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SPATIO-TEMPORAL ANALYSIS OF LAND USE AND LAND COVER CHANGES IN MYSURU USING GEO-INFORMATICS: 1991–2024

Mr. Prakasha A P[1] & Dr. Manjunatha C S[2]

[1]Assistant professor in Geography, The Rural College, Kanakapura and Research Scholar, Department of studies and Research in Geography, Karnataka State Open University, Mysuru-06, India.

[2]Assistant Professor, Department of Studies and Research in Geography, Karnataka Open University Mysuru-06, India.

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Keywords

Land Use Land Cover Change, Urban Sprawl, Remote Sensing, Sustainable Planning.

Abstract

Urban expansion has become a defining characteristic of developing cities, often resulting in significant alterations to land use and land cover (LULC) patterns. This study investigates the spatial and temporal dynamics of LULC changes in the Mysuru Local Planning Area over a 33-year period (1991–2024) using multi-temporal satellite imagery and geospatial techniques. The research utilizes Landsat datasets (TM, ETM+, and OLI) sourced from the USGS Earth Explorer platform, classified using the Maximum Likelihood Classification method into six major LULC categories: built-up, agricultural land, forest, water bodies, barren land, and others. The analysis reveals a 273% increase in built-up land, driven by rapid urbanization, infrastructural development, and population growth, particularly after 2001. Conversely, agricultural land declined by over 31%, forest areas by 10.6%, and water bodies by 23.3%, indicating a substantial ecological transformation. These trends underscore the pressures exerted by urban growth on natural and agricultural systems. Ancillary data, including administrative boundaries and field surveys, supplemented the classification accuracy and interpretation. The findings highlight the urgent need for sustainable land management

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practices and integrated urban planning to balance development and environmental conservation. The study not only provides a detailed spatial understanding of Mysuru's urban sprawl but also offers valuable insights for policymakers, urban planners, and environmental managers in the context of future urban development.

1. INTRODUCTION

Land is one of the most vital and finite natural resources on Earth, serving as the foundation for socio-economic development and ecological balance (Lambin et al., 2003). The rapid pace of global urbanization over the past few decades has significantly altered Land Use and Land Cover (LULC) patterns, particularly in developing countries like India, where demographic pressure, economic reforms, and policy shifts have catalyzed dramatic spatial transformations (Verburg et al., 2011). As urban populations swell, cities expand horizontally and vertically, replacing agricultural fields, forests, wetlands, and open spaces with concrete infrastructure, thereby generating complex challenges for sustainable development (Jat et al., 2008).

LULC change analysis is essential for understanding these dynamics and guiding land-use planning, resource management, and urban policy. Remote Sensing (RS) and Geographic Information System (GIS) technologies have proven effective in detecting and quantifying spatial changes in LULC, helping stakeholders visualize and monitor urban growth, environmental degradation, and land transformations over time (Rawat & Kumar, 2015). These tools are particularly valuable in urban and peri-urban areas where land conversion is fastest and often least regulated.

India's urban transition is particularly noteworthy, with cities witnessing rapid growth driven by economic liberalization, migration, and infrastructure development. Numerous studies have shown how Indian cities are expanding at the expense of ecologically sensitive land classes such as agricultural land, forests, and wetlands, leading to concerns about groundwater depletion, loss of biodiversity, and increased vulnerability to climate change (Sudhira et al., 2004; Bharath et al., 2021). Mid-sized cities, often neglected in policy discussions, are now emerging as hotspots of unplanned urban sprawl.

Mysuru, the cultural capital of Karnataka, exemplifies this transformation. Once known for its planned layout and heritage architecture, Mysuru is now experiencing intense urbanization. Following its inclusion in the Smart Cities Mission and other development initiatives, the city has attracted real estate investments, educational institutions, and administrative infrastructure. Consequently, the Mysuru Local Planning Area (LPA) has undergone significant LULC transformations in recent decades, with rapid expansion of built-up areas and simultaneous decline in agricultural land, forest cover, and water bodies (Manjunatha & Basavarajappa, 2020; Shiva Kumar, 2023; Manjunatha et al., 2023).

This study aims to analyze the spatiotemporal trends in LULC change in the Mysuru LPA from 1991 to 2024 using geospatial techniques. By interpreting land transformation data and correlating it with urban growth patterns, the study provides valuable insights into the pace, pattern, and

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implications of urban expansion in Mysuru. In doing so, it also contributes to the broader discourse on sustainable land use planning and urban resilience in rapidly growing Indian cities.

2. REVIEW OF LITERATURE

Land Use Land Cover (LULC) dynamics have been a central concern in environmental and urban studies, particularly in rapidly urbanizing regions like Mysuru. Several studies have emphasized the role of urban expansion in altering land use patterns and ecological balance. Manjunatha et al. (2023) analyzed the urban footprint of Mysuru using geoinformatics techniques and highlighted how the city's growth has transformed land cover classes, especially built-up areas, at the cost of agriculture and vegetation. Supporting this, Manjunatha and Basavarajappa (2020) conducted a detailed LULC classification of Mysuru Taluk and revealed a sharp decline in agricultural zones, attributing it to urban encroachment and lack of policy enforcement.

Shiva Kumar (2023) used Sentinel-2 satellite data to assess LULC dynamics in Mysuru district, documenting a significant increase in built-up areas between 2018 and 2022, with an accompanying decrease in vegetation and farmland. Sushmitha and Chandrashekara (2023) also reported land degradation and loss of agricultural land in Mysuru Taluk, attributing these trends to urban pressure and poor land-use governance. Bharath et al. (2023), studying Bengaluru Rural, observed a fourfold increase in settlement land from 2001 to 2021, illustrating a regional pattern of urban dominance over ecological land uses, which is similarly observed in Mysuru.

Manjunatha et al. (2014) examined the land use around Mysuru and Chamarajanagara districts using IRS-1D PAN and LISS-III satellite data. Their findings indicated continuous decline in forest cover and agricultural zones, emphasizing the need for ecological conservation amidst urban expansion. In coastal Karnataka, Naik et al. (2023) evaluated the Kundapura region and identified how tourism development led to significant LULC transformations, underlining the importance of integrating tourism planning with environmental sustainability.

Agrawal et al. (2023) conducted a pan-India study of rural land use changes and noted that declining farm incomes, migration, and shifting economic priorities have pushed rural land toward non-agricultural uses, which echoes the transformations seen in peri-urban Mysuru. In a study on Netravati River Basin, Venu and Shivanna (2021) identified agricultural expansion and settlement growth as major factors for deforestation and wetland loss, reflecting the direct implications of land conversion for ecosystem services. Lamani and Malini (2021) also examined Mysuru Taluk using remote sensing and concluded that declining NDVI values indicated deterioration in vegetation health due to increased built-up areas.

Together, these studies demonstrate the intensity and multidimensional nature of land use changes in Mysuru and similar regions across India. The widespread expansion of built-up areas, reduction in agricultural and forest lands, and loss of water bodies and open spaces underscore the critical need for sustainable land management and regulatory planning mechanisms. Geospatial technologies, as shown by the referenced works, offer valuable tools to monitor, assess, and guide future land use planning in rapidly growing urban areas.

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Study Area: Mysuru Local Planning Area

The present study focuses on the Mysuru Local Planning Area (LPA), as defined by the Mysuru Urban Development Authority (MUDA) in its Comprehensive Development Plan (CDP). The boundary under investigation corresponds to the proposed MUDA limits for the year 2031, which include both core urban and peripheral growth areas.

Mysuru, located in the southern part of Karnataka, is one of the state's most historically and culturally significant cities. As a former capital of the Wodeyar dynasty and a renowned center for tourism, culture, and education, Mysuru has experienced substantial urbanization over the past few decades. In recent years, it has emerged as a rapidly expanding urban center in Karnataka, second only to Bengaluru in terms of urban growth dynamics.

The urban sprawl of Mysuru has notably intensified in the last decade, primarily driven by factors such as:

- Industrial expansion, including the development of industrial estates and IT parks.
- Tourism growth, due to Mysuru's heritage value and connectivity.
- Population increase, both through natural growth and in-migration from rural and surrounding areas.

These forces have particularly affected the fringe areas of the city, leading to significant land use and land cover changes, especially the conversion of agricultural and forest lands into built-up spaces.

The delineated study area provides a representative spatial extent to examine these land use transformations over time, making it a critical case for understanding the implications of urban growth and planning in Tier-II Indian cities.

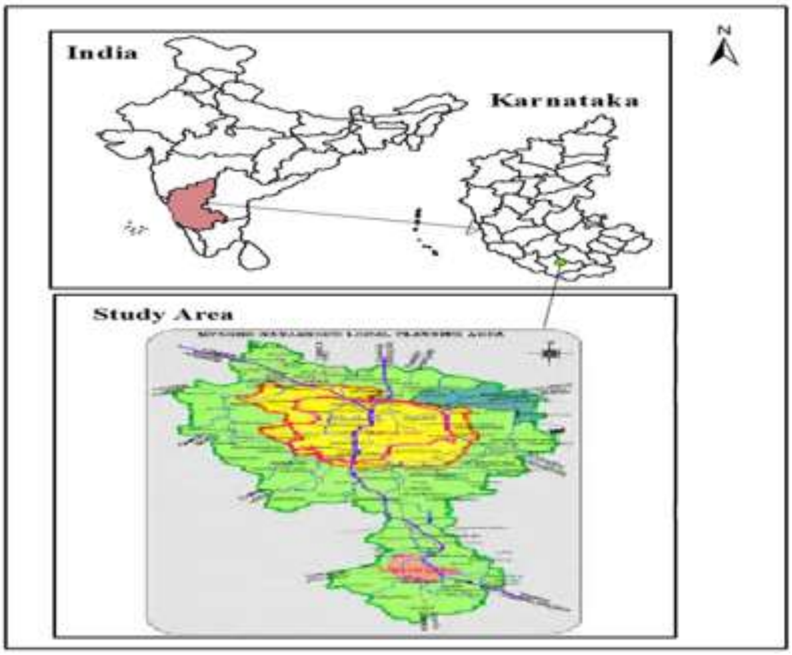

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Figure- 1: Study Area map: Mysuru Local Planning Area

3. MATERIALS AND METHODS

This study undertook a spatio-temporal analysis of Land Use and Land Cover (LULC) changes in the Mysuru Local Planning Area over a 33-year period, utilizing multi-temporal satellite data and geospatial techniques to map, classify, and analyze LULC transformations from 1991 to 2024.

Data Sources: The primary dataset comprised satellite imagery obtained from the United States Geological Survey (USGS) Earth Explorer platform. A total of four temporal datasets were used:

- 1991: Landsat 5 Thematic Mapper (TM)
- 2001: Landsat 7 Enhanced Thematic Mapper Plus (ETM+)
- 2013: Landsat 8 Operational Land Imager (OLI)
- 2024: Landsat 8 OLI

All datasets offer a 30-meter spatial resolution, which ensures consistency and comparability for multi-date analysis. These sensors were selected based on their historical availability, radiometric quality, and compatibility with long-term change detection studies.

Ancillary Data: To improve classification accuracy and contextual interpretation, ancillary datasets were also collected and used. These included:

- Administrative boundary shapefiles of the Mysuru Local Planning Area
- Census and demographic data from the Indian Census (1991, 2001, 2011, and relevant projections)
- Field survey data collected using GPS-enabled devices
- High-resolution satellite images and Google Earth visual references for training data and accuracy assessment

Software Used:

A combination of open-source and proprietary geospatial tools was employed:

- ERDAS Imagine 2015: Used for image preprocessing and supervised classification
- ArcGIS 10.8: Utilized for mapping, spatial analysis, and change detection
- QGIS 3.x: Used for overlay analysis, data visualization, and validation mapping

Pre-processing:

All satellite images were geometrically corrected and radiometrically calibrated prior to classification. Atmospheric correction was also applied to remove haze, cloud cover, and radiometric distortions to ensure inter-comparability of different images.

Classification Technique:

Land Use and Land Cover classification was carried out using the Maximum Likelihood Classification (MLC) method, a widely accepted supervised classification approach in remote sensing. MLC was chosen for its statistical robustness and its ability to incorporate class variances and covariances.

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Training Data Collection:

Ground-truth data were collected through field visits using GPS devices and cross-referenced with high-resolution imagery for enhanced accuracy. Six major LULC classes were defined based on standard classification schemes and local relevance:

1. Built-up Land
2. Agricultural Land
3. Forest Cover
4. Water Bodies
5. Barren Land
6. Others (including scrublands, open lands, marshes, etc.)

Training sites were digitized and labeled for each LULC class to guide the supervised classification process.

Change Detection:

Post-classification comparison was employed to detect LULC changes across the four-time intervals (1991–2001, 2001–2013, 2013–2024, and overall 1991–2024). This method allowed direct comparison of classified maps and quantified the area changes for each class. The net change, loss, gain, and transitions between land use categories were tabulated and interpreted.

4. RESULT AND DISCUSSION

Table – 1: LULC Changes in Mysuru Local Planning Area (1991–2024) in Hectares

LULC Class	1991 (ha)	2001 (ha)	2013 (ha)	2024 (ha)	Net Change (1991–2024) (ha)
Built-up Land	4,345.67	6,890.34	11,314.01	16,201.68	11,856.01
Agricultural Land	28,123.45	26,045.67	22,345.78	19,234.56	-8,888.89
Forest	12,567.89	12,345.67	11,978.34	11,234.56	-1,333.33
Water Bodies	2,045.23	1,890.45	1,834.56	1,567.89	-477.34
Barren Land	2,925.01	2,890.45	2,656.78	2,123.45	-801.56
Others	1,200.56	1,145.23	1078.34	845.67	-354.89

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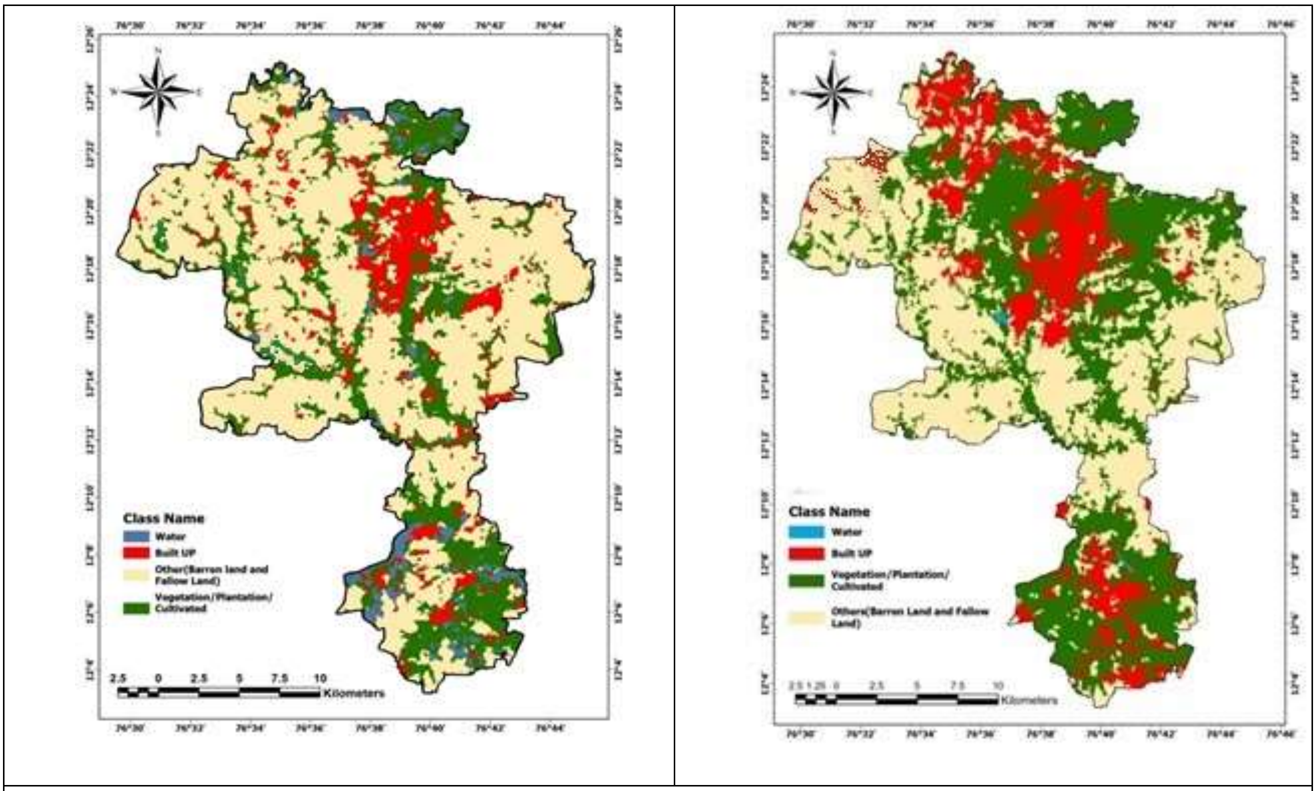
Table 1 shows the LULC Changes in Mysuru Local Planning Area (1991–2024) in Hectares. This analysis aims to examine the trends and extent of change across major land use categories—Built-up Land, Agricultural Land, Forest, Water Bodies, Barren Land, and Others. By quantifying these changes, the study highlights patterns of urbanization, environmental pressures, and land degradation.

1. **Built-up Land**

   Built-up land has increased by nearly 273% over the 33-year period, growing from 4,345.67 ha in 1991 to 16,201.68 ha in 2024. This substantial growth reflects rapid urbanization and infrastructure development, likely driven by population growth, economic expansion, and increased administrative or commercial investments in Mysuru. The pace of growth notably accelerated after 2001, indicating intensified urban sprawl or densification strategies.

2. **Agricultural Land**

Agricultural land has declined by over 31%, dropping from 28,123.45 ha in 1991 to 19,234.56 ha in 2024. This decline is largely due to conversion into built-up areas and



LULC maps of Mysuru for the years 1991 and 2001

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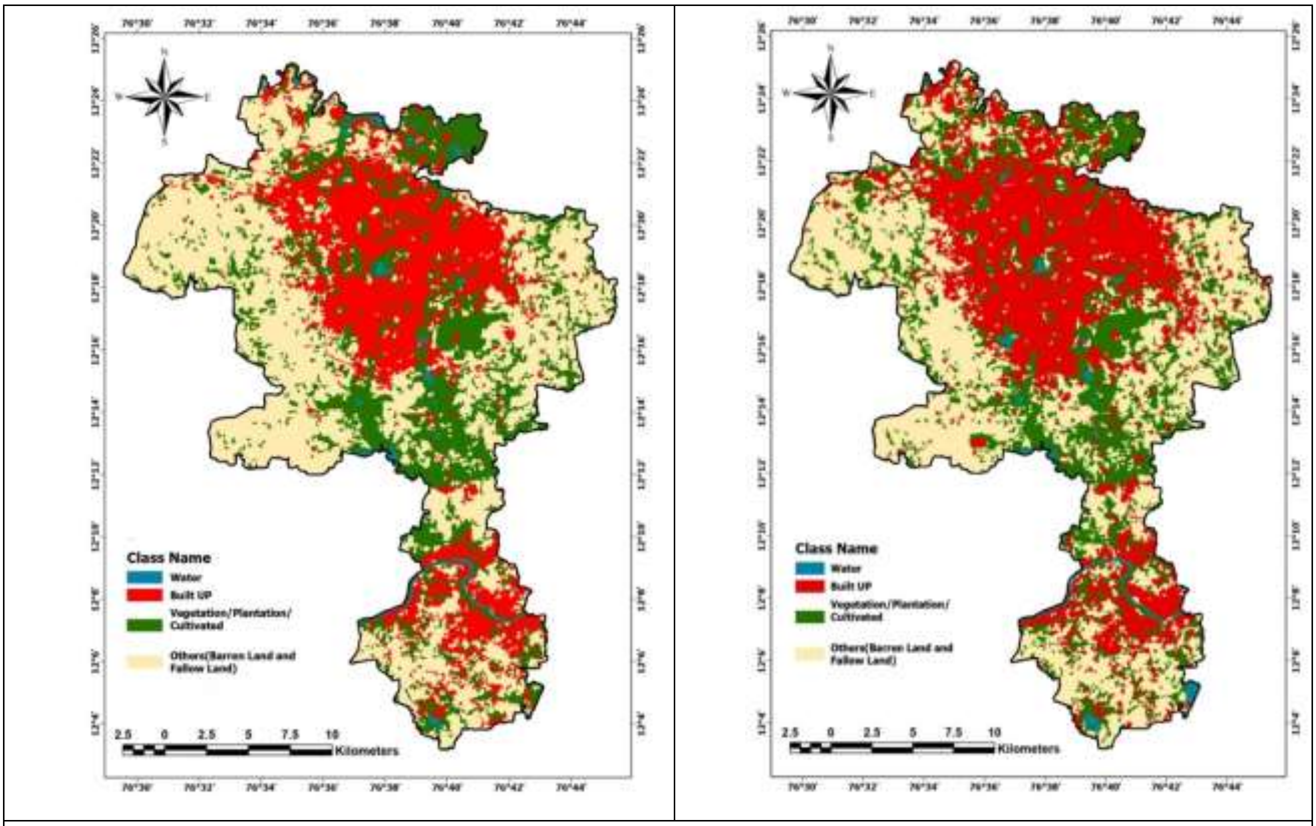

LULC map of Mysuru for the year 2014 and 2024

possible fragmentation from infrastructure development. The loss of agricultural land indicates urban encroachment and declining rural land use, potentially impacting local food security, rural livelihoods, and ecological balance, unless addressed through sustainable land use planning.

3. **Forest Land**
   Forest cover has decreased by around 10.6%, from 12,567.89 ha in 1991 to 11,234.56 ha in 2024. Although this reduction is moderate compared to agricultural land, it still suggests encroachment, fragmentation, or conversion to other land uses. Continued deforestation poses risks to biodiversity, carbon sequestration, and local climate regulation.
4. **Water Bodies**
   Water bodies have shrunk by approximately 23.3%, declining from 2,045.23 ha in 1991 to 1,567.89 ha in 2024. This reduction may be attributed to land reclamation, siltation, pollution, or neglect of traditional tanks and lakes. Such a decline has serious implications for urban water supply, groundwater recharge, and flood mitigation. Strengthening urban water governance is essential to reversing this trend.
5. **Barren Land**

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Barren land has reduced by 27.4%, from 2,925.01 ha in 1991 to 2,123.45 ha in 2024. This could result from land reclamation or conversion into productive uses like agriculture or urban development. While this may appear positive, it could also mask land degradation or misclassification of transitional landscapes

6. **Others (Scrub/Wasteland/Marsh etc.)**
The "Others" category has decreased by 29.6%, from 1,200.56 ha in 1991 to 845.67 ha in 2024. This class likely includes scrubland, marshes, and other transitional ecosystems, whose decline reflects land conversion or ecological degradation. The loss of such areas reduces habitat diversity and eliminates natural buffers that help manage runoff, erosion, and heat regulation in urban landscapes

5. CONCLUSION

The Land Use Land Cover (LULC) analysis of the Mysuru Local Planning Area from 1991 to 2024 reveals a clear trajectory of urban expansion and corresponding decline in natural and agricultural land resources. Built-up land has increased more than threefold, signifying accelerated urbanization and infrastructure development. However, this growth has occurred at the expense of agricultural land, which has seen a significant decline of over 8,800 hectares, indicating a shift away from agrarian land use.

Similarly, forest areas, water bodies, and other ecologically significant categories have experienced gradual but notable reductions, raising concerns over environmental sustainability, biodiversity loss, and groundwater recharge potential. The shrinkage of water bodies and forested areas may also contribute to long-term ecological imbalances, including urban flooding, heat island effects, and reduced resilience to climate variability.

These findings underscore the urgent need for integrated urban and environmental planning that balances development with ecological conservation. Policymakers must prioritize the protection of critical green and blue spaces, promote sustainable urban forms, and implement land use regulations to mitigate further degradation. This analysis serves as a foundation for future planning interventions aimed at achieving a more sustainable and resilient Mysuru.

6. AUTHOR(S) CONTRIBUTION

The writers affirm that they have no connections to, or engagement with, any group or body that provides financial or non-financial assistance for the topics or resources covered in this manuscript.

7. CONFLICTS OF INTEREST

The authors declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

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8. PLAGIARISM POLICY

All authors declare that any kind of violation of plagiarism, copyright and ethical matters will take care by all authors. Journal and editors are not liable for aforesaid matters.

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