**Royal International Global Journal of Advance and Applied Research**
Peer Reviewed International, Open Access Journal.
*ISSN: 2998-4459 | Website: https://rlgjaar.comVolume-3, Issue-1 | January - 2026*

Original Article

# Spatio-Temporal Assessment of Land Use and Land Cover Dynamics in Malegaon Tehsil, Nashik District, Maharashtra Using Remote Sensing and GIS Techniques

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**Manuscript ID:**
RIGJAAR-2026-030125

ISSN: 2998-4459
Volume 3
Issue 1
Pp. 122-127
January 2026

**Submitted:** 15 Dec. 2025
**Revised:** 25 Dec. 2025
**Accepted:** 18 Jan. 2026
**Published:** 31 Jan. 2026

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Quick Response Code:

Web. https://rlgjaar.com

DOI: 10.5281/zenodo.21701038

DOI Link:
https://doi.org/10.5281/zenodo.21701038



***Abstract***

*Our Land Use and Land Cover (LULC) shows the interactions between our activities and ecosystems and can indicate that over the last few years, region lands have undergone significant modifications mainly due to increase in population, growing urbanization, shift of industries and expansion of agriculture, thus has great influence on the local fauna, flora and water resources. To track these changes effectively, researchers rely heavily on Remote Sensing (RS) and Geographic Information Systems (GIS) (Chandel et al., 2013). By analyzing multi-temporal satellite imagery essentially looking at a region from above across different years. We can accurately capture how a landscape is shifting. This provides policymakers with the concrete data they need for sound environmental planning and decision-making (Zhou et al., 2020). The TE of Maharashtra Malegaon Tehsil in Nashik District. Malegaon tehsil is one such example that is under dynamic change. The rich black soil on Deccan traps formation of igneous basic rocks of volcanic origin with adequate irrigation from networks of rivers like Mosam and Girna, provides a source of living, producing and commercial center. The process of urbanization, changed cropping patterns, expansion of industries over LULC footprint is dynamic in last few decades (Diwate et al., 2024). The primary goal of this study is to quantify these spatio-temporal land dynamics in Malegaon Tehsil using GIS and Remote Sensing. By clearly mapping out what has changed, this research aims to provide a reliable, scientific foundation to help guide sustainable land resource planning in the region for the years to come.*

***Keywords****: Land Use and Land Cover, Remote Sensing, GIS, Change Detection, Malegaon Tehsil, Sustainable Land Management.*

## Introduction

Land use and land cover (LULC) are important indicators of environmental conditions and human interaction with natural resources. "Rapid urbanization, population growth, agricultural expansion, and industrial development have significantly altered LULC patterns, affecting water resources, biodiversity, and ecosystem sustainability" (Brar G.S. 2013). Therefore, to manage the available resources on the land accordingly the status of such changes is assessed and monitoring is carried out regularly. "Remote Sensing (RS) and Geographic Information System (GIS) have become reliable tools for mapping and analyzing spatio-temporal changes in land use and land cover" (Chandel, et.al. 2013). "Multi-temporal satellite imagery enables accurate assessment of landscape transformations and provides valuable information for environmental planning and decision-making" (Zhou, Y., et. al 2020).

"Malegaon Tehsil, located in Nashik District of Maharashtra, is an important agricultural and industrial region characterized by fertile black soils, Deccan Trap basalt formations, and the Girna and Mosam River systems" (Diwate., et.al. 2024). "In recent years, increasing urbanization, industrial growth, and changing agricultural practices have led to significant changes in land use and land cover" (Survey, U. S. 1982).



***How to cite this article:***
*Misar, J. V. & Nikam, S. N. (2026). Spatio-Temporal Assessment of Land Use and Land Cover Dynamics in Malegaon Tehsil, Nashik District, Maharashtra Using Remote Sensing and GIS Techniques. Royal International Global Journal of Advance and Applied Research, 3(1), 122–127. https://doi.org/10.5281/zenodo.21701038*

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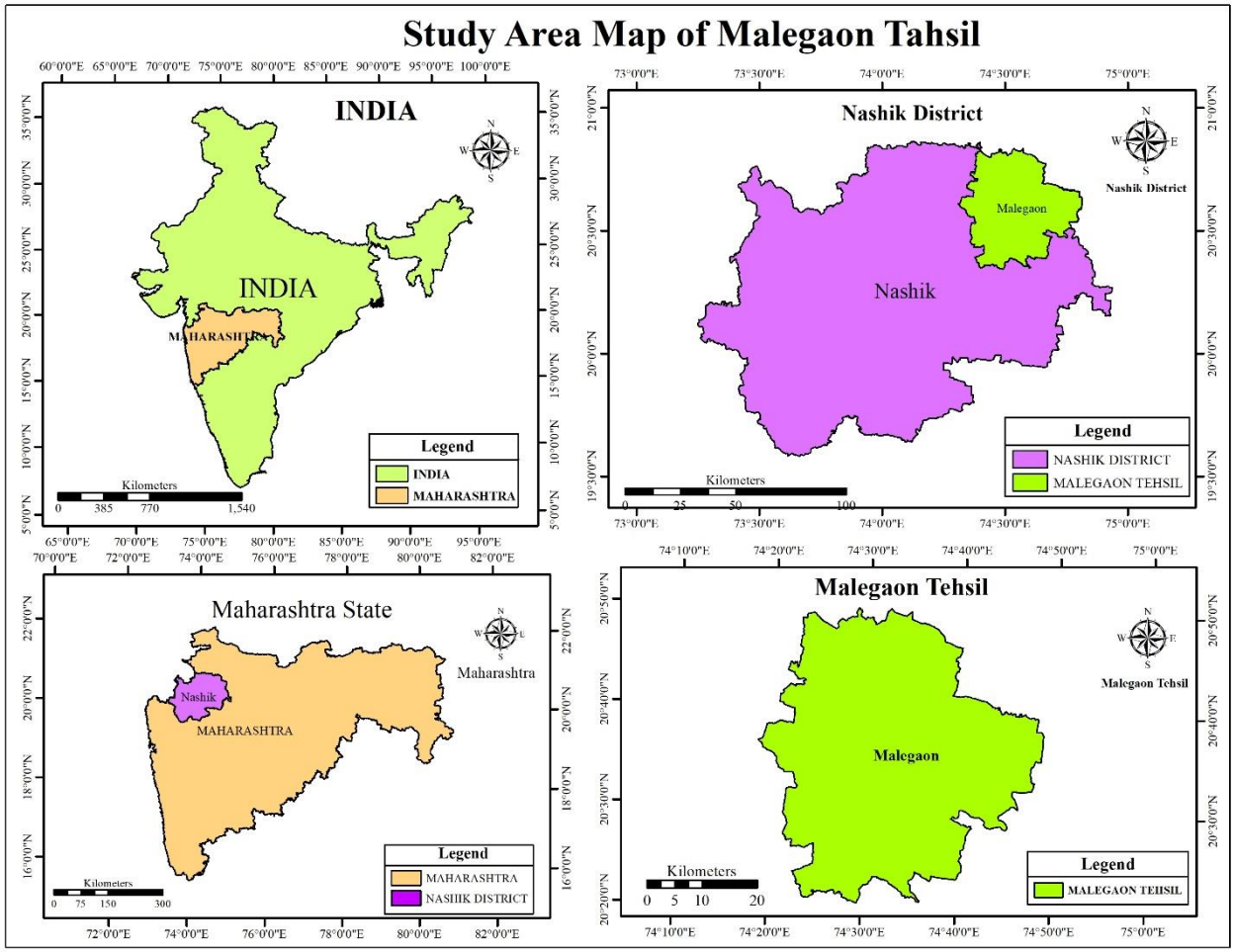
The present study to quantify the dynamics of LULC at spatio-temporal perspective by using Remote Sensing and GIS, so that it will serve as a valid scientific base for land resources for planning for a sustainable basis in the Malegaon Tehsil.

**Study Area:**

This study has undertaken for Malegaon Tehsil of district Nashik of state Maharashtra lying in the northeastern region of Maharashtra has 15 tehsils, out of total fifteen, has covers with the area approximately of 1,937.65 km2 located on the altitude 458 meter from MSL with latitudinal and longitudinal extent are varying between 20° 20' N. and 20° 50' N. and 74° 18' E. and 74° 48' E. respectively. This tehsil is bounded by Dhule District towards its north, towards East Jalgaon District, towards South Nandgaon Tehsil and towards West Baglan (Satana) Tehsil. Malegaon tehsil topographic is mainly like deccan trap is one is to high level ground with large flat to gentle slope without even hills on the region basalt plateau that was divided into the deep, narrow, river valleys.

This tehsil receives irrigation from Girna and it's only a tributary river is the Mosam and other numerous tributary seasonal streams for groundwater recharging and irrigation purposes. Girna dam (1966) is one such important source of water for irrigation (having more than 600 MCM of storage). From a micro-economic perspective, the region is defined by well-established economic potential with rich black and alluvial agricultural soil; in addition to that, Malegaon city serves as one of the largest centers of commerce in the country with an extensive boom in power loom textile industry.

**Fig No. 1 Study Area Map**




**Materials and Methods:**

**Table No: 1 Data Sources**

| Sr. No. | Data | Sources |
|---|---|---|
| 1 | Landsat 8 Images USGS Earth Explorer | https://earthexplorer.usgs.gov/ |
| 2 | SOI Toposheets Survey of India | https://surveyofindia.gov.in/ |
| 3 | Administrative Boundary Survey of India | https://surveyofindia.gov.in/ |
| 4 | DEM Bhuvan | https://bhuvan.nrsc.gov.in/ |

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1. **Software Used:**

Land Use and Land Cover (LULC) of Malegaon Tahsil in the year 2015 and 2025 were carried out using ArcGIS 10.8, ERDAS Imagine, QGIS and Google Earth Pro software. In ERDAS Imagine Software satellite images pre-processed and classification along with change detection were analyzed. In ArcGIS 10.8 and QGIS Software spatial analysis was performed, preparation of map and calculations on the area for each class. Google Earth pro software assists the interpretation, visual confirmation and validation with field visit to LULC classes.

2. **Methodology:**

For this study to delineate the changes within Malegaon Tehsil's landscape the multi-temporal Landsat 8 imagery was employed. Prior to proceeding with any classification, the obtained satellite images were pre-processed for its geometric and radiometric consistency to gain a clean and precise geo-spatial data base.

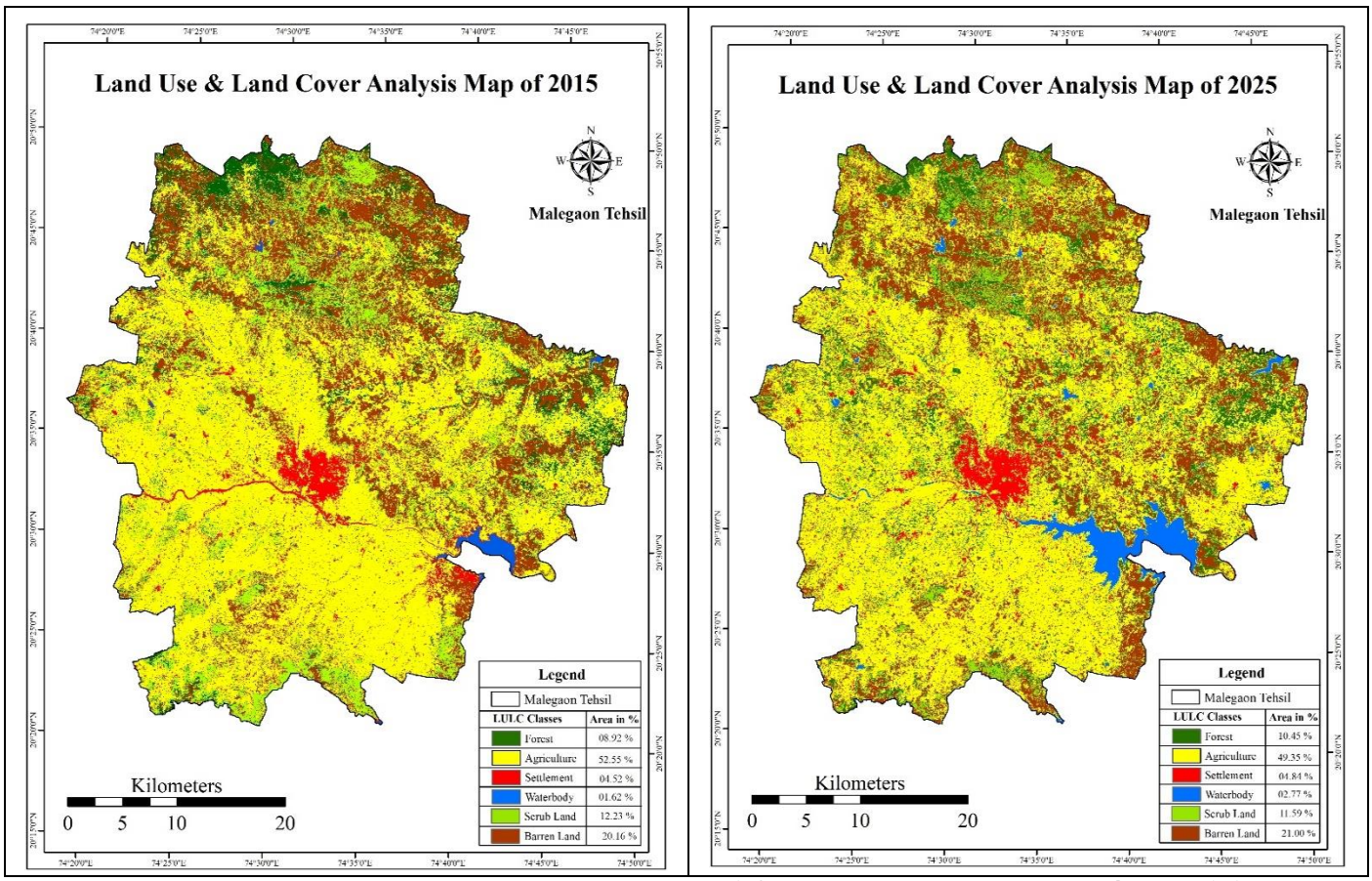
Classification: Pre-processed images were used for supervised classification by utilizing the ERDAS Imagine. The land cover classes were created and delineated for maximum classification efficiency through applying the 'Maximum Likelihood' technique.

A quality check was then undertaken to perform a comparative analysis to assess the LULC classification through creating change detection maps for precise mapping of land use transitions during the period between 2015 and 2025 with specific emphasis to LULC. Thematic areas of land use and land cover categories were enumerated to show the overall spatial extent of different categories.

**Results & Discussion**

The analysis from 2015 to 2025 highlighted changes in various LULC categories of Malegaon Tehsil with 193,765 hectares: The prime category identified in the map has still been forest while other significant changes been noticed in agriculture remained dominant in land use over the years, even with decline between 2015 and 2025. Area allocated to agriculture in 2015 stood at 101,824 ha or 52.55% of total, while decreased to 6,201 ha or down to 95,623 ha or 49.35% in 2025. Forest cover area has increased by 2,964 ha or 1.53% of total in decade which stands at 17,284ha or 8.92% in 2015 to 20,248 ha or 10.45% in 2025 which may be because of regeneration process natural, planted or other. Area of water spread features increased from 3,138 ha or 1.62% of total in 2015 to 5,366 ha or 2.77% in 2025 an increase by 2,228 ha and possibly because of rain, water collection methods & watershed management projects.

**Fig No. 2 LULC Analysis Map of Malegaon Tehsil of for 2015 & 2025**




However, signs of urban expansion and land degradation are also evident in the data. Built-up settlements expanded moderately by 620 hectares (0.32%) as infrastructure grew to support the population. Furthermore, barren land the second-largest land use category grew by 1,628 hectares to cover 21.00% of the tehsil in 2025. Concurrently, scrublands decreased by 1,240

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hectares. Taken together, these statistics demonstrate how effective GIS and remote sensing platforms are at unpacking complex land dynamics, illustrating a landscape that is balancing environmental gains in water and forestry with agricultural losses and urban sprawl.

1. **Land Use Land Cover (LULC) Analysis of the Malegaon Tahsil for 2015:**

**Table No: 2** LULC Proportion 2015 of Malegaon Tahsil

| Sr. No | LULC Classes | Area in Hect. 2015 | Area in % |
|---|---|---|---|
| 1 | Forest | 17284 | 08.92 |
| 2 | Agriculture | 101824 | 52.55 |
| 3 | Settlement | 8758 | 04.52 |
| 4 | Waterbody | 3139 | 01.62 |
| 5 | Scrubland | 23697 | 12.23 |
| 6 | Barren Land | 39063 | 20.16 |
| | **Total** | **193,765** | **100 %** |

Table No.2 represents the Land Use Land Cover (LULC) categories of the Malegaon Tahsil for 2015 total geographical area 193,765 ha. Maximum category was an Agriculture with area101,824 ha (52.55%.) of an agriculture land; It proved agriculture significance area within the tehsil. Barren area was the second place which has occupy area to 39,063 ha (20.16%) of uncultivated land is found. Area of Scrubland was 23,697 ha (12.23) %, the forest land use category of the area is 17,284 ha (8.92) %. In case of settlement, there is 8,758 ha (4.52) %, while area under water body categories was 3,139 ha (1.62%) to the area study is very less as surface water resources.

2. **Land Use Land Cover (LULC) Analysis of the Malegaon Tahsil for 2025:**

**Table No: 3** LULC Proportion 2025 of Malegaon Tahsil

| Sr. No | LULC Classes | Area in Hect. 2025 | Area in % |
|---|---|---|---|
| 1 | Forest | 20248 | 10.45 |
| 2 | Agriculture | 95623 | 49.35 |
| 3 | Settlement | 9378 | 04.84 |
| 4 | Waterbody | 5367 | 02.77 |
| 5 | Scrubland | 22457 | 11.59 |
| 6 | Barren Land | 40691 | 21.00 |
| | **Total** | **193,765** | **100 %** |

Land Use Land Cover (LULC) Patten Malegaon tahsil 2025: As it is found from Table No. 3 it is revealed that, the agricultural land continues to lead at 95,623 ha (49.35% of the total geographical area 193,765 ha). Agricultural land will be continued important for the region. The area under barren land is found to be 40,691 ha (21.00% of total geographical area) which would be the second largest land use category which founds to be slightly decrease in comparison with the2020. Forestland is expanded from 18,843ha to 20,248 ha (10.45%) due to commencement of growing vegetation covering the land under improved environmental and efforts in conservation measures have created favorable conditions resulting increase of vegetation and scrub lands is maintained at 22,457 ha (11.59%), Settlement rise to9,378 ha (4.84%) while area cover with water bodies is 5,367 ha (2.77%), showing an improved environment situation in surface water situation. Thus, the LULC scenario of 2025 will indicate slight improvement of the environmental parameter and at moderate level of urban growth.

3. **Changes Detection Analysis of Malegaon for 2015 to 2025:**

**Table No:.4** Changes Detection Analysis of Malegaon Tehsil From 2015 to 2025

| Sr. No | LULC Classes | Area in Hect. 2015 | Area in Hect. 2025 | Net Change (ha) | Net Change (%) | Trend |
|---|---|---|---|---|---|---|
| 1 | Forest | 17284 | 20248 | +2,964 | +1.53 | Increased |
| 2 | Agriculture | 101824 | 95623 | -6,201 | -3.20 | Decreased |
| 3 | Settlement | 8758 | 9378 | +620 | +0.32 | Increased |
| 4 | Waterbody | 3139 | 5367 | +2,228 | +1.15 | Increased |
| 5 | Scrubland | 23697 | 22457 | -1,240 | -0.64 | Decreased |
| 6 | Barren Land | 39063 | 40691 | +1,628 | +0.84 | Increased |
| | | **193,765** | **193,765** | **00** | **0.00** | — |

Table. No 4 shows a comparative change detection analysis of LULC at Malegaon Tehsil from 2015 and 2025 over a total geographical area of 193,765 ha. The analysis shows significant changes in the land use between the said period. Agriculture being the major land class, lost an area of 6201 ha (3.20%), from an area of 101,824 ha (52.55%) to an area of95,623 ha (49.35%). Forest cover increase by an area of 2

964 ha (1.53%), the significant increase in forest can be due to efforts of plantation, natural regeneration and conservation practices. Increase in area of water bodies was also observed 2228 ha (1.15%), likely due to increase in

watershed development, rain water harvesting and good rain falls. Settlement has increased by an area of 620 ha (0.32%), indicating increasing process of urbanization and growth of infrastructure. Decline by 1240 ha (0.64%) of scrubland is noted, the Barren land increased by 1628 ha (0.84%).

Hence, it can be concluded that despite loss in agricultural land, the area gained under forest cover and water bodies contributes positively to the environment of the tehsil. Thus, Remote Sensing and GIS techniques have been found effective in monitoring spatio-temporal changes of LULC, natural resources management and planning of sustainable land use, environmental aspects.

**Environmental Implications**

Malegaon Tehsil (2015-2025) Environmental Implications These landscape changes in Malegaon Tehsil from 2015 to 2025 have both positive and negative environmental implications. On the positive end, the expansion in forest coverage by 1.53% indicate denser vegetal resources. This would lead to a stable environment as more trees will support local biodiversity while improving carbon sequestration and reducing the strain on local wildlife habitat.

Additionally, the expansion of water surfaces by 1.15% suggest the success of community-oriented initiatives like water conservation (rainwater harvesting, watershed management). These could be vital for groundwater replenishment and also sustenance of agriculture. Unfortunately, there are still negative implications: The decrease of agricultural land by 3.20% indicate a reduction in good soils available for agriculture because of shift to some non- agricultural purpose. Increase in barren lands by 0.84% would translate to localized degradation of soils. Increase of settlement areas by 0.32%, even though is small, may suggest towards continuous sprawl, which puts pressure on land and other scarce local resources such as water. Therefore, future plans must be made which check these negative trends and sustain positive changes for local ecosystem and community.

**Suggestions:** To encourage environmental conservation and ensure sustainable land management in Malegaon Tehsil, several actionable steps should be prioritized based on these findings:

- **Protect Farmland:** Sustainable farming techniques must be promoted to halt the steady conversion and loss of productive agricultural land.
- **Expand Green Cover:** Local authorities should double down on afforestation and social forestry initiatives to further boost vegetation and protect regional biodiversity.
- **Enhance Water Security:** It is vital to expand current watershed management and rainwater recharge programs to secure the area's surface and groundwater future.
- **Reclaim Degraded Areas:** For barren zones, scientific reclamation efforts focused heavily on soil and water conservation are highly recommended.
- **Manage Urban Sprawl:** City and regional planning need to be strictly regulated to prevent unchecked development from encroaching on farmlands and sensitive ecological zones.
- **Continuous Monitoring:** Maintaining an active, periodic monitoring system using GIS and remote sensing will provide the ongoing, evidence-based data needed for smart policy formulation.

**Conclusion:**

This, in essence, demonstrates clearly the significance and us ability of GIS and Remote Sensing in monitoring Land Use and Land Cover change, over time. This analysis is evidenced that from 2015 to 2025, agricultural is indeed prevalent throughout Malegaon Tehsil, however is now retracting as agricultural space; the area covered by cultivated and irrigational agriculture declined by 6201 Hectare. It is equally clear that natural resources of Malegaon Tehsil registered growth during the period, with forests grew by 2964 Hectares and water bodies by 2228 Hectares.

Above growth patterns are clearly correlated to micro watershed management planning activities. Nonetheless, the dual growth of urban land and unproductive rocky areas highlight an increase in soil erosion and urban pressure and indicate how geospatial tool clearly give accurate insight as necessary planning tools and guides resource management practices toward balanced development of the region.

**Acknowledgment**

I express my sincere gratitude to my respected Research Guide, Dr. Subhash N. Nikam, Principal, MGV's Maharaja Sayajirao Gaikwad College, Malegaon Camp, for his constant guidance, valuable suggestions, scholarly insight, and continuous encouragement throughout the course of this research work. His expert supervision and constructive criticism greatly contributed to the successful completion of this study.

**Financial support and sponsorship**

Nil.

**Conflicts of interest**

The authors declare that there are no conflicts of interest regarding the publication of this paper.

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