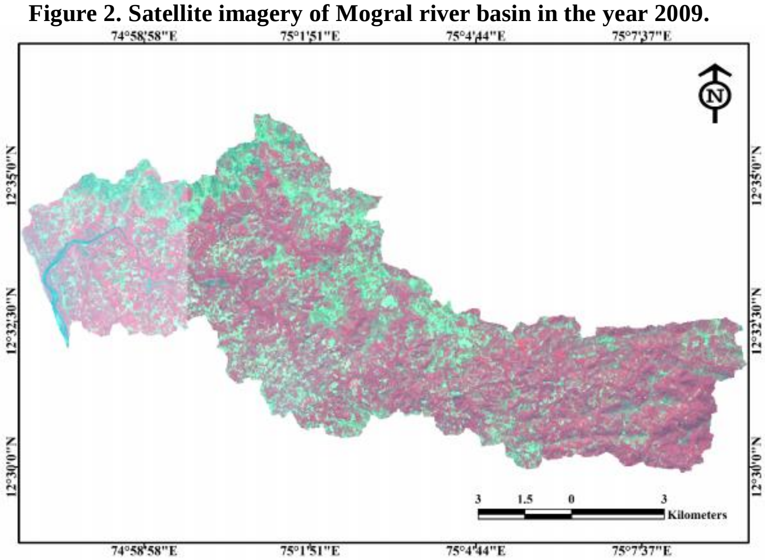
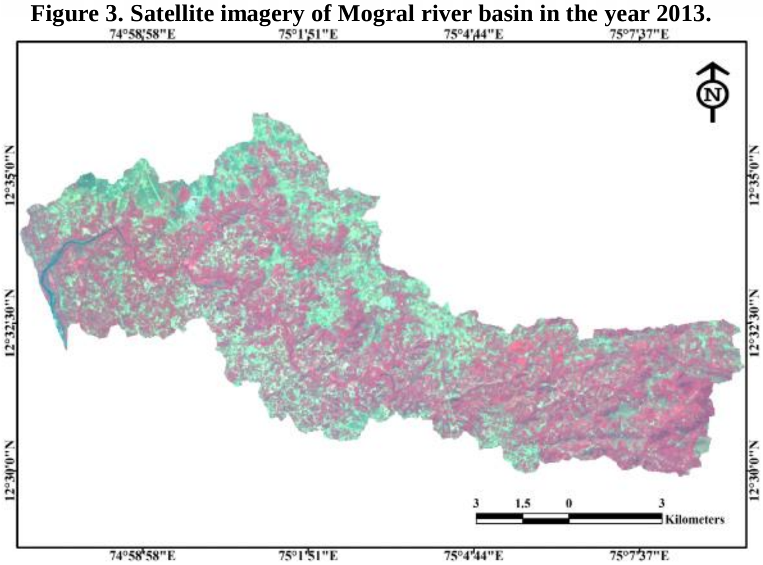


Figure 3. Satellite imagery of Mogral river basin in the year 2013.



METHODOLOGY

Two software were used, namely ERDAS Imagine 9.2 and Arc GIS10.1 to analyze the spatial changes in Mogral River basin. ERDAS Imagine 9.2 software is used specifically for image processing and image classification. ArcGIS 10.1 software is used specifically for database maintenance and to prepare interactive layouts. The data used for the analysis is derived from the satellite imageries of IRS P6 and LANDSAT 8. The details are shown in Table 1.

The downloaded zip files were extracted using WinRAR software. Individual bands were layer stacked to get a composite image. The composite image is extracted to the study area using extract by mask in ArcGIS 10.1. The Focal analysis tool is used in ERDAS Imagine 9.2 software to remove strips in IRS images. Supervised classification is performed using the signature training set collected from the field work. The classification is recoded and area of each class is calculated by adding add area column. The same procedure is applied to all 3 imageries to get the spatial and temporal change analysis of the parameters like water body, vegetation, Agricultural land, forest land, urban land and laterite exposure (Figure 2, 3 and 4). The analysis clearly shows the applications of Remote Sensing and GIS in Land Use Land Cover analysis.

Table 1.
Details of satellite imageries.

Satellite	Sensor	Resolution	Date of the image
IRS-P6 (RESOURCE SAT-1)	LISS-III	23.5 meter	15 Dec 2009
			28 Jan 2013
Landsat 8	OLI	30 meter	24 Dec 2016

Figure 4. Satellite imagery of Mogral river basin in the year 2016.

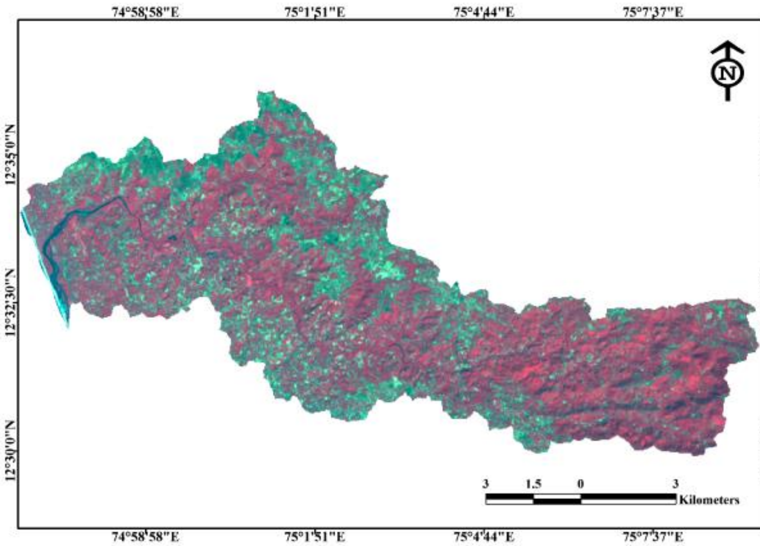


Figure 5. NDVI of Mogral river basin in the year 2009.

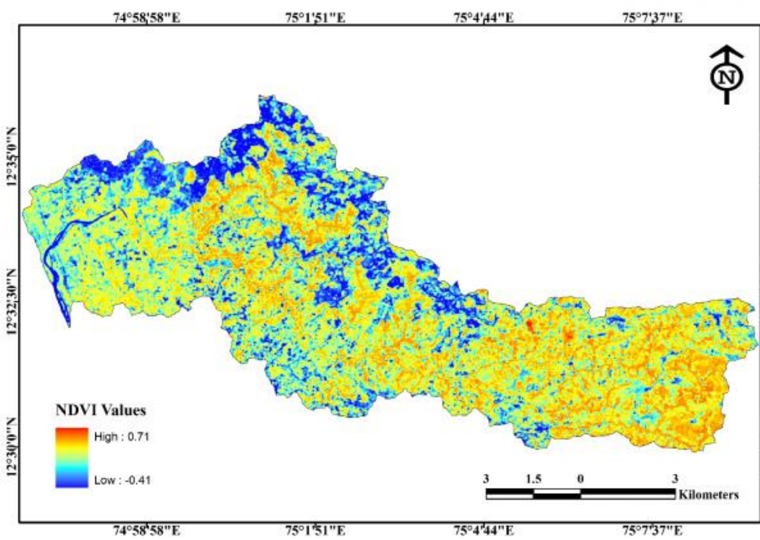
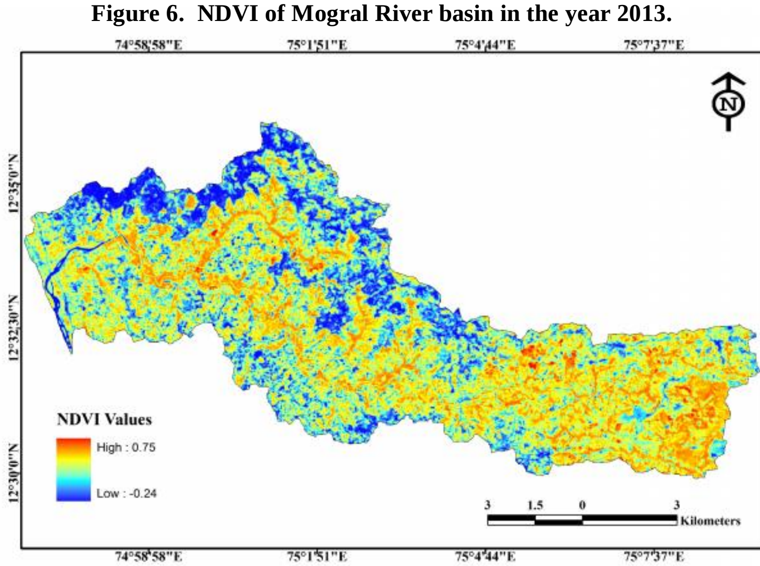


Figure 6. NDVI of Mogral River basin in the year 2013.



Normalized Difference Vegetation Index (NDVI)

Remote sensing data are widely used for vegetation mapping and monitoring. The NDVI derived from satellite imageries is one of the useful criteria of vegetation index for the detection of change in vegetation and classification of vegetation into various types. The NDVI also provides a measure of the cover of vegetation and its density on a land surface (Badamasi et al., 2012). Areas of dense vegetation show up very strongly in the imagery than the areas of no vegetation. Natural vegetation shows a tendency to absorb strongly the red wave length of sunlight and it reflects the near infrared wave lengths. Hence the areas of vegetative cover that appear on a satellite imagery are highly differs from other land surfaces (Jwan Al- doski et al., 2013). The images of a given area, separated by a definite duration of time, are compared to find the change in land cover with respect to pixels of image that changed during the selected interval (Lillesand et al., 2004). Vegetation density is changed by seasonal and annual dynamics (Ozyavuz et al., 2015). The acquisition dates of images are normally selected so that they fall in the same month or season annually. This reduces spectral difference between the images due to seasonal vegetation phenology, angle of sunlight and shading, cloud cover and concentration of particles in the atmosphere.

In the present study, three satellite images (December 2009, January 2013 and December 2016) of Mogral river basin (Figure 5, 6 and 7) have been classified based on NDVI calculated by using the formula (Tucker, 1979).

$$NDVI = (NIR - RED) / (NIR + RED) \quad (1)$$

Where, NIR is near-infrared radiation and RED is the red visible radiation. The result obtained out of this formula is called the Normalized Difference Vegetation Index (NDVI). The value of NDVI ranges between -1 to +1. The water bodies,

Figure 7. NDVI of Mogral River basin in the year 2016.

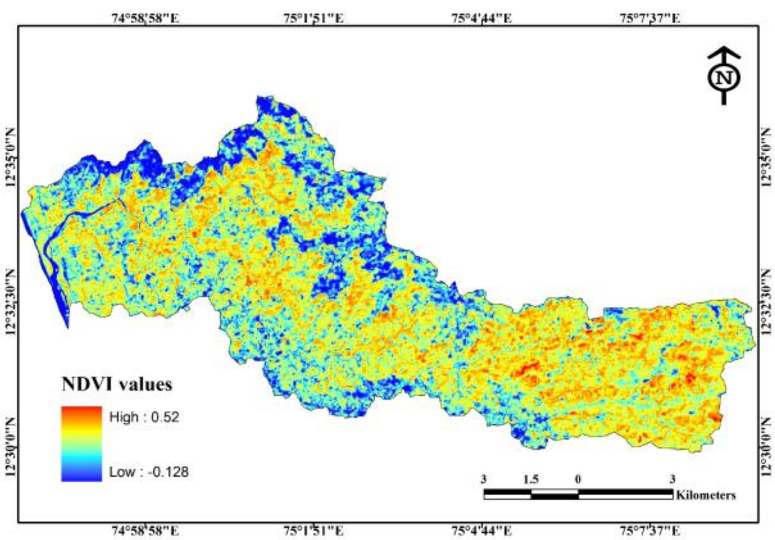


Figure 8. Land cover of Mogral river basin in the year 2009.

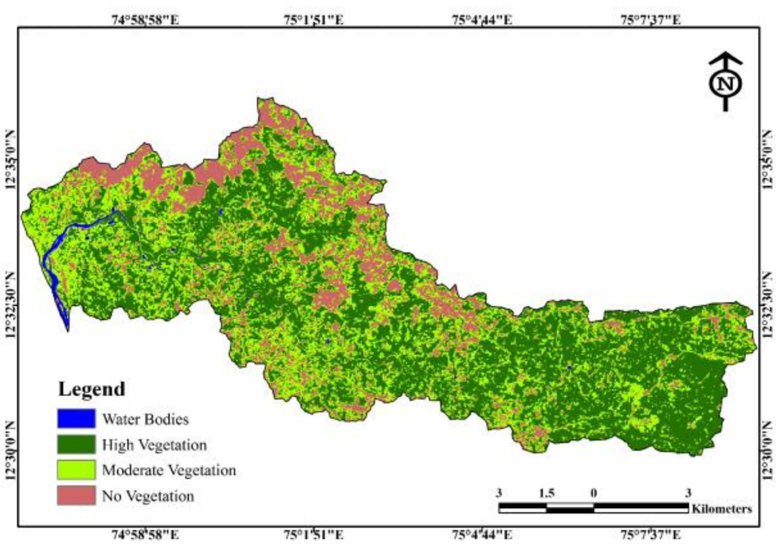
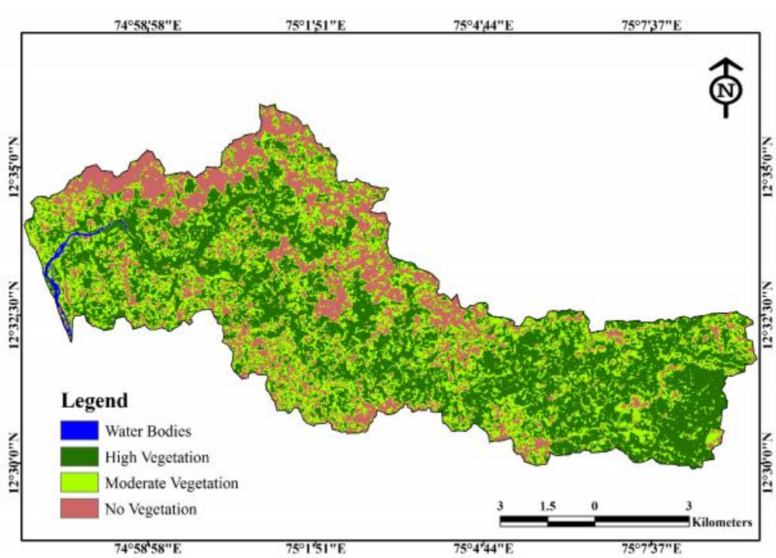


Figure 9. Land cover of Mogral river basin in 2013.



clouds, and snow cover reflect more in the visible band than that in the near-infrared band .So they have negative NDVI values. The NDVI value of bare soil and rock outcrops are around zero. Healthy green vegetation, on the other hand, has higher near-infrared reflectance there by providing NDVI values close to +1 (Lillesand et al., 2004). A greater value of NDVI infers the presence of dense vegetation on a terrain and its lesser value infers sparse vegetation (Ravi Prakash et al., 2016). Based on this information, the two-date NDVI images were classified into five classes The NDVI derived from IRS P6 satellite image of the year 2009 of Mogral river basin ranges from + 0.71 to - 0.41 and that of the year 2013 ranges from + 0.75 to - 0.24. In 2016, the NDVI value of the basin derived from LANDSAT image ranges between + 0.520 to - 0.128. The higher value of NDVI is seen along the eastern portion of the study area and also along the banks of stream course. The eastern part of the basin having comparatively higher NDVI value belongs to the Karadka reserve forest. Compared to the NDVI value of 2009 the NDVI value of the basin in 2016 is decreased. This decrease in value indicates the loss of vegetation due to human encroachment.

In the year 2009, area under moderate vegetation, in the basins was estimated as 41.14 km^2. This has decreased to 38.24 km^2 by 2013, and it was again reduced into 35.76 km^2 in the basin (Figure 8, 9 and 10). The area of high vegetation of the basin in the years 2009, 2013 and 2016 are 47.46, 44.80 and 40.02 km^2 respectively. This shows a declination in the aerial cover of high vegetation from 42.00 % in 2009, to 33.56 % in 2016. This change was due to the deforestation in the area for laterite quarrying and construction activities .Consequently the percentage of the area of no vegetation land increased in the basin.

NDVI also identifies water bodies. In 2009, area under water body in the basins was

Figure 10. Land cover of Mogral river basin in the year 2016.

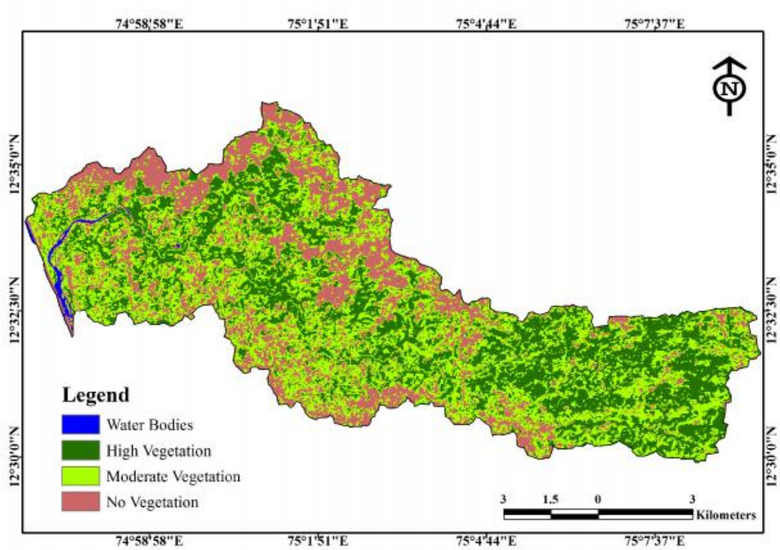


Figure 12. Land use of Mogral river basin in the year 2009

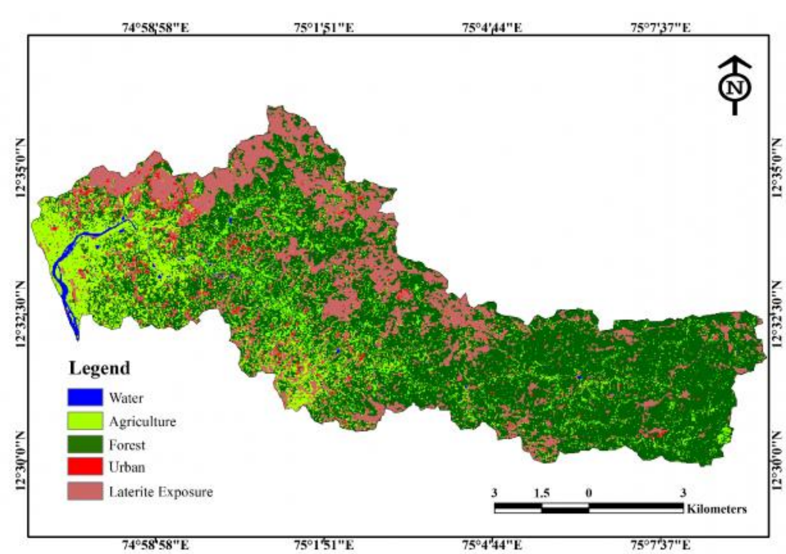


Table 2. Land cover changes of Mogral river basin.

Class	Year					
	2009		2013		2016	
	Area km^2	Area %	Area km^2	Area %	Area km^2	Area %
Water	0.98	0.87	0.90	0.80	0.86	0.76
No Vegetation	23.42	20.45	29.06	25.39	36.36	25.60
Moderate Vegetation	41.14	36.68	38.24	34.16	35.76	39.99
High Vegetation	47.46	42.00	44.80	39.65	40.02	33.56
Total	113	100	113	100	113	100

estimated as 0.982 km^2. This has come down to 0.900 km^2 by 2013, and it was again reduced into 0.86 in 2016. In the year of 2009 the area of water body was 0.87 % and in 2013 it was reduced to 0.80 % .The water body is further reduced to 0.76 % in the year 2016. It is observed that about 11 % of water body has been lost in Mogral river basins during a time span of 7 years.The land cover changes of water bodies, high vegetation, moderate vegetation and no vegetation in the study area is summarized in Table 2 and Figure 11.

Changes in Land use and Land cover

Analyzing the spatial and temporal changes in land use and land cover (LULC) is one of the diagnostic methods to understand the problems persisting in a river basin. Rapid growth of urbanization along with other increasing human intervention factors have been identified as major reasons of land use changes and land conversions (Mayaja and Srinivasa, 2017). Many studies have been done on land use changes by using satellite imageries and GIS by different workers (Bisht and Kothari 2001, Bhaskaran et al., 2008; Nikhil Raj and Azeez,2010 ; Mahapatra et al., 2013). In the present work, an attempt was made to assess and evaluate the land use and land cover change in Mogral river basin between the years 2009 and 2016 by using Remote Sensing and GIS. Land is used for different purposes including agriculture, mining, forestry and nature protection, leisure, and urban and industrial development (Willy H. Verheye, 1997). Land use of the Mogral river basin was categorized under five broad groups. The categories are as follows: water bodies, agriculture, forest, urban land and laterite exposure (Figures 12, 13 and 14).The type of the land use and the area under each category within the Mogral river basin for the years 2009, 2013 and 2016 is summarized in Table 3 and graphical representation of LULC by supervised classification are shown in figure 15.

Figure 13. Land use of Mogral river basin in 2013.

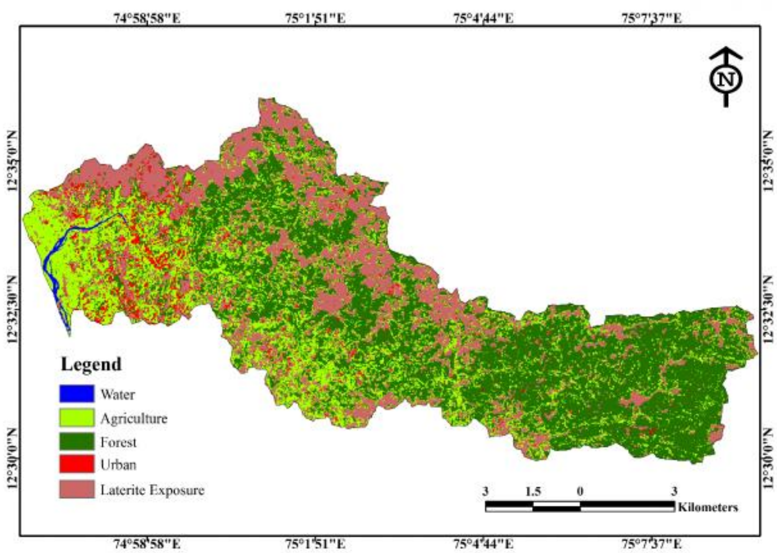


Figure 14. Land use of Mogral river basin in 2016.

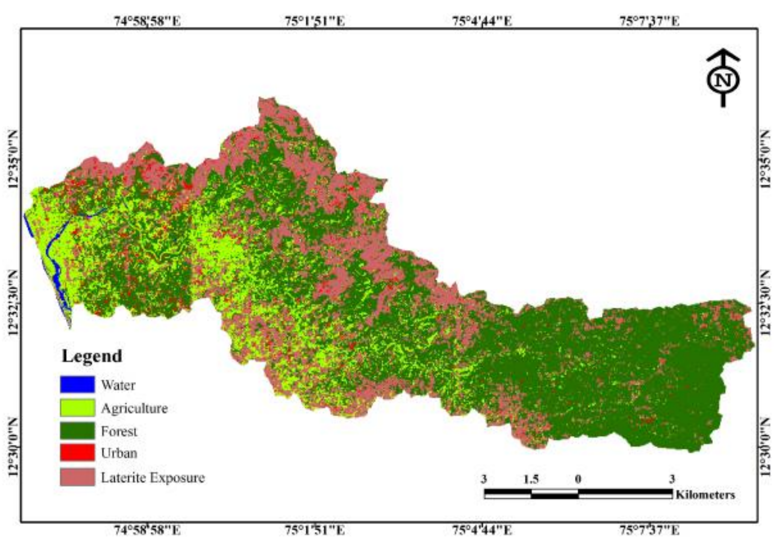


Table 3. Land Use / Land Cover Statistics of Mogral rive basin.

Class	Year					
	2009		2013		2016	
	Area km^2	Area %	Area km^2	Area %	Area km^2	Area %
Urban	0.29	0.26	0.34	0.31	0.41	0.36
Water	0.98	0.87	0.90	0.80	0.86	0.76
Agriculture	31.37	27.76	31.47	27.85	30.90	27.35
Forest	57.25	50.66	51.59	45.64	48.49	42.91
Laterite exposure	23.11	20.45	28.70	25.40	32.34	28.62
Total	113	100	113	100	113	100

Water body

River flow, ponds and estuary are the prominent water bodies observed in the basin. In general water bodies are represented by light blue to dark blue in tone and the texture show smooth to mottled appearance in satellite imagery. The changes shown by the satellite imagery owing to intensity of absorption of incoming infrared radiation (Nagaraju et al., 2016).The areal extension of water bodies showed a decrease in trend from the year 2009 to 2016 .In the year 2009, an area of 0.87 % of the basin was covered with water and by 2016 it was reduced to 0.76%.

Agriculture land

Agricultural land can be defined as the land which primarily used for farming which includes production of food, fibre, horticultural crops etc. The agricultural areas are largely developed along the flood plains and coastal low lands of the Mogral river basin. Paddy and vegetables are the major food crops that have been cultivating on these areas. The analysis of imageries of the years 2009, 2013 and 2016, revealed that the area under agriculture land does not varied much.

Forest land

Forst land perhaps described as the areas which associated with trees and other vegetation types within the notified forest territory. Vast areas of forest is seen on the eastern portion of the basin and intermitttently along the bank zone of the river course.In the year 2009 an area of 57.25 km^2 was observed under forest cover. It has been declined by 51.59 km^2 in 2013 and 48.49 km^2 in the year 2016. A total of 7.75 % of loss of forest cover between the years 2009 and 2016.The widening of laterite quarries and construction activities has removed large forest cover form the study area.

Urban land

In the year of 2009 the urban area in the basin was 0.29 km^2 and it was spread to 0.34 km^2 in 2013. It is again inceased to an area of 0.41 km^2 in the year 2016.It is

Figure 11. Changes of NDVI classes in the study area.

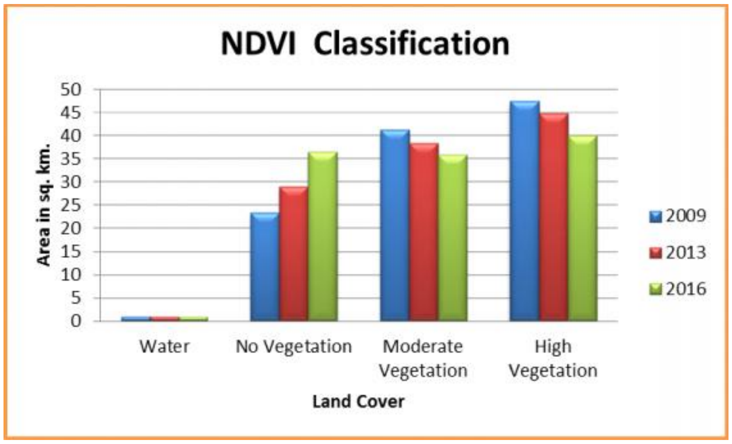
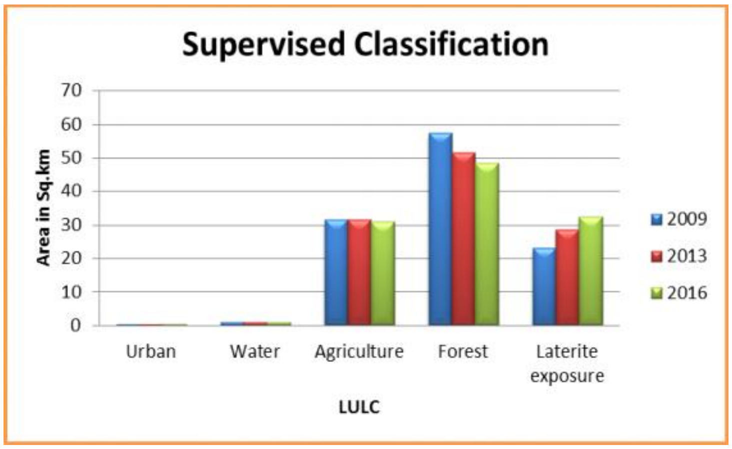


Figure 15. Land use / Land cover changes in Mogral river basin.



clearly understand that urbanization processes are severe in the study region ,hence it is anthroprogenic damge to the Mogral river basin.

Laterite exposure

The crystalline rocks of the basin are concealed by laterite cover.Lateries are developed by intensive and prolonged chemical weathering of the underlying rock and leaching of mineral elements (Ronald, 2012). In the year 2009 the exposed laterite cover of the basin was 23.11 km^2 and it increased to 28.70 km^2 in the year 2013. The laterite exposure further increased to 32.34 km^2 by the year 2016.This indicate a hike in 8.17 % of barren laterite between years 2009 and 2006 within the basin.

CONCLUSION

The land use land cover classification of the study area comprises of urban land, water bodies, agricultural land, forests (dense vegetation) and laterite exposure. From the land use land cover classification, it was clear that there has been a decreasing trend in forest land of the study area. About 7.75 % decrease in area under forest land had been witnessed. The area under water bodies was also found to be depleting over the years. About 0.11 % decrease in area under water bodies have been found out. It was supported by clear evidences that forest cover decrease occurred due to quarrying activates and cultivation of agriculture crops. It can be concluded that quarrying, agriculture expansions, deforestation has a crucial role in this degradation. The present study also suggested that preventive measures should be taken to reduce forest disturbances and for implementing sustainable management of the developmental activities in Mogral river basin.

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