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Assessment of Land Cover Changes in Musi River Basin: Part of Rangareddy and Hyderabad districts, Telangana

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ABSTRACT:
Land cover is the physical material at the surface of the earth. Land cover includes grass, asphalt, trees bare ground, water, etc. There are two primary methods for capturing information on land cover: field survey and analysis of remotely sensed imagery. This study is an investigation into the changing land cover in the Musi Basin Watershed within Rangareddy and Hyderabad District to figure out possible reasons for the increased stress on Musi River. Main objectives of the present study are todelineate the watershed of Musi river within Rangareddy and Hyderabad Districts and spatio-temporal analysis of land cover in Musi river basin area for the year 2000 to 2019.
Key Words: Spatio- Temporal, Remote Sensing, Land Cover and Co-relation matrix

INTRODUCTION

Telangana was carved out as a separate state from Andhra Pradesh in 2014 as the 29th state of the Union of India. The state has a total area of 112,077 square kilometers comprising of 33 districts. The present study limits to two districts- Rangareddy and Hyderabad. Rangareddy district encircles the city of Hyderabad. River Musi flows through Telangana state and is a tributary of Krishna River. Surface water sources like Osmansagar was built in 1920 across Esi, a tributary of Musi River and Himayatsagar was built in 1927 across Musi. The water quality of the river is reported to have declined over the years(Chigurupati and Manikonda, 2007).

The river had been an important source of water for the city of Hyderabad and its environs. There had been a change in the character of the river in terms of degradation in the upstream area in Vicarabad. Hyderabad Urban Agglomeration (HUA) is situated within Rangareddy district. The district experiences a deficient rainfall and the cropped area varies annually. The Ibrahimpatnam, Shankarpally and Basherabad mandalas of Rangareddy district are under cultivation. These areas receive annual rainfall of 468 to 869 mm. Agricultural production needs to be managed sustainably in the wake of frequent droughts (Murthy & Madhuri, 2015).

Non-compliance of environmental laws associated with the protection of water resources and indiscriminate planning and growth of the city have applied a formidable pressure on water resources like Musi River (Chigurupati and Manikonda, 2007). Encroachment of water bodies have resulted in flooding of the city in 2000. The existing study will have an implication on the conservation of the watershed of River Musi and its ecology. Observing the change in land cover will uphold the integrated management of Musi River in these districts. Location map of the study area is presented in Figure-1.

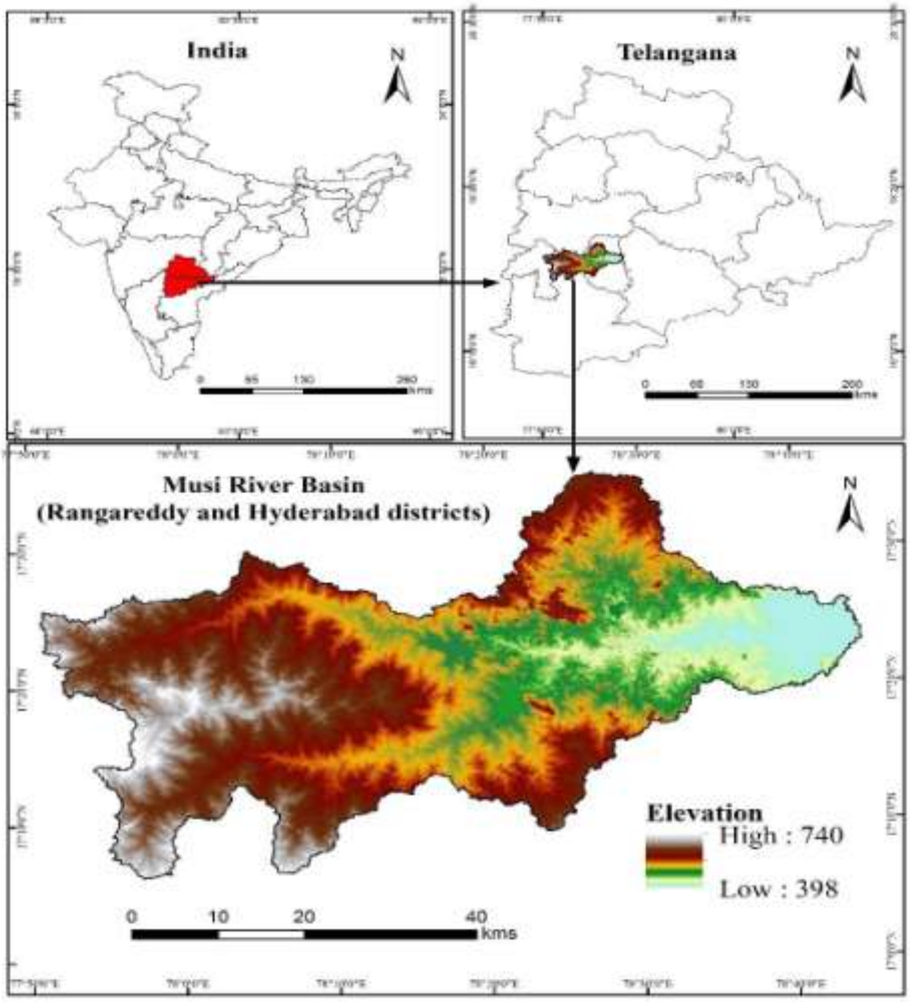


Figure 1: Location map of study area

DATABASE &METHODOLOGY

Database

Two time periods were chosen on the basis of availability of imagery for the year2000 and 2019 (Table-1). The ASTER, Landsat 7 and 8 satellite images have been obtained from United States Geological Survey (USGS) Earth explorer site. Landsat 8 is an American earth observation satellite started on February 11, 2013, hence, for the data sets before that (i.e. 2000) we refer to Landsat 7 satellite image.

Table 1: Detail of data used

Data	Path	Year of Acquisition	Spatial Resolution	Sources
Landsat 7ETM+	144/48	2000	30m	USGS Web Portal
Landsat 8OLI/TRS	144/48	2019	30m	USGS Web Portal
ASTER (DEM)		2011	30m	USGS Web Portal

The CRS system selected for the area is EPSG: 32644, UTM Zone 44N. All the layers are re- projected to this CRS system from the original WGS 84 system. The bands utilized for image processing in this study are highlighted as below:

Table 2: Band Selection for Generation FCCs

LANDSAT 8			LANDSAT 7		
Band Number	**Range**	**Description**	**Band Number**	**Range**	**Description**
Band 1	0.43-0.45	Coastal Aerosol	Band 1	0.45-0.52	Blue
Band 2	0.45-0.51	Blue	Band 2	0.52-0.60	Green
Band 3	0.53-0.59	Green	Band 3	0.63-0.69	Red
Band 4	0.64-0.67	Red	Band 4	0.77-0.90	NIR
Band 5	0.85-0.88	Near Infrared (NIR)	Band 5	1.55-1.75	SWIR 1
Band 6	1.57-1.65	SWIR 1	Band 6	10.40-12.50	TIR
Band 7	2.11-2.29	SWIR2	Band 7	2.09-2.35	SWIR 2
Band 8	0.50-0.68	Panchromatic	Band 8	0.52-0.90	Panchromatic
Band 9	1.36-1.38	Cirrus			
Band 10	10.60-11.19	Thermal Infrared (TIRS) 1			
Band 11	11.50-12.51	Thermal Infrared (TIRS) 2			

Methodology

To conduct the study on the river basin of Musi, watershed of the river was delineated in the districts of Rangareddy and Hyderabad. For watershed delineation, ASTER Global DEM was used. After extracting the watershed of Musi basin, land cover classification was done for the years 2000 and 2019 to understand the change in various classes over a period of 20 years.Hydrological studies consider river basins instead of administrative boundaries but owing to the paucity of time, river basin of Musi has been studied using the administrative boundaries of the districts of Rangareddy and Hyderabad.

The Digital Elevation Model (DEM) captures were obtained from the USGS Earth Explorer Website for the area of Rangareddy and Hyderabad districts was done for the date* for 30 m resolution. This resulted in four captures of the study area, which were then stitched in QGIS using the 'build virtual raster tool'. The resulting raster was re-projected to our study area zone – UTM Zone 44N. After re-projection, the resulting DEM is clipped using a mask layer of the vector outline of merged Rengareddy and Hyderabad districts.Detailed scheme of adopted methodology is discussed in Figure-2.

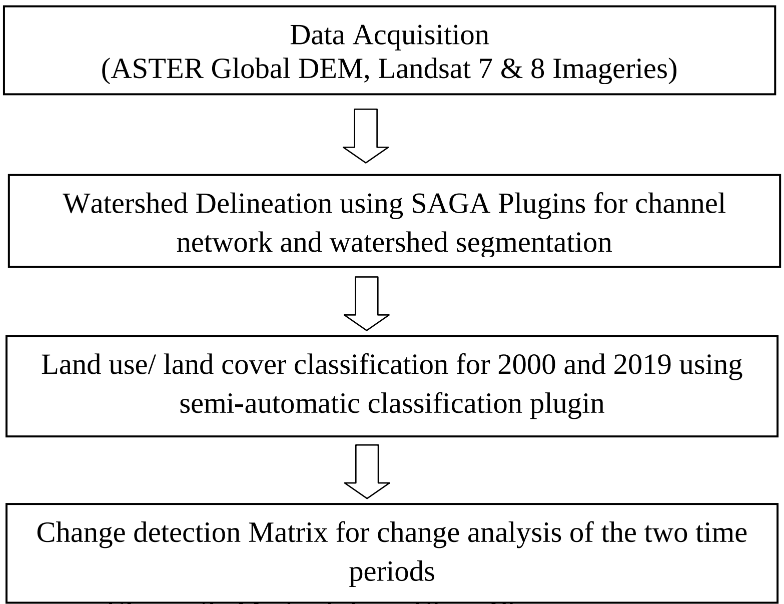


Figure 2: Methodology Flow Chart

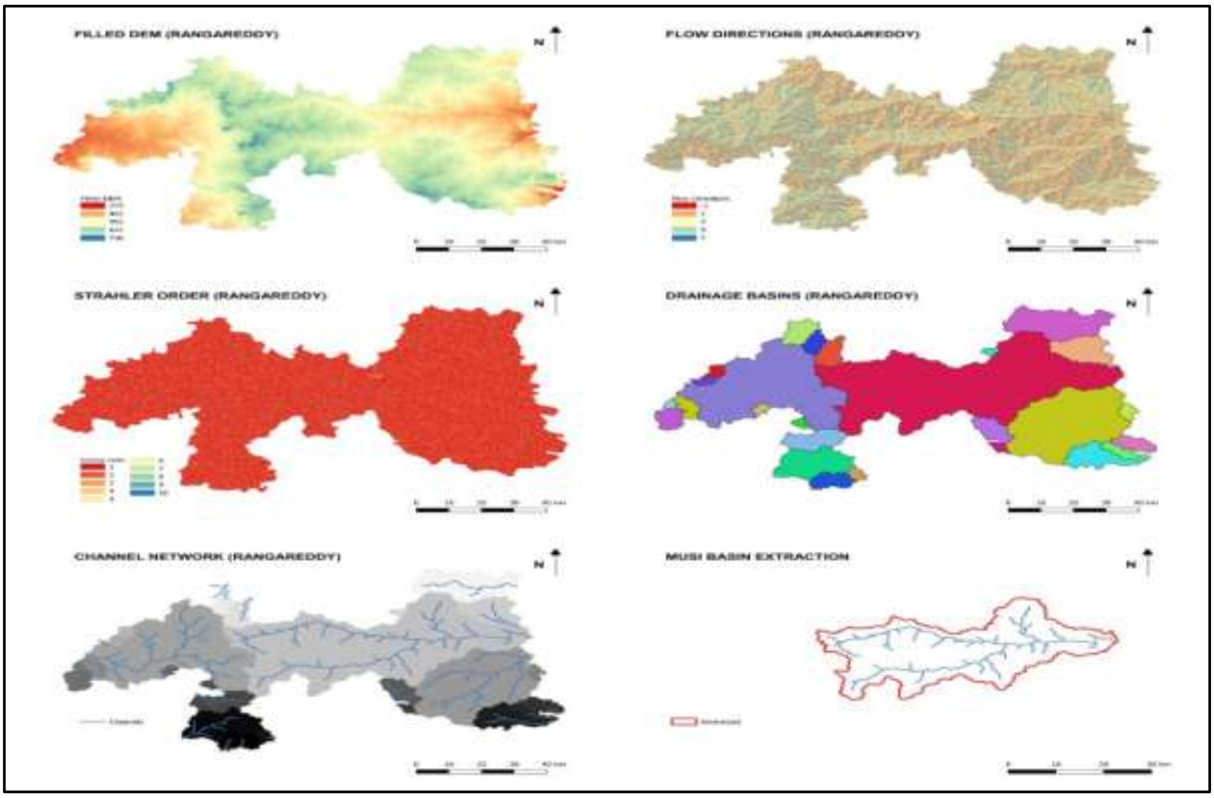
RESULTS & DISCUSSION

Watersheddelineation

Prior to classification of the data, there is a need to delineate the watershed of Musi River when it passes into the Rangareddy Districts. This was achieved through a basic watershed analysis for classifying drainage basins of different streams, starting with the whole area of Rangareddy.

The images portray the process used for delineation of watersheds in the district. After creation of a filled DEM (corrected using fill sinks plugin by SAGA), a flow direction map is processed to get an idea of the kind of terrain contained in the watershed.

A Strahler order map is then created with stream ordering from 1 to 10 for further analysis. Stream ordering is a method of assigning a numeric order to links in a stream network. This order is a method for identifying and classifying types of streams based on their numbers of tributaries. In the Strahler method, all links without any tributaries are assigned an order of 1 and are referred to as first order. The stream order increases when streams of the same order intersect. Therefore, the intersection of two first-order links will create a second-order link, the intersection of two second-order links will create a third-order link, and so on. The intersection of two links of different orders, however, will not result in an increase in order. For example, the intersection of a first-order and second-order link will not create a third-order link but will retain the order of the highest ordered link. The raster calculator is used to create a ratser with stream channels with order 8 and above.



Then the watershed basins tool form SAGA is used to delineate basins within the district area, from which the Musi Basin is extracted using 'upslope analysis' tool. The resulting layer is polygonised and subsequently used to clip the Filled DEM and Channel Network to give us the final study area used further for classification.

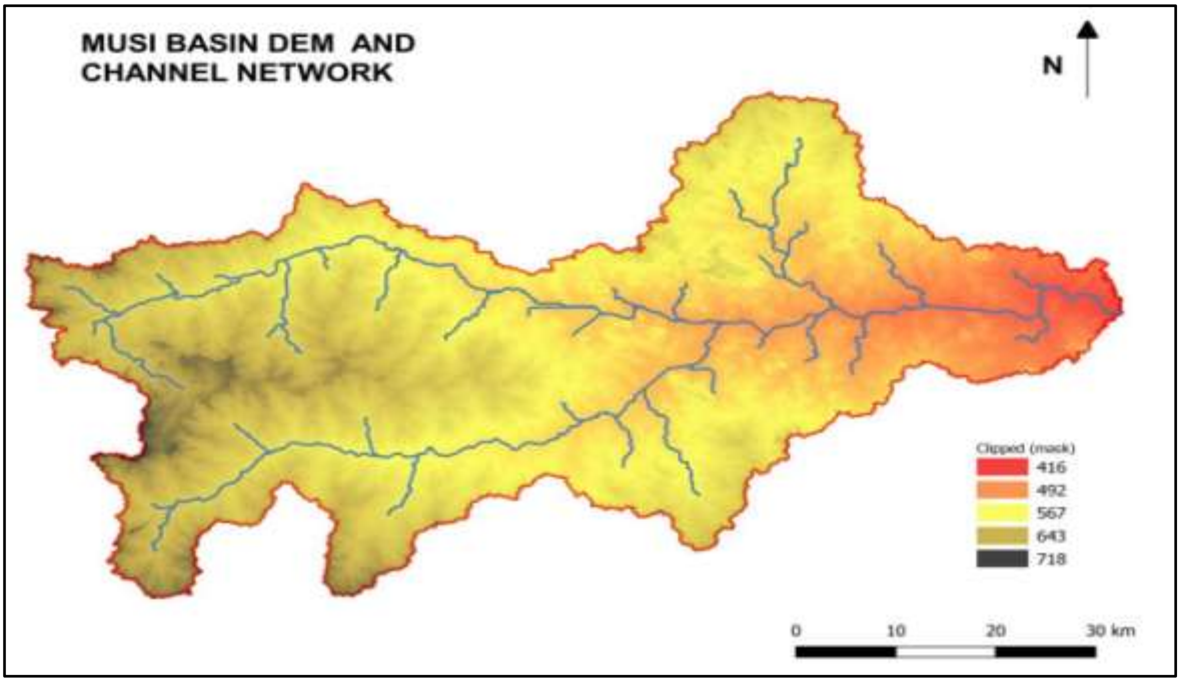


Figure 4: Delineated Study Area: Musi Basin

The same is represented by a three dimensional model using hill shade analysis and
Exporting a scene through the 'Qgis to 3Dplug-in.

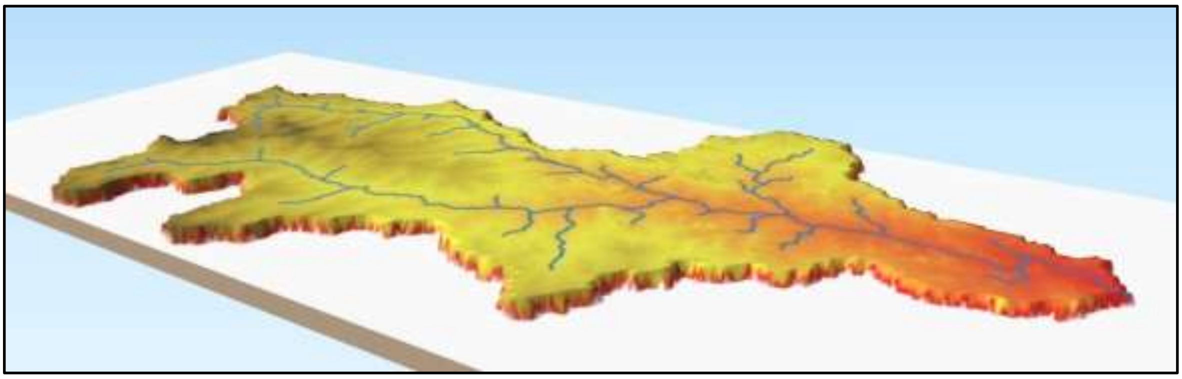


Figure 5: Musi Basin 3D View

SupervisedClassification

The watershed delineation was followed by identification of land cover classes under the following heads; such as Water Bodies, Built-up, Vegetation, Agricultural Land, Rocky Land and Barren Land.

The supervised classification was done with the semi-automatic classification plugin in QGIS for the study area for the years 2000 and 2019. For the year 2000, bands 1, 2, 3, 4, 5 and 7 of Landsat 7 were imported in the SCP console and clipped according to the watershed of Musi River in the study area. Subsequent to this, the data was converted into surface reflectance (the metadata file downloaded with the satellite images contains the required information for the conversion). Further, the Dark Object Subtraction (DOS) atmospheric correct was also applied to image. In the band set, refresh the layer list and select Landsat 7ETM+ from the list Quick wavelength settings, in order to set automatically the CentreWavelength of each band and the Wavelength unit (required for spectral signature calculation). This was followed by displaying a False Colour Composite of bands: Near-Infrared, Red, and Green (4-3-2).

The next step was to create a Training input in order to collect Training Areas (Regions of Interest - ROIs) which were then used to calculate the Spectral Signature. In this ROIs were constructed defining the Classes and Macro-classes. Each ROI was identified by a Class ID (i.e. C ID), and each ROI was assigned to a land cover class through a Macro-class ID (i.e. MC ID). Around 50 polygons were constructed as training sites for the spectral signatures. Consequently, spectral signatures were assessed. Following plot describes the spectral signatures of various land cover classes.

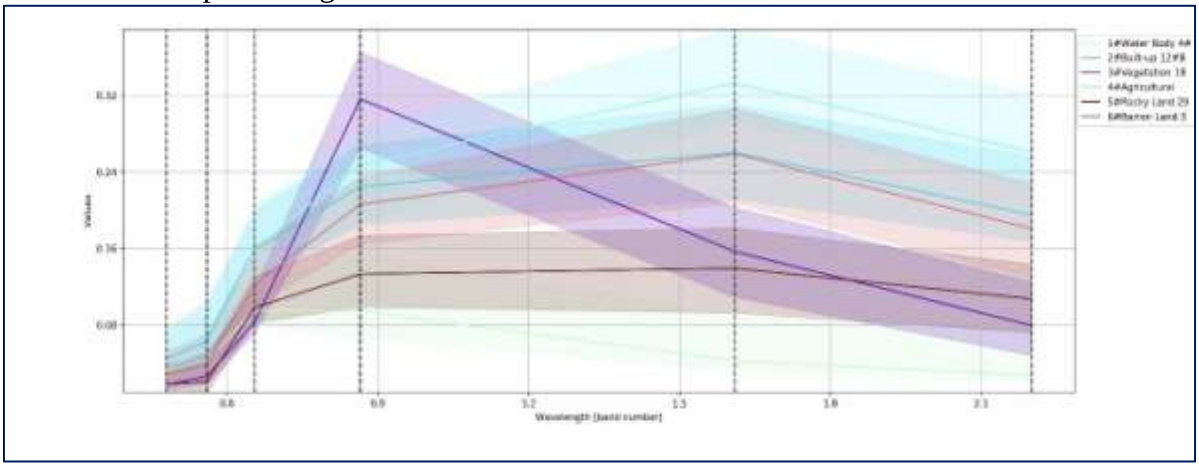


Figure 6: Sample spectral signatures of various land cover classes

The classification was then viewed in the preview mode. Maximum Likelihood algorithm was chosen and the classification was run. Following map (Figure 8) is the land cover classification for the year 2000. The same exercise was repeated for Landsat 8 OLI data (where bands 2,3, 4, 5, 6 and 7 were taken). The land cover map for 2019 is presented below in Figure 9, and the pie charts for the same are depicted below.

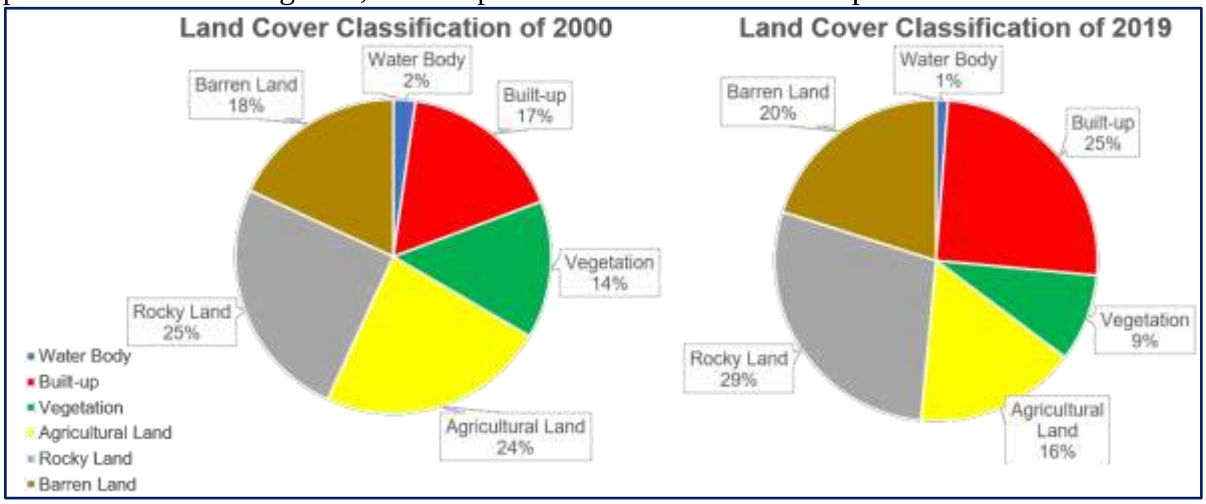


Figure 7: Pie charts for Land cover classification

Distribution of Land Cover in 2000: The land cover distribution in the year 2000 was about

25% under rocky terrain, 24% under agricultural land, 18% under barren land, 17% of built- up, around 14% of vegetation and about 2% of water bodies.

Distribution of Land Cover in 2019: For the year 2019, land cover was distributed amongst rocky terrain (29%), agricultural land (16%), barren land (20%), built-up (25%), vegetation (95) and water bodies (1%).

After conducting the land cover classification of the study area for both the years 2000 and2019, a change analysis was undertaken to understand the change in land cover in the study area. Below is the graph representing a comparison between the area of various land cover types in the years 2000 and 2019. It can be seen from the graph that the area under water bodies has reduced in 2019 from 2000 by about 48%. There has been a reduction in the vegetation by about 38% as well as in agricultural land by 31% from the year 2000. There has been an increase in area of built-up by almost 50% of the area in 2000 and that of barren land by about 11%. Further, the rocky land has also been revealed by the reduction in the vegetation on the terrain (as observed by the increase in rocky surface by about 13%).

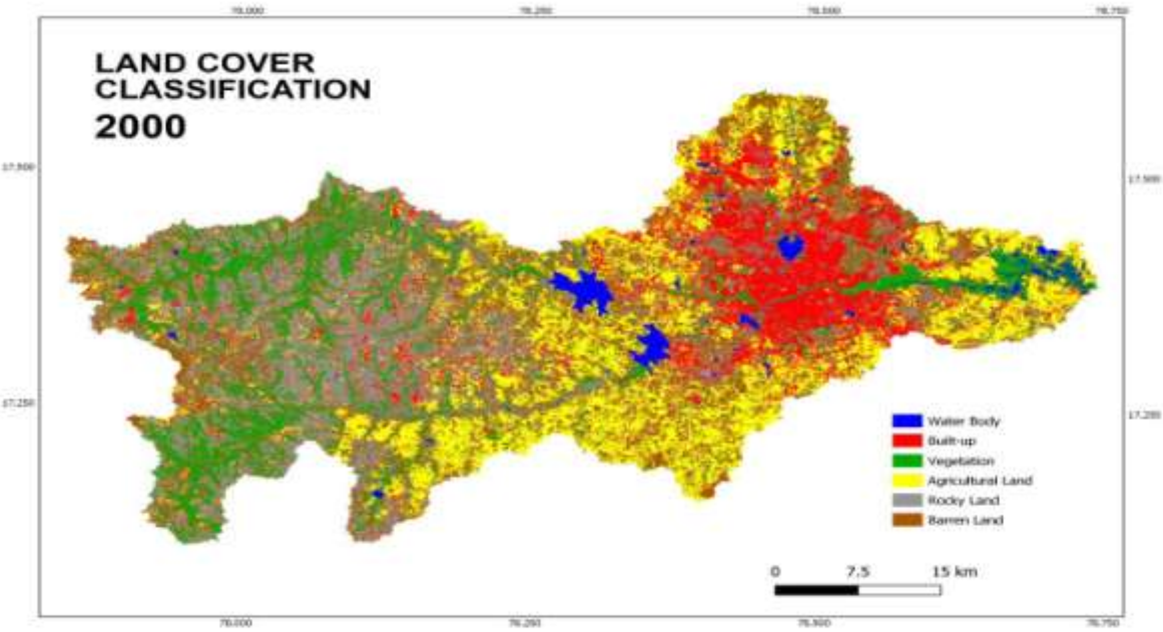


Figure 8: Land cover map (2000)

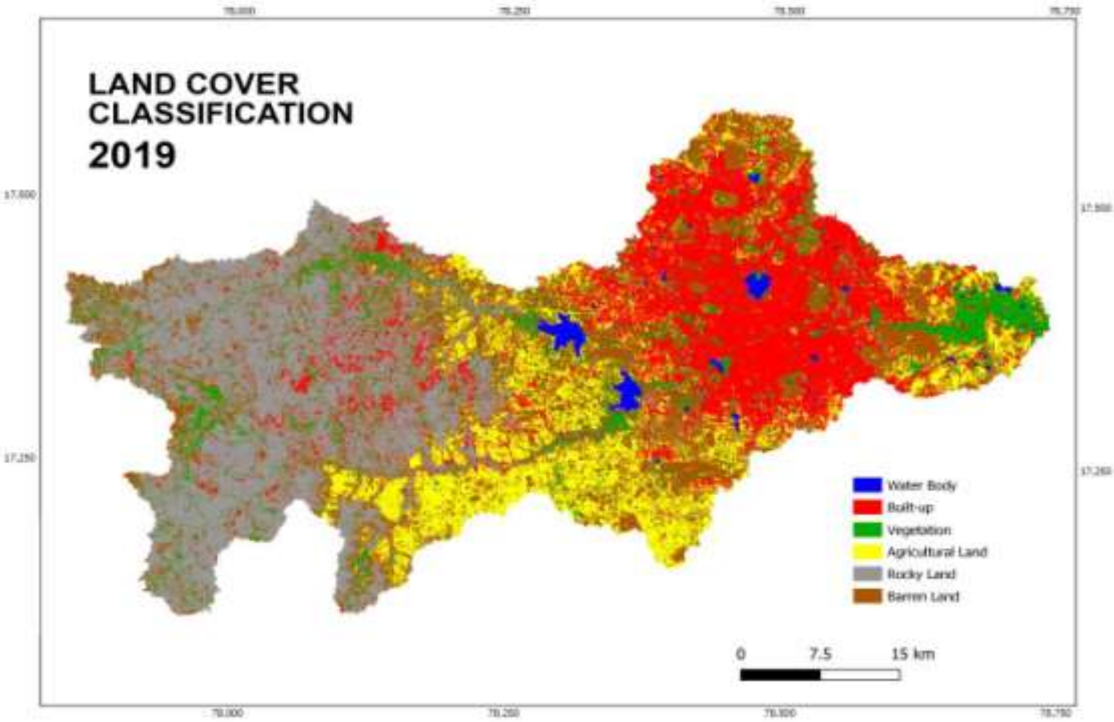


Figure 9: Land cover map (2019)

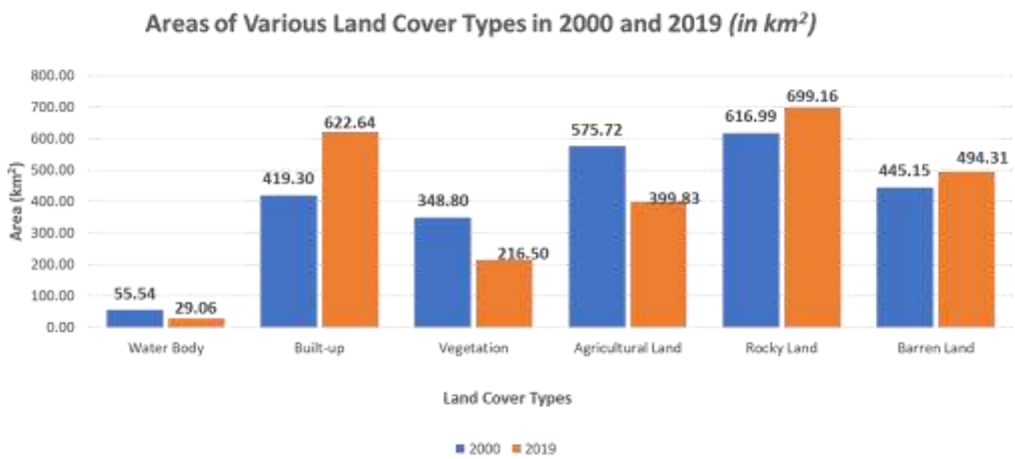


Figure 10: Bar Chart showing comparative increase/decrease

Spatio-Temporal Analysis

The change detection matrix is made to analyses the transformation of numerous land use/land cover classes across different time periods. It gives an exact idea, not just about the increase/ decrease in every class but also into which class the subsequent increase or decrease can be traced. Following is the change detection matrix created for the time periods – 2000 and2019 spread across six classes.

Table 3: Spatio-Temporal Analysis for 2000 and 2019 (Square Kilometers)

		2000						
		Water	**Built-Up**	**Vegetation**	**Agriculture**	**Rocky**	**Barren**	**Total**
2019	**Water**	25.17	0.65	0.94	1.09	0.57	0.64	29.06
	Built-Up	5.48	287.03	39.56	134.60	104.61	51.36	622.64
	Vegetation	13.87	13.12	68.39	28.71	48.39	44.01	216.50
	Agriculture	3.23	28.66	17.25	259.63	30.50	60.56	399.83
	Rocky	4.46	54.22	164.69	41.72	307.07	126.99	699.16
	Barren	3.32	35.62	57.97	109.97	125.84	161.60	494.31
	Total	55.54	419.30	348.80	575.72	616.99	445.15	2461.49

Data Interpretation

As it is clearly evident from the above, about 52% of the land cover under water remained constant while almost 25% was absorbed into vegetation, about 10% was encroached by built- up, around 8% was reclaimed by rocky area, and the remaining was equally divided into agriculture and barren land. What is also notable that, only 45% of agricultural land covers was preserved, 23% encroached by built-up and 19% turned barren. This may be seen as an adverse effect of successive droughts faced by Telangana state and also the deterioration of river Musi especially in this district.

Adversely, analyzing the built-up land cover, there has been an increase of 48% with major contributors being agriculture (21% of total built-up in 2019) and rocky surface (17% of total built-up in 2019).

CONCLUSIONS

Hyderabad is located in the Musi sub-basin, which forms a part of Krishna river basin. Satellite imagery is used to study sprawl and land use/ land cover changes in the urban areas (Gumma et al., 2017). The present investigation reveals an expansion of built-up area, rocky and barren land over a period of nearly two decades (2000-2019). There has been a simultaneous decrease in the respective areas of classes under categories- water body, vegetation and agricultural land.

Hyderabad- the former capital of Andhra Pradesh and then newly formed state of Telangana has expanded as a megacity as other Indian capital cities. Hyderabad Urban Agglomeration (HUA) lies within the Rangareddy district (Gumma et al., 2017; Murthy &Madhuri, 2015). The change in built-up area is by virtue of infrastructure development in the form of new industrial and educational institutions (Murthy &Madhuri, 2015).

Urbanisation andindustrialization exert an influence on peri-urban areas. As aresult agricultural land use in the peri-urban areas gets transformed into urban (Murthy &Madhuri,2015). Theperi-urban agriculture contributes to food security and hence is an important asset (Murthy &Madhuri, 2015). Over the years Hyderabad has developed as an IT hub of the country. Owing to this reason the city has witnessed immigration of skilled and unskilled labour. The burgeoning population has a bearing on the natural resources (water, land and biodiversity) (Gumma et al., 2017).

The expansion of the city led to a neglect of a number of water bodies and Musi River. The river acts a carrier of domestic and industrial waste generated in Hyderabad affecting the river ecology. Hyderabad and its environs were known to have several natural and man-made water bodies known as *Cheruvu*and*Kuntas*etc. Some of these likeSatam,Cheruvu andJamalikunta are known to be threatened water bodies. Musi River flows for a distance of 70 km before reaching the reservoirs of Osmansagar and Himayatsagar. The river's flow has been impacted due to a change in the drainage pattern of Hyderabad urban area. The catchment area has also witnessed an indiscriminate plotting by real estate. Quarrying has also been reported to have diverted some of its feeder channels. The integrated management of the wider catchment should be taken up for the conservation of the river (Chigurupati & Manikonda, 2007).

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