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Change Detection Of Land Use Land Cover (LULC) Of Panchganga River Basin, Maharashtra, India.

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Abstract:
Land Use and Land Cover (LULC) change detection is an important technique used to monitor and analyze spatial and temporal transformations occurring on the Earth's surface. It helps in understanding human and natural influences on land resources. The Panchganga River Basin in Maharashtra, India, has experienced significant LULC changes over the past few decades due to urbanization, agricultural expansion, and industrial development. Remote Sensing (RS) and Geographic Information System (GIS) techniques are effectively used to study these changes and assess their environmental impacts. The Panchganga river is one of the principal tributary of Krishna River system lies between the 16^0 17' 55'' to 16^0 55'33'' north latitude and 73^0 42' 33'' to 74^0 37' 44'' east latitude. The main objective of the present study is to understand the change detection of Land Use Land Cover (LULC) of the Panchganga drainage basin. Land Use-Land Cover (LULC) maps for the Panchganga basin were prepared using SRTM, Landsat-8, and Sentinel-2 imagery. In this study identify the details of changes in land use and land cover (LULC) in the Panchganga basin during 2000 to 2019, providing valuable insights into the basin's environmental dynamics. The growth of built-up areas reflects the basin's development and urbanization. However, unplanned expansion can lead to increased runoff, flooding, and air and water pollution.

Keywords: *Land Use and Land Cover, (LULC), Panchganga River basin, Kolhapur.*

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I. Introduction:

Land Use and Land Cover (LULC) change detection represents a vital analytical approach for monitoring and assessing spatial and temporal transformations on the Earth's surface. These transformations reflect the dynamic interactions between human activities and natural processes that continuously reshape terrestrial environments. Understanding such changes is essential for evaluating the impacts of human interventions, guiding sustainable resource management, and formulating evidence-based environmental policies. The Panchganga River Basin, located in Maharashtra, India, has undergone notable LULC alterations over recent decades, primarily driven by rapid urbanization, agricultural intensification, and industrial expansion. These transformations have significantly influenced the basin's hydrological regime, ecological balance, and overall environmental quality. Therefore, systematic investigation of LULC changes within this basin is crucial for understanding the spatial extent, nature, and implications of human-induced land transformations. Remote Sensing (RS) and Geographic Information System (GIS) technologies provide powerful tools for examining LULC dynamics across space and time. The integration of satellite imagery, spatial data processing, and geospatial analysis enables accurate detection, quantification, and visualization of land surface changes. Such geospatial techniques facilitate the assessment of environmental impacts, trend identification, and future projection of land use scenarios, thereby supporting effective land management and policy formulation.

Land use refers to the purposeful utilization and management of land resources for various socio-economic activities such as agriculture, settlement, and industry within a defined spatial unit. It embodies human decision-making processes and planning strategies directed toward optimizing land productivity and socio-economic development. Conversely, land cover denotes the biophysical and structural characteristics of the Earth's surface, encompassing both natural features such as forests, vegetation, and water bodies, and human-made structures like roads and buildings. Land cover is often a direct consequence of land use decisions, as anthropogenic activities significantly modify the natural landscape.

Changes in land use and land cover are therefore closely interlinked and have profound implications for environmental sustainability, land resource management, and regional planning. Monitoring and analyzing these changes through remote sensing and GIS not only enhance our understanding of land transformation processes

but also contribute to the formulation of sustainable land-use policies and adaptive management strategies. In the context of the Panchganga River Basin, such studies are instrumental in ensuring the judicious use of land resources, preserving ecological integrity, and promoting balanced regional development.

II. Study Region:

The Panchganga river is one of the principal tributary of Krishna River system lies between the 16^0 17' 55'' to 16^0 55'33'' north latitude and 73^0 42' 33'' to 74^0 37' 44'' east latitude. On the western margin of south plateau region Panchganga commands the considerably large drainage area through its main tributaries like Kasari, Kumbhi, Tulsi, Dhamni and Bhogawati. Total length of main river course of Panchganga is about 80.71 km. Panchganga basin occupying a total area of 2597.71 square km which is about 33.52 percent of the total area of the district. The major area of Kolhapur district falls under catchment area of the Panchganga basin. Relief of the Panchganga basin varies from place to place.

III. Objectives:

The main objective of the present study is to understand the change detection of Land Use Land Cover (LULC) of the Panchganga drainage basin.

IV. Methodology:

The Panchganga River basin was delineated using the Krishna River watershed maps. Land Use-Land Cover (LULC) maps for the Panchganga basin were prepared using SRTM, Landsat-8, and Sentinel-2 imagery. These morphometric data formed the basis for the fluvial morphometric analysis. The processed and analyzed data were used to generate maps, charts and diagrams. These were created using advanced cartographic techniques, GIS, and remote sensing. The final draft of the paper was written using these visual representations of the results.

V. Results And Discussion:

LULC of the Panchganga Basin 2000:

The LULC map of the Panchganga basin shows that the basin is predominantly covered by agricultural land (53.79%), followed by forest (40.77%), built-up land (2.90%), water bodies (2.31%) and bare land (0.24%). (Fig. 2.8) Forest is the second most common land cover type in the Panchganga basin, accounting for 40.77% of the total area. Agricultural land is the dominant land cover type, accounting for 53.79% of the total area. The forest cover is concentrated in the western and eastern parts of the basin, while the agricultural land is concentrated in the central and southern parts of the basin. Built-up land, bare land, and waterbodies account for 2.90%, 0.24%, and 2.31% of the total area, respectively. The built-up areas are scattered throughout the basin, but are more concentrated along the major rivers and roads. The water bodies are also scattered throughout the basin, but are more concentrated in the central and southern parts of the basin. (Table 1.)

Table 1: LULC of the Panchganga Basin - 2000

Sr. No.	LULC Class	Area (Sq.km)	Area (%)
1	Forest	1059.032	40.77
2	Built Up	75.234	2.90
3	Agricultural Land	1397.228	53.79
4	Bare Land	6.349	0.24
5	Waterbodies	59.957	2.31

Source: Landsat 8 Image from USGS Earth Explorer and Data Compiled by Researcher

The high proportion of forests in the Panchganga basin is a positive sign as forests play an important role in regulating the water cycle, preventing soil erosion and providing habitat for diverse flora and fauna. However, it is important to ensure that these forests are managed sustainably to protect their long-term health and productivity. The relatively high proportion of agricultural land also reflects the importance of agriculture for the economy and culture of the catchment area. However, it is important to ensure that agricultural practices are sustainable and do not lead to environmental damage such as water pollution and soil erosion. The expansion of built-up areas is worrying as it can lead to a number of negative impacts, such as: B. increased runoff and flooding, habitat loss and air and water pollution. It is important to carefully plan the development of built-up areas to minimize these impacts. The relatively low proportion of water bodies is a cause for concern as water is a vital resource for both people and ecosystems. It is important to protect and restore waters in the watershed to ensure water security for all.

Table 2: LULC of the Panchganga Basin 2019

Sr. No.	LULC Class	Area (Sq.km)	Area (%)
1	Forest	1018.188	39.19
2	Built Up	234.239	9.02
3	Agricultural Land	1286.039	49.50
4	Bare Land	1.369	0.05
5	Waterbodies	57.966	2.23

Source: Landsat 8 Image from USGS Earth Explorer and Data Compiled by Researcher

LULC of the Panchganga Basin 2019:

The LULC map of the Panchganga basin shows that the basin is predominantly covered by agricultural land (49.5%), followed by forest (39.19%), built-up land (9.02%), waterbodies (2.23%), and bare land (0.05%). (Fig. 2.9) Agricultural land is the dominant land cover type in the Panchganga basin, accounting for 49.5% of the total area. Forest is the second most common land cover type, accounting for 39.19% of the total area.

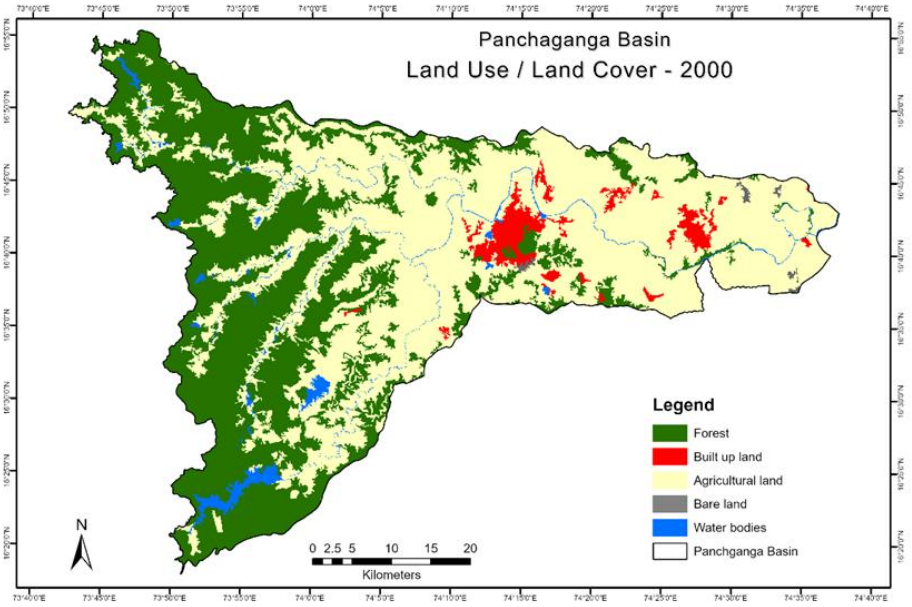

Fig.1. Panchganga Basin: Land Use and Land Cover (LULC) - 2000

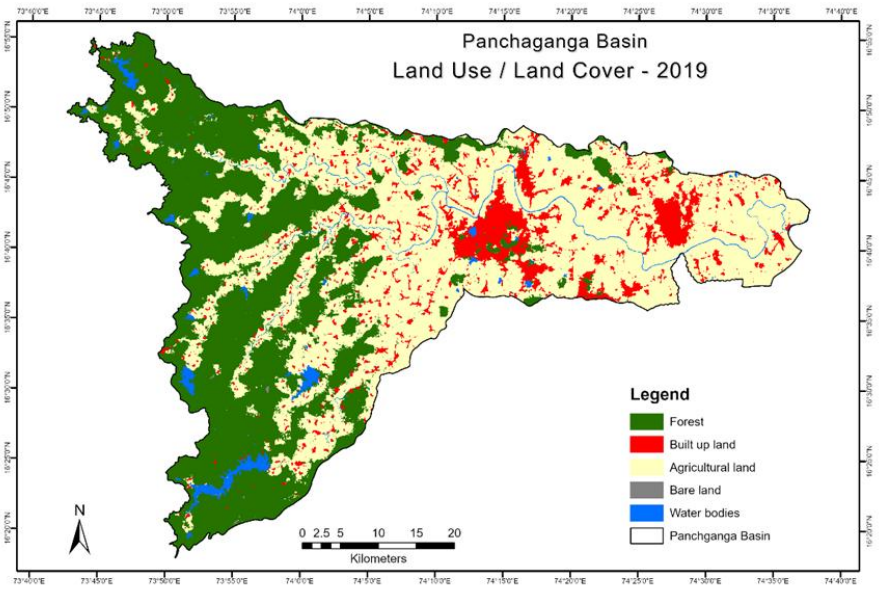

Fig. 2.9 Panchganga Basin: Land Use and Land Cover (LULC) - 2019
Source: Landsat 8 Image from USGS Earth Explorer

The agricultural land is concentrated in the central and southern parts of the basin, while the forest cover is concentrated in the western and eastern parts of the basin. Built-up land, waterbodies, and bare land account for 9.02%, 2.23%, and 0.05% of the total area, respectively. The built-up areas are scattered throughout the basin, but are more concentrated along the major rivers and roads. The water bodies are also scattered throughout the basin, but are more concentrated in the central and southern parts of the basin. (Table 2.)

Agriculture plays a significant role in the economy and culture of the Panchganga basin, as evidenced by the large proportion of agricultural land in the region. Soil erosion and water pollution are two examples of environmental degradation that can be caused by agricultural practices; Instead, it is important to ensure that they are sustainable. The comparatively high proportion of forests is encouraging, as forests are crucial for controlling the water cycle, controlling soil erosion and providing habitat for a wide range of plants and animals. To maintain the long-term productivity and health of these forests, sustainable management is crucial. It is concerning when developed areas grow due to the potential negative impacts on the environment, including increased flooding and runoff, habitat loss, and air and water pollution. To minimize these impacts when developing built-up areas, careful planning is essential. Given that water is a scarce resource for both people and ecosystems, the comparatively low proportion of water bodies is worrying. The waters in the catchment area must be conserved and restored to ensure access to water for all people.

Change Detection of LULC of the Panchganga Basin (Year 2000 to 2019):

Table 3. have shown the details of changes in land use and land cover (LULC) in the Panchganga basin during 2000 to 2019, providing valuable insights into the basin's environmental dynamics. The forest cover in the Panchganga basin has decreased significantly. This is mainly due to its conversion to agricultural land (5.628%) and built-up land (0.567%). Although small, there is a positive trend of forest gain from agricultural land (5.208%) and bare land (0.021%). Built-up land has expanded primarily by encroaching upon agricultural land (5.045%) and forest (0.567%). Agricultural land has decreased due to conversion to built-up land (5.045%) and forest (5.208%). Some agricultural land has been gained from forest (5.628%) and bare land (0.183%). Bare land has decreased slightly, mainly due to its conversion to built-up land (0.054%) and agricultural land (0.183%). Bare land has gained a small amount from forest (0.021%). Water bodies have shown a net loss, primarily due to conversion to agricultural land (0.717%). Water bodies have gained some area from forest (0.307%) and built-up land (0.035%). A significant portion of the Panchganga basin (81.496%) has remained unchanged in terms of LULC.

The significant loss of forest cover raises concerns about biodiversity loss, habitat degradation, and soil erosion. While some conversion to agricultural and built-up land is inevitable, sustainable management practices and afforestation efforts are crucial.

Table 3. Change Detection of LULC of the Panchganga Basin, from Year 2000 to 2019

Sr. No.	LULC Class	Area (Sq.km)	Area (%)
1	Forest->Built-up land	14.731	0.567
2	Forest->Agricultural land	146.212	5.628
3	Forest->Bare land	0.55	0.021
4	Forest->Water bodies	8.564	0.33
5	Agricultural land->Forest	135.291	5.208
6	Agricultural land->Built-up land	131.049	5.045
7	Agricultural land->Bare land	0.236	0.009
8	Agricultural land->Water bodies	9.624	0.37
9	Bare land->Forest	0.55	0.021
10	Bare land->Built-up land	1.414	0.054
11	Bare land->Agricultural land	4.753	0.183
12	Water bodies->Forest	7.974	0.307
13	Water bodies->Built-up land	0.904	0.035
14	Water bodies->Agricultural land	18.62	0.717
15	Water bodies->Bare land	0.236	0.009
16	No Change	2117.09	81.496

Source: Landsat 8 Image from USGS Earth Explorer and Data Compiled by Researcher

VI. Conclusion:

The expansion of agricultural land highlights the importance of the sector in the basin's economy. However, the encroachment on forests and bare land raises concerns about environmental sustainability. Promoting sustainable agricultural practices and land management strategies can address these concerns.

The growth of built-up areas reflects the basin's development and urbanization. However, unplanned expansion can lead to increased runoff, flooding, and air and water pollution. Implementing sustainable urban planning and infrastructure development strategies is crucial.

The decrease in bare land indicates its conversion to other land uses, which can be positive if done sustainably. However, it's important to monitor potential changes in soil erosion and dust generation.

The net loss of water bodies is concerning, considering their vital role in the ecosystem. Protecting existing water bodies and restoring degraded ones are crucial for ensuring water security and ecological balance.

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