Spatial Analysis of Asiatic Elephant Habitat and Protected Areas in India

PRESENTED BY:

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1. INTRODUCTION

Elephas maximus, the Asiatic elephant, is a keystone species whose survival depends on the availability of safe passageways and continuous forest environments. Elephant ranges in India are becoming more limited because to human pressure, habitat fragmentation, and rapid land-use change. Elephant distribution, forest cover, and the significance of protected areas in conservation planning could all be accurately analyzed with the use of spatial technologies like Geographic Information Systems (GIS).

This study maps the occurrence of elephants throughout India, evaluates the amount of forest cover in and surrounding protected areas, and investigates possible habitat connectivity using open-source spatial data and GIS methodologies.

2. OBJECTIVES

2.1. To map the spatial distribution of Asiatic elephant occurrences in India.

2.2. To analyze forest cover distribution across the country.

2.3. To assess forest availability within and around protected areas.

2.4. To discuss potential habitat connectivity and movement corridors for elephants.

3. STUDY AREA

The study covers the entire geographical extent of India, with emphasis on regions known for elephant presence such as the Western Ghats, Eastern Ghats, Central India, North-East India, and parts of the Himalayan foothills.

4. DATA SOURCE

The entire work is based on reliable, open-access databases that are frequently utilized in ecological and conservation studies. Transparency, reproducibility, and applicability for policy and field-level conservation planning are ensured by using open data.

- **Elephant occurrence data (GBIF):** Occurrence records of the Asiatic elephant (*Elephas maximus*) were downloaded from the Global Biodiversity Information Facility (GBIF). The data include geographic coordinates and observation details, providing a broad picture of elephant presence across India.
- **Land Use / Land Cover (LULC) data:** Forest and land-cover information was obtained from ESA/Bhuvan Land Use–Land Cover datasets (Latest version 2024-25).
- **Protected Areas (WDPA):** Boundaries of protected areas were sourced from the World Database on Protected Areas (WDPA), the most widely used global database for conservation planning and environmental assessments.
- **Administrative boundary:** The national boundary of India was used to clip and standardize all spatial layers to a common study extent.

5. METHODOLGY

The analysis was carried out using QGIS 3.40 LTR, an open-source Geographic Information System. The workflow was designed to be simple, transparent, and replicable, focusing on spatial relationships rather than complex modelling.

- Data preparation

All vector and raster datasets were imported into QGIS and checked for coordinate reference system consistency. Layers were reprojected where necessary and clipped to the India boundary to ensure spatial alignment and reduce processing errors.

- Elephant Occurrence Mapping

Elephant occurrence records from GBIF were cleaned to remove incomplete entries and visualize as point features. Mapping these points helped identify major regions of elephant presence and broad spatial clustering patterns across India.

- Forest Habitat Extraction

The LULC raster was examined to identify forest-related land-cover classes relevant to elephant habitat. These classes were reclassified into a binary raster representing forest (habitat) and non-forest (non-habitat) areas. This simplification allowed clearer interpretation of habitat availability at a national scale.

- Forest Area Buffer Analysis

Protected area polygons from WDPA were merged to create a unified layer. A 5 km buffer was generated around these areas to represent zones of ecological influence beyond formal boundaries. Forest cover within

these buffer zones was extracted to assess habitat availability near protected areas.

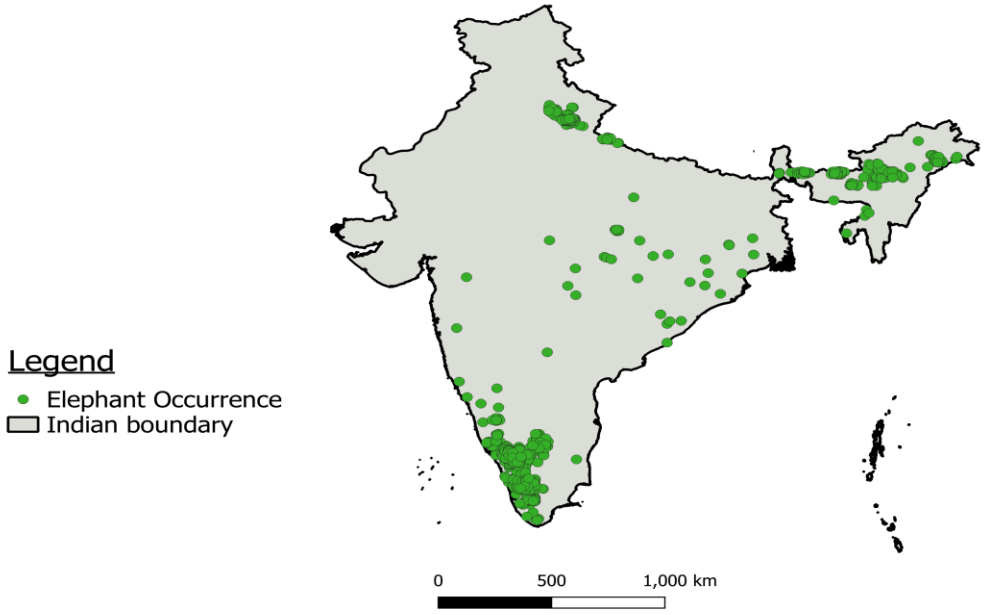
- Spatial overlay and Visualization

Elephant occurrence points were overlaid with forest and protected area layers to examine spatial relationships. Three thematic maps were produced to visualize elephant distribution, forest habitat extent, and forest cover within protected area buffers.

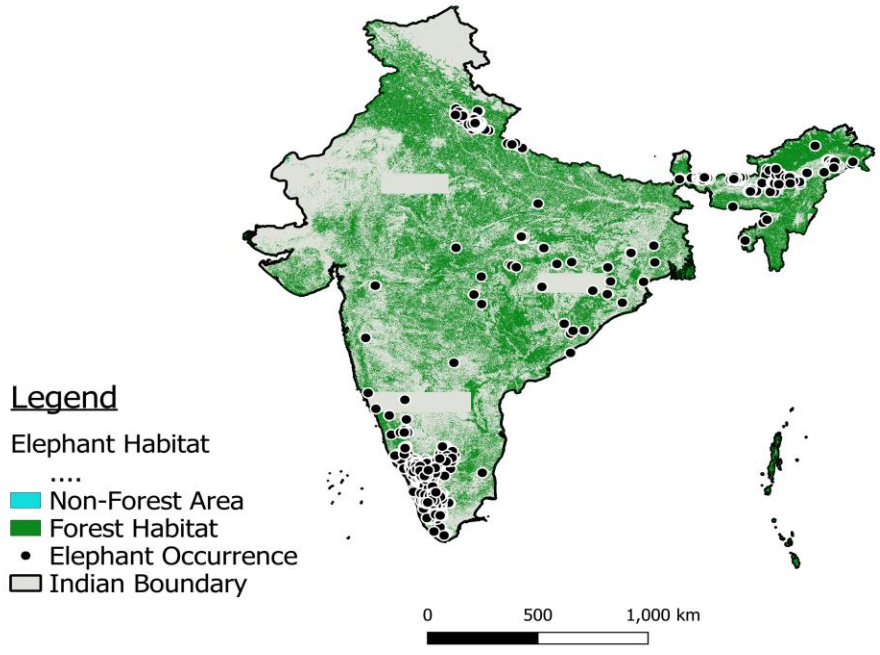
6. RESULTS

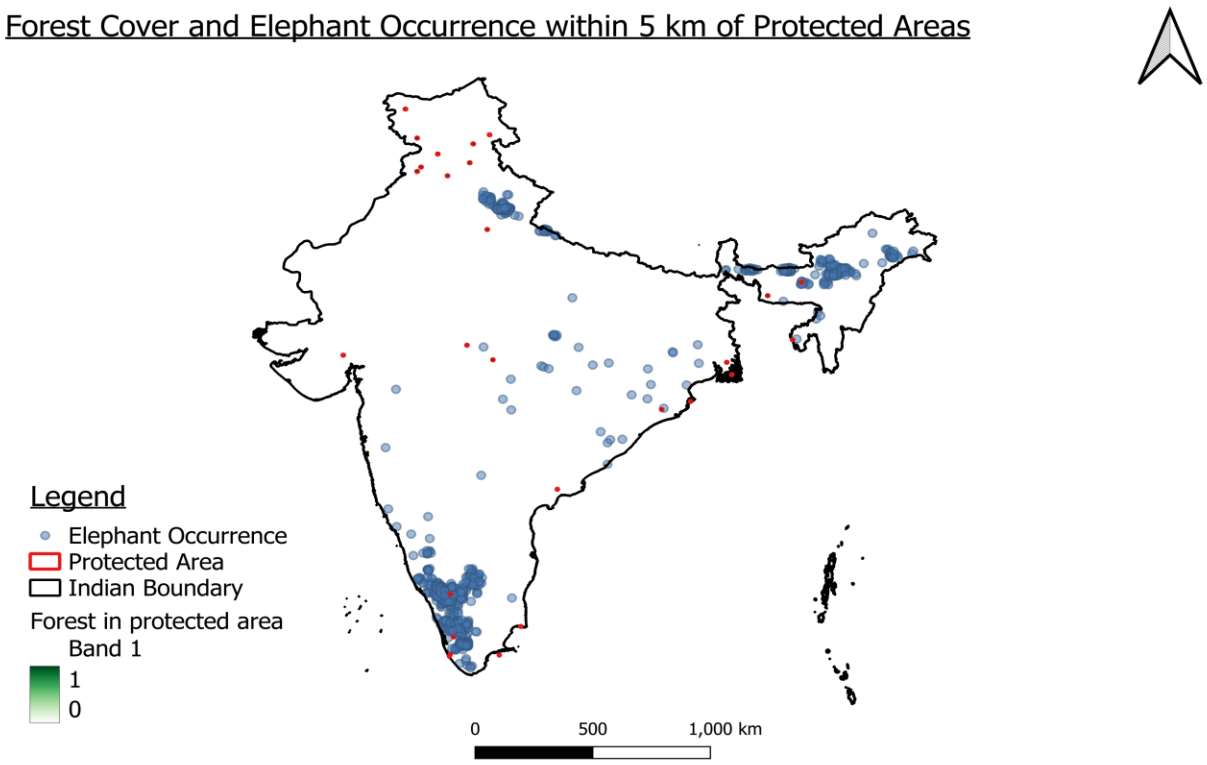
The elephant occurrence map shows major clusters in the Western Ghats, North-East India, and parts of Central and Eastern India. Forest cover is unevenly distributed, with dense forest patches aligning with major elephant habitats. Analysis of protected area buffers indicates that substantial forest cover exists both within and outside protected areas, highlighting the importance of non-protected forests.

Distribution of Asiatic Elephant Occurrences in India



Forest Habitat and Elephant Occurrence in India





7. DISCUSSION

The spatial overlap between elephant occurrences and forested landscapes confirms the dependence of elephants on continuous forest habitats. Several elephant points were observed outside protected areas but within forest patches, suggesting the functional importance of corridors and buffer zones. These areas may serve as potential movement pathways connecting protected populations.

8. LIMITATIONS

- Occurrence data may be spatially biased toward accessible areas
- LULC classification accuracy depends on source data resolution

9. CONCLUTION

This study demonstrates the utility of GIS in wildlife habitat assessment and conservation planning. The findings emphasize the need to conserve forested landscapes beyond protected area boundaries to maintain elephant connectivity and reduce human–elephant conflict.

10. FUTURE SCOPE

Future studies can integrate climate variables, human pressure indices, and advanced connectivity models to refine corridor identification and support conservation decision-making.