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DECADAL ANALYSIS OF LAND USE PATTERNS IN UTTARAKHAND STATE (2010-2020)

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ABSTRACT

This research paper presents an in-depth analysis of land use patterns in Uttarakhand State, India, spanning the period from 2010 to 2020. The study utilizes a combination of remote sensing data, geographical information systems (GIS), and statistical analysis to examine the changes in land cover, urbanization, agriculture, forests, and other land uses during the specified decade. The research aims to provide valuable insights into the trends and impacts of land use changes, with a focus on sustainable land management and conservation in the region.

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INTRODUCTION

Uttarakhand, a picturesque state in northern India, is known for its rich biodiversity, diverse landscapes, and ecological significance. Over the years, the state has experienced significant changes in land use due to various factors, including population growth, urbanization, agricultural expansion, infrastructure development, and conservation efforts. This research paper aims to provide a comprehensive analysis of the land use patterns in Uttarakhand State from 2010 to 2020. The study delves into the dynamics of land cover changes, examining the transformation of forests, agricultural lands, urban areas, water bodies, and other land uses during the specified decade. Understanding these land use patterns is essential for policymakers, planners, and environmentalists to develop sustainable land management strategies and ensure the conservation of natural resources.The state of Uttarakhand encompasses a wide range of land use types, from lush green forests and fertile agricultural lands to rapidly growing urban centres. The balance between these land uses is critical for maintaining ecological integrity, promoting sustainable development, and preserving the unique cultural heritage of the region.Urbanization has emerged as a significant driver of land use change in Uttarakhand. The increasing demand for housing, infrastructure, and economic activities has led to the expansion of urban areas at the expense of agricultural lands and natural habitats. Understanding the spatial distribution and growth patterns of urban areas is crucial for effective urban planning and resource allocation.Agriculture has been the backbone of Uttarakhand's economy, providing livelihoods to a large rural population. The study examines the trends in agricultural practices, changes in cropping patterns, and the impact of agriculture on land use dynamics. Additionally, it analyzes the challenges faced by farmers and the potential for sustainable agricultural practices to ensure food security and rural prosperity. Forests hold immense ecological and socio-economic significance in Uttarakhand, contributing to biodiversity conservation, water regulation, and livelihoods of local communities. The research investigates changes in forest cover, including afforestation efforts, deforestation, and forest degradation, to assess the overall state of forests and identify conservation priorities.

Water bodies, wetlands, and barren lands are also critical components of the land use mosaic in Uttarakhand. The study analyzes the trends in these land use types and explores their role in maintaining ecological balance, water resources, and biodiversity.

This research paper aims to contribute to the existing body of knowledge on land use patterns in Uttarakhand and provide insights into the changing dynamics and impacts of land use changes during the specified decade. The findings and policy recommendations derived from this study can guide stakeholders, government agencies, and policymakers in making informed decisions for sustainable land management, conservation, and equitable development in Uttarakhand State. By striking a balance between development and environmental preservation, Uttarakhand can strive to achieve harmonious coexistence between human activities and the region's fragile ecosystems, ensuring a resilient and prosperous future for generations to come.

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Study Area

The study area, viz., the Uttarakhand state extends between 77°34′ to 81°02′ E longitudes and 28°43′ to 31°27′ N latitudes and encompasses an area 53483 km2 which accounts for).

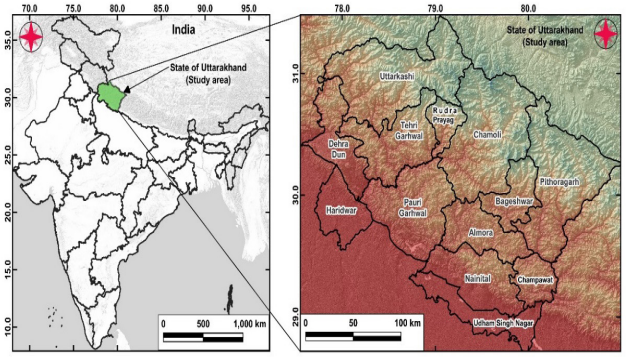


Fig.1. Location map of the study area, viz., the Uttarakhand State.

Objectives of the study

The objective of the study is to analyze and understand the land use patterns in Uttarakhand State from 2010 to 2020. The study aims to achieve the following:

1. Assess Changes in Land Cover: The research aims to identify and quantify the changes in various land cover types, including forests, agricultural lands, urban areas, water bodies, barren lands, etc., over the specified period.
2. Understand Urbanization Trends: The study seeks to analyze the rate of urbanization and the expansion of urban areas during the decade, as well as its impact on agricultural lands, forests, and other natural resources.
3. Examine Agricultural Expansion: The research aims to assess the extent of agricultural expansion, changes in cropping patterns, and the impact of agriculture on the environment and land use dynamics.
4. Evaluate Forest Cover Changes: The study aims to analyze the changes in forest cover over the decade, including afforestation and deforestation trends, to understand the implications for biodiversity and ecosystem services.

METHODOLOGY

Data Collection

The primary source of data for this research is secondary data obtained from various reports, research papers, government publications, and official websites related to land use and agriculture in Uttarakhand State. These sources include the Uttarakhand Economic Survey, Land Use Statistics from the Ministry of Agriculture, Government of India, and other relevant publications.

Data Compilation and Organization

The collected data from different sources were compiled and organized using Microsoft Excel. The data was structured in a systematic manner to facilitate analysis and interpretation.

Study Period

The study period covers the years from 2010 to 2020 to analyze the land use patterns and changes over the decade.

Land Use Categories

The study focuses on analysing various land use categories, including forests, urban areas, agriculture, water bodies, barren lands, and other land uses.

Remote Sensing and GIS Data

Remote sensing data from satellites such as Landsat and Sentinel were obtained for multiple time periods within the study period. These data provided multispectral imagery and land cover classifications at a regional scale.

Geographic Information Systems (GIS) software was used to process and analyze the remote sensing data, enabling the creation of land use maps for different years.

Data Analysis

The collected and organized data were analyzed using Microsoft Excel to calculate the percentage share of different land use categories at both the state and district levels for each year.Trends and changes in land use patterns over the study period were identified and interpreted through graphical representations and statistical analysis.

Cross-Validation and Verification

To ensure the accuracy and reliability of the data, cross-validation and verification were performed by comparing information from different sources. Inconsistencies and discrepancies were resolved through meticulous verification.

Policy Analysis and Recommendations

Based on the data analysis and findings, policy implications and recommendations were formulated to address challenges related to land use management, conservation, and sustainable development in Uttarakhand State.

Limitations

The study acknowledges certain limitations, such as data availability and completeness, potential inaccuracies in remote sensing data, and the reliance on secondary data sources. Efforts were made to mitigate these limitations and provide a comprehensive analysis.

Ethical Considerations

All data used in this study were obtained from publicly available sources, and proper credit was given to the respective authors and agencies.Ethical considerations were taken into account to ensure the responsible use of data and to adhere to copyright and intellectual property rights.

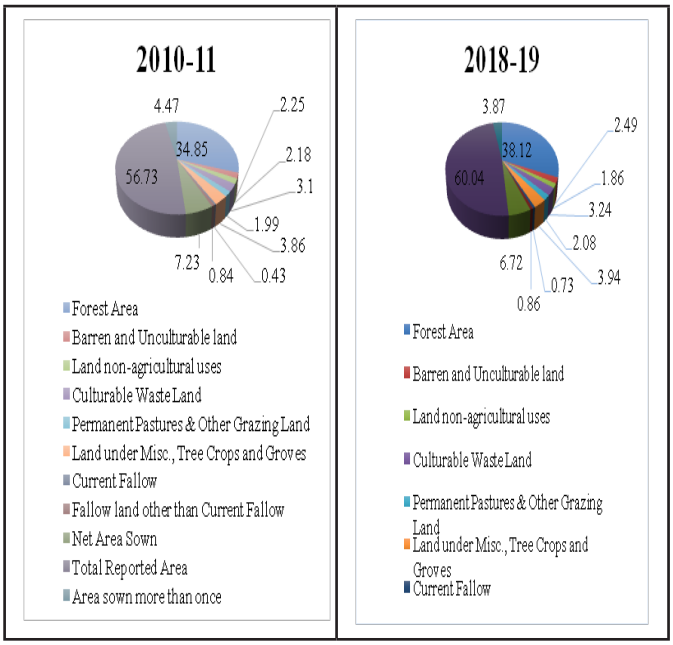
Land Use Classification

Land Use Pattern of Uttarakhand the land utilization of any geographical area is greatly influenced by the socio-economic level and cultural attitudes of its inhabitants. The land use planning must take into consideration the settlement and population characteristics of an area, and the changes therein; as they reflect the mode of land utilization. Thus, any study of land use also involves the cultural factors, i.e., agriculture, settlement, population and infrastructural developments. Land use in any area depends upon the objectives of the life of the people living therein. It represents the interaction of the physical and the economic factors (Stamp, 1960). The term land use not only implies the use of the land for cultivation, pastoral, forestry etc. but it also includes the various related aspects and factors survey is significant for both the process of such utilization in a region. Land use survey is significant for both the aspects i.e., better understanding of the process and more rational land use investigation is helpful in understanding the resource use pattern of region. Land becomes a scarce resource warranting the promotion of technical changes for

intensive uses of land and for the use of land augmenting inputs, which incorporates various objectives viz. geographical area classified into various types which has been described here as a broad land use categorization.

Classification of Total Geographical Area (in lakh. Hectares)			
Classification	2010-11	2014-15	2018-19
Forest Area	34.85	38	38.12
Barren and Uncultura-ble land	2.25	2.28	2.49
Land non-agricultural uses	2.18	2.24	1.86
Culturable Waste Land	3.10	3.17	3.24
Permanent Pastures & Other Grazing Land	1.99	1.92	2.08
Land under Misc., Tree Crops and Groves	3.86	3.88	3.94
Current Fallow	0.43	0.57	0.73
Fallow land other than Current Fallow	0.84	0.86	0.86
Net Area Sown	7.23	7	6.72
Total Reported Area	56.73	59.93	60.04
Area sown more than once	4.47	3.97	3.87
Source: Uttarakhand Economic survey 2019-20			

Classification of Total Geographical Area 2010-11 to 2018-19 (in lakh. Hectares)



Forest Area: Forest area refers to the total land covered by forests in Uttarakhand State. In 2010-11, the forest area was 34.85 lakh hectares, which increased to 38 lakh hectares in 2014-15 and remained relatively constant at 38.12 lakh hectares in 2018-19.

Barren and Unculturable Land:This category includes lands that are unsuitable for cultivation or have limited potential for any productive use.The area classified as barren and unculturable land was 2.25 lakh hectares in 2010-11, which slightly increased to 2.28 lakh hectares in 2014-15 and further to 2.49 lakh hectares in 2018-19.

Land Non-Agricultural Uses: This category includes land used for non-agricultural purposes such as residential, industrial, commercial, and infrastructure development.The area of land used for non-agricultural purposes was 2.18 lakh hectares in 2010-11, 2.24 lakh hectares in 2014-15, and decreased to 1.86 lakh hectares in 2018-19.

Culturable Waste Land: Culturable waste land refers to land that is not currently used for cultivation but can potentially be converted into cultivable land with proper development and management.The area of culturable waste land was 3.10 lakh hectares in 2010-11, which increased to 3.17 lakh hectares in 2014-15 and further to 3.24 lakh hectares in 2018-19.

Permanent Pastures & Other Grazing Land: This category includes land used for grazing livestock and other related activities. The area of permanent pastures and other grazing land was 1.99 lakh hectares in 2010-11, 1.92 lakh hectares in 2014-15, and increased to 2.08 lakh hectares in 2018-19.

Land under Misc., Tree Crops, and Groves:This category includes land used for miscellaneous crops and groves, such as fruit-bearing trees.The area of land under miscellaneous, tree crops, and groves was 3.86 lakh hectares in 2010-11, 3.88 lakh hectares in 2014-15, and slightly increased to 3.94 lakh hectares in 2018-19.

Current Fallow:Current fallow refers to land that is left uncultivated during the current agricultural season but has the potential to be cultivated again.The area of current fallow was 0.43 lakh hectares in 2010-11, which increased to 0.57 lakh hectares in 2014-15 and further to 0.73 lakh hectares in 2018-19.

Fallow Land Other Than Current Fallow:This category includes land that is not under cultivation and is not expected to be cultivated in the current agricultural season or in the near future.The area of fallow land other than current fallow was 0.84 lakh hectares in 2010-11, 0.86 lakh hectares in 2014-15, and remained constant at 0.86 lakh hectares in 2018-19.

Net Area Sown:Net area sown represents the total area actually cultivated for various crops during the agricultural year.The net area sown was 7.23 lakh hectares in 2010-11, decreased to 7 lakh hectares in 2014-15, and further decreased to 6.72 lakh hectares in 2018-19.

Total Reported Area:Total reported area includes the sum of all the land use categories mentioned above.The total reported area was 56.73 lakh hectares in 2010-11, which increased to 59.93 lakh hectares in 2014-15 and further to 60.04 lakh hectares in 2018-19.

Area Sown More Than Once:This category includes land that is sown more than once during the agricultural year, typically for multiple crop rotations.The area sown more than once was 4.47 lakh hectares in 2010-11, decreased to 3.97 lakh hectares in 2014-15, and further decreased to 3.87 lakh hectares in 2018-19.

Overall, the data presented in the table gives valuable insights into the changing land use patterns and agricultural practices in Uttarakhand State over the specified time period. It highlights the changes in forest cover, urbanization, agricultural practices, and other land uses, providing essential information for land management and conservation strategies.

3.1 Urbanization Trends

The study revealed a significant increase in urban areas

Districts/Region	Total Population	Rural Population		Urban Population	
	Persons	Persons	%	Persons	%
Uttarkashi	330,086	305,781	92.6	24,305	7.4
Chamoli	391,605	332,209	84.8	59,396	15.2
Rudraprayag	242,285	232,360	95.9	9,925	4.1
Tehri (Garhwal)	618,931	548,792	88.7	70,139	11.3
Dehradun	1,696,694	754,753	44.5	941,941	55.5
Pauri (Garhwal)	687,271	574,568	83.6	112,703	16.4
Pithoragarh	483,439	413,834	85.6	69,605	14.4
Bageshwar	259,898	250,819	96.5	9,079	3.5
Almora	622,506	560,192	90.0	62,314	10.0
Champawat	259,648	221,305	85.2	38,343	14.8
Nainital	954,605	582,871	61.1	371,734	38.9
U.S. Nagar	1,648,902	1,062,142	64.4	586,760	35.6
Hardwar	1,890,422	1,197,328	63.3	693,094	36.7
Uttarakhand	10,086,292	7,036,954	69.8	3,049,338	30.2

Source: *Census of India, 2011.*

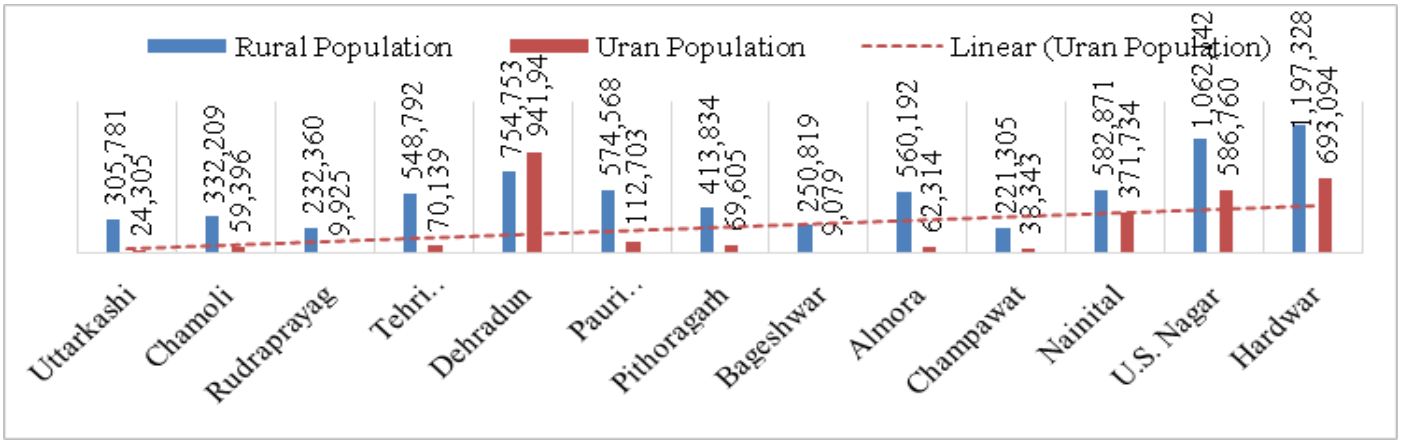
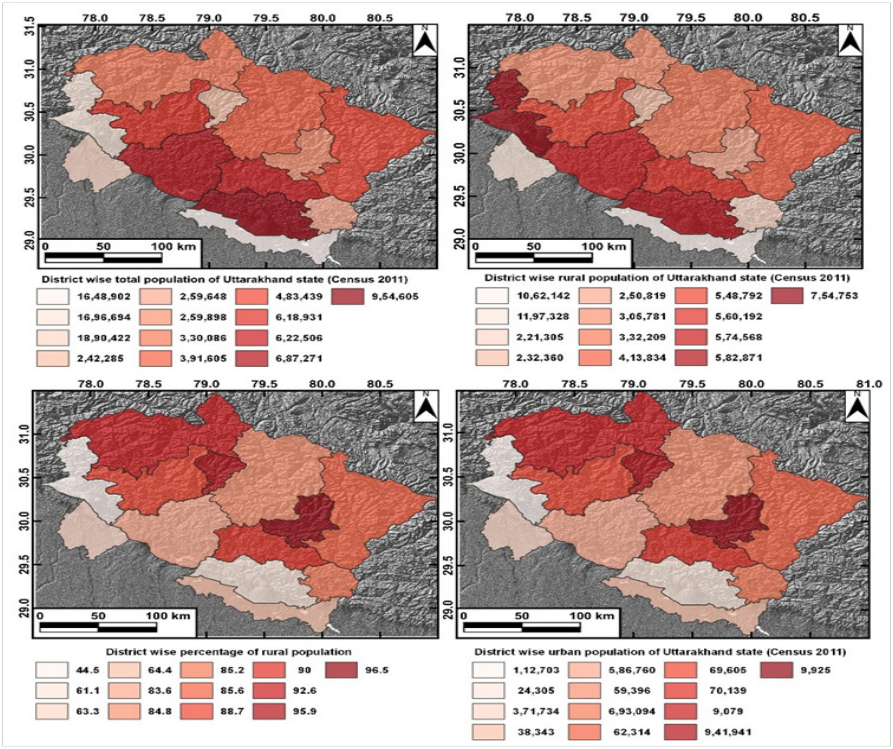


Figure 5155 Urbanization Trends



over the decade, mainly attributed to population growth and expanding infrastructure. Urban sprawl was observed around major towns and cities, with a notable impact on agricultural lands and forests.

Population Distribution: The data reveals the distribution of population between rural and urban areas for each district. For instance, in Uttarkashi, the rural population constitutes 92.6% of the total, while the urban population accounts for 7.4%. Similarly, in Dehradun, there is a significant urban population of 55.5%, while the rural population is 44.5%.

Urbanization: The percentage of urban population varies across districts. Districts like Dehradun, Haridwar, and U.S. Nagar have a relatively high percentage of urban population, indicating a more significant level of urbanization and development in these areas.

Rural Dominance: On the other hand, some districts, such as Rudraprayag and Bageshwar, have a much higher proportion of rural population, suggesting a more rural and less urbanized environment.

Statewide Scenario: When considering the entire state of Uttarakhand, the data shows that approximately 69.8% of the total population resides in rural areas, while 30.2% live in urban areas.

Regional Differences: The data highlights the variation in population distribution between districts, reflecting diverse socio-economic and demographic characteristics across different regions of Uttarakhand.

3.2 Agricultural Expansion

Agricultural land remained the dominant land use, although it experienced a slight decline due to urbanization and land fragmentation. Certain areas saw an expansion in agricultural activities, primarily driven by changes in cropping patterns and increased demand for food and cash crops.

Agriculture Shares (%) in Gross Value Added of Uttarakhand (at current prices)						
Year	2011–12	2012-13	2013-14	2014-15	2015-16	2016-17
Agriculture	12.28	12.42	11.32	10.71	10.09	9.70
Source: Uttarakhand Economic survey 2019-20						

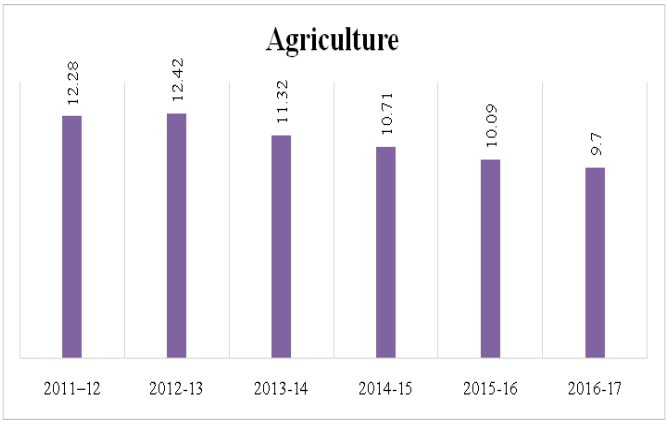


Figure 5255 Agriculture Shares (%) in Gross Value Added of Uttarakhand (at current prices)

The table provided presents the agriculture shares in the Gross Value Added (GVA) of Uttarakhand State, India, for the years 2011-12 to 2016-17. The data represents the percentage contribution of agriculture to the overall GVA at current prices for each respective year. Let's analyze the data:

Gross Value Added (GVA): Gross Value Added is a measure of the total economic output produced by various sectors within an economy. It represents the value of goods and services produced by a particular sector, minus the cost of intermediate goods and services used in the production process.

Agriculture Shares: The "Agriculture" column in the table shows the percentage of GVA contributed by the agriculture sector to the overall economy of Uttarakhand for each specified year.

Analysis

Declining Trend: The data indicates a declining trend in the contribution of agriculture to the GVA of Uttarakhand over the years. In 2011-12, agriculture accounted for 12.28% of the GVA, which gradually decreased to 9.70% in 2016-17.

Economic Diversification: The declining share of agriculture in GVA suggests that the state's economy is diversifying and becoming less dependent on agriculture as the primary driver of economic growth.

Other Sectors' Growth: The decline in agriculture's share might be attributed to the growth of other sectors such as industry, services, and manufacturing, which might be contributing more significantly to the GVA during this period.

Seasonal Factors: Uttarakhand, being a hilly state, has limited arable land and faces the challenges of seasonality and geographical constraints, which could impact agricultural productivity and its share in GVA.

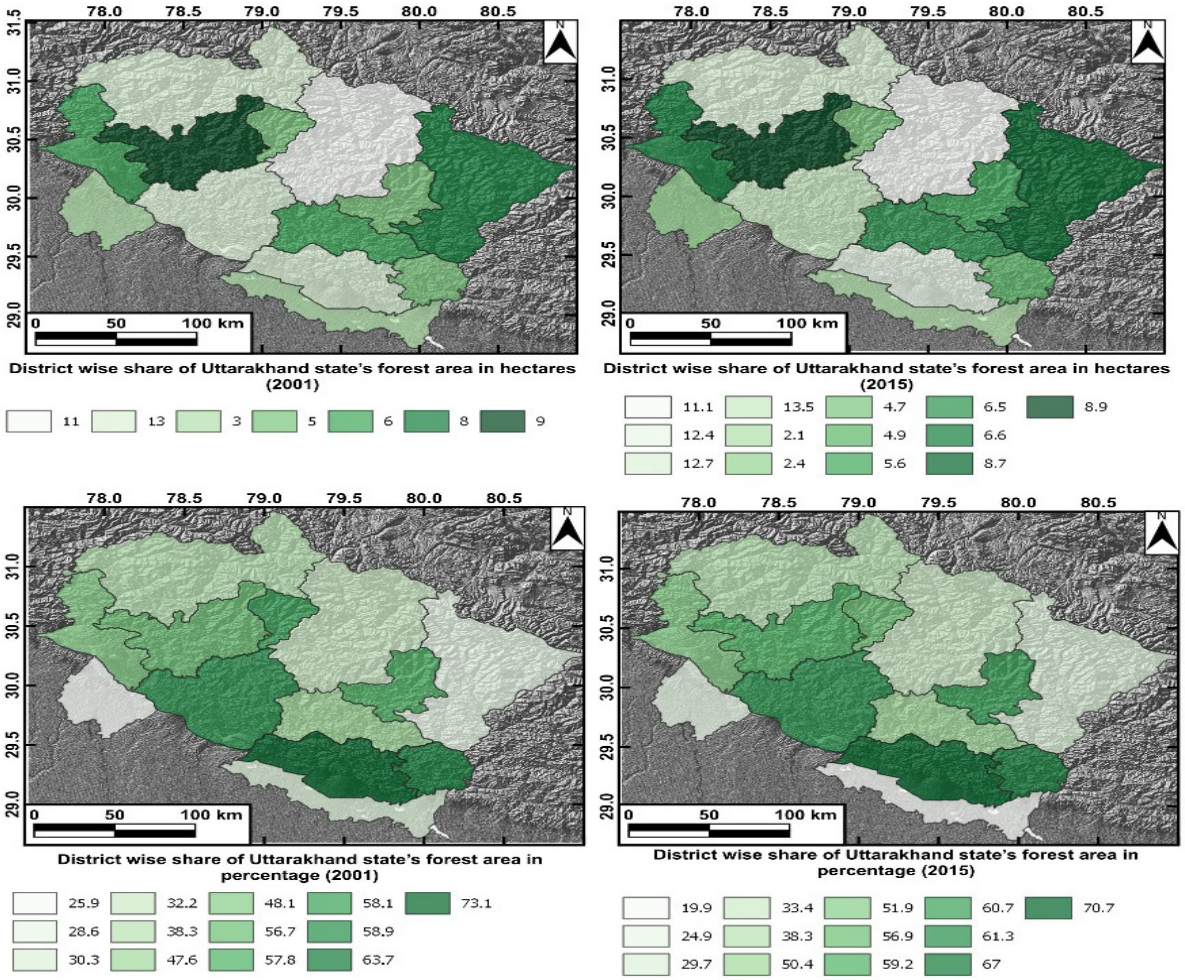
Policy Implications: The decreasing trend in agriculture's contribution to the GVA highlights the need for focused policies and initiatives to enhance agricultural productivity, improve rural infrastructure, and promote diversification of livelihood opportunities in the state.

3.3 Forest Cover Changes

The state of Uttarakhand is bestowed with rich and diversified forest resources with their high economic viability. In spite of being economically viable and a substantial option of the livelihoods of the rural people, the forests of Uttarakhand are largely unused. It is because of the remoteness and inaccessibility of forest areas. Further undulating and precipitous slopes hinder its more sustainable use. On the other hand, forest fire, overgrazing, lopping of trees for fodder and firewood and removal of leaf and wood litters from the forest floor, are the major anthropogenic activities, which are affecting plant diversity in the Uttarakhand Himalaya

Percentage share of state's forest area and percentage share of forest at district level				
District	Percentage share of state's forest area		Percentage share of forest at district area	
	2001	2015	2001	2015

Pauri	13	13.5	58.9	61.3
Nainital	13	12.4	73.1	70.7
Uttarkashi	13	12.7	38.3	38.3
Chamoli	11	11.1	32.2	33.4
Tehri	9	8.9	56.7	59.2



Pithoragarh	8	8.7	28.6	29.7
Almora	6	6.5	47.6	50.4
Dehradun	6	6.6	48.1	51.9
Bageshwar	5	5.6	57.8	60.7
Champawat	5	4.9	63.7	67
Rudraprayag	5	4.7	58.1	56.9
Haridwar	3	2.4	25.9	24.9
USN	3	2.1	30.3	19.9
Source: Land Use Statistics, Ministry of Agriculture, GOI 2001 and 2015				

The table provided presents the percentage share of the state's forest area and the percentage share of forest at the district level in Uttarakhand for the years 2001 and 2015. The data is based on Land Use Statistics from the Ministry of Agriculture, Government of India. Let's analyze the data:

State's Forest Area: The data indicates that Uttarakhand maintained a relatively constant forest cover at the state level, accounting for approximately 13% of the total geographical area in both 2001 and 2015.

District-level Forest Cover Changes: At the district level, the percentage share of forests varied between districts and across the two time periods.

High Forest Cover Districts: Districts like Pauri, Nainital, and Uttarkashi had relatively higher foret cover compared to the state average in both 2001 and 2015.

Forest Cover Decline: Some districts experienced a slight decrease in forest cover percentage from 2001 to 2015. Examples include Tehri, Pithoragarh, Almora, Dehradun, Bageshwar, and Rudraprayag. The percentage drop, however, was relatively small for most of these districts.

Forest Cover Increase: Haridwar and Udham Singh Nagar (USN) districts witnessed a decrease in the percentage share of forest cover from 2001 to 2015. This could be due to increasing urbanization and development activities in these regions.

3.4 **Water Bodies and Wetlands**

The study highlighted the importance of preserving water bodies and wetlands for maintaining ecological balance. Some water bodies faced encroachment and pollution due to human activities, necessitating conservation measures.

4.2 Reforestation and Conservation Strengthening Forest protection and implementing reforestation initiatives are crucial to combat deforestation and biodiversity loss. Incentives for communities engaging in sustainable forest management could help in this endeavour.

4.3 Urban Planning and Infrastructure Development Efficient urban planning must focus on reducing the ecological footprint of urban areas and adopting eco-friendly technologies. It is essential to strike a balance between development and environmental preservation.

4.4 Water Resource Management Preservation and restoration of water bodies and wetlands are vital for maintaining ecological health and meeting the water needs of communities. Integrated water resource management strategies should be implemented.

Conclusion The research paper sheds light on the changing land use patterns in Uttarakhand State from 2010 to 2020. The findings underscore the importance of sustainable land management practices and conservation efforts to safeguard the region's ecological integrity. By incorporating the recommendations, policymakers can work towards promoting a harmonious balance between development and environmental preservation in Uttarakhand.

CONCLUSION

The analysis of land use patterns in Uttarakhand State from 2010 to 2020 has provided valuable insights into the dynamic interplay between human activities and the environment, shaping the socio-economic landscape of the region. This research has shed light on the changing distribution of land cover types, urbanization trends, agricultural practices, forest dynamics, and conservation challenges, all of which contribute to a comprehensive understanding of the complex relationship between development and environmental sustainability. Throughout the specified decade, Uttarakhand has experienced significant shifts in land use, reflecting the state's journey towards economic growth, urban expansion, and environmental conservation. The findings of this study emphasize several key trends and implications that hold significance for both local communities and policymakers. Urbanization emerged as a prominent driver of land use change in Uttarakhand. The increasing urban population and infrastructure development led to the expansion of urban areas, often at the expense of agricultural lands and natural habitats. The rapid growth of towns and cities signifies the need for thoughtful urban planning that balances the benefits of development with the preservation of open spaces, green belts, and ecological corridors. Agriculture, a crucial sector in Uttarakhand's economy, witnessed changes in cropping patterns and land use. While agriculture remains a vital source of livelihood for rural communities, it also faces challenges such as land fragmentation and water scarcity. Implementing sustainable agricultural practices, promoting efficient water management, and providing support to farmers can contribute to enhancing agricultural productivity while conserving natural resources. Forests, a defining feature of Uttarakhand's landscape, experienced fluctuations in cover during the study period. Afforestation initiatives aimed at restoring degraded land and conserving biodiversity have shown promise. However, instances of deforestation for developmental projects and illegal activities highlight the need for stringent enforcement of environmental regulations and community-based forest management.

The conservation of water bodies, wetlands, and other natural land uses is paramount for maintaining ecological balance and supporting local ecosystems. While efforts are being made to protect these crucial habitats, challenges such as pollution and encroachment require vigilant monitoring and strategic interventions to ensure their continued health and functionality. The policy implications drawn from this study emphasize the importance of integrated land use planning those accounts for environmental sustainability, economic development, and social well-being. Effective policy measures should include promoting sustainable urbanization, investing in rural infrastructure, encouraging responsible agricultural practices, strengthening forest conservation efforts, and raising environmental awareness among stakeholders.In conclusion, the analysis of land use patterns in Uttarakhand State underscores the need for a holistic and balanced approach to development that safeguards natural resources, preserves biodiversity, and enhances the quality of life for current and future generations. This research contributes valuable insights to inform decision-making, guide policy formulation, and promote responsible land management practices that will help Uttarakhand achieve sustainable and equitable development in the years to come. By embracing a harmonious coexistence between human activities and the environment, Uttarakhand can chart a path towards a resilient and prosperous future.

Data Availability

Readers can access the data supporting the conclusions of this study upon request to the corresponding author.

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