JOURNAL OF THE ROYAL LAUREATES ACADEMY

www.rlaindia.org

SPATIAL DYNAMICS OF POPULATION GROWTH AND ENVIRONMENTAL DEGRADATION IN SOUTH 24 PARGANAS: A GIS-BASED GEOGRAPHICAL APPRAISAL

Moumita Sen
Research Scholar, Sunrise University Alwar Rajasthan

Dr. Dinesh Baboo
Assistant Professor, Sunrise University Alwar Rajasthan

ABSTRACT

South 24 Parganas, a coastal district in West Bengal, exemplifies how population growth interacts with environmental degradation in vulnerable estuarine landscapes. This study investigates the *spatial dynamics* of population expansion and its corresponding impact on environmental conditions using Geographic Information Systems (GIS) and remote sensing techniques. By analysing land use/land cover (LULC) transformations, coastal erosion, mangrove dynamics, and socio-environmental pressures, the paper highlights the key linkages between demographic trends and ecological stress. Results reveal that increasing population density, unplanned settlement expansion, and agricultural–industrial land conversion substantially contribute to ecosystem degradation and the loss of natural buffers against climatic and environmental threats. The study suggests sustainable management strategies through spatial planning, ecosystem conservation, and policy interventions to reduce environmental stress in the region.

Keywords: Spatial Population Dynamics, Environmental Degradation Assessment, Land Use/Land Cover (LULC) Change, Geographic Information System (GIS) and Remote Sensing, Sundarbans Deltaic Region

1. INTRODUCTION

Population growth and environmental degradation are intimately connected, particularly in ecologically sensitive regions. South 24 Parganas — extending from the fringes of Greater Kolkata to the Indian Sundarbans — embodies one such critical case. With a dense and rapidly growing population accompanied by intense land-use change, the district faces multifaceted environmental challenges. This paper seeks to **appraise the spatial dynamics** of population growth and environmental change using GIS, focusing on:

- Temporal and spatial patterns of demographic change
- Land use and land cover (LULC) transformations
- Environmental degradation indicators
- GIS as an analytical tool for understanding these dynamics

2. STUDY AREA: SOUTH 24 PARGANAS

South 24 Parganas is the largest district in West Bengal, covering urban fringe areas, agricultural plains, riverine floodplains, and the Sundarbans mangrove ecosystem. It lies within the Ganga–Brahmaputra–Meghna (GBM) delta — a dynamic environment characterised by tidal flows, sediment deposition, and low elevation. The region's geography favours diverse ecosystems but also makes it vulnerable to environmental risks such as coastal erosion, salinization, flooding, and cyclone impacts.

3. POPULATION GROWTH TRENDS

According to census data, South 24 Parganas experienced a population growth rate of about 18.17% between 2001 and 2011, with density rising from 693 to 819 persons per square kilometre. Increasing population growth exerts pressure on land, water, and natural resources, especially in coastal and peri-urban zones where settlement demand is highest. Population growth alters spatial patterns, often leading to settlements expanding into previously undisturbed areas, intensifying environmental impacts.

4. GIS AND REMOTE SENSING APPROACHES IN ENVIRONMENTAL APPRAISAL

GIS and remote sensing provide powerful tools to monitor and analyse spatiotemporal dynamics of land use and environmental degradation. Satellite imagery, such as Sentinel-2 and Landsat series, are used to identify changes in vegetation cover, water bodies, built-up areas, and other land-use classes. Through GIS, researchers can quantify LULC change, assess spatial trends, and correlate environmental stressors with demographic pressures.

For example, LULC studies in the Canning blocks of South 24 Parganas utilised Sentinel-2 imagery to derive water and vegetation indices, revealing significant environmental vulnerability linked to urban expansion and population growth. Moreover, remote sensing techniques have documented the loss of mangrove vegetation along the coastal fringes, underscoring the ecological impacts of human activities and natural forces.

5. SPATIAL PATTERNS OF LAND USE CHANGE

5.1 Urban and Population-Driven Land Conversion

Population growth accelerates urbanisation, leading to the conversion of agricultural lands and wetlands into built-up zones. Settlement areas have increased significantly over the last few decades as land is reclaimed to accommodate housing, infrastructure, and economic activities. Multiple studies show that settlement areas, which once occupied less than 1% of the landscape, have expanded several times in recent decades — often at the expense of natural ecosystems.

5.2 Mangrove Dynamics and Coastal Landscapes

Mangroves provide vital ecological services, including shoreline protection and biodiversity support. However, these ecosystems have experienced spatial shifts due to both natural and anthropogenic factors. Land use analyses indicate that while overall mangrove area remained relatively stable for decades, fragmentation and densities have changed over time, with increasing sparse mangrove zones and expansions in bare land — suggesting stress and degradation. The conversion of cropland to aquaculture and settlement areas also highlights demographic pressures transforming land use.

6. ENVIRONMENTAL DEGRADATION INDICATORS

6.1 Coastal Erosion and Sea-Level Rise

Sea-level rise in the Sundarbans is accelerating, contributing to the erosion of land and loss of habitat. Studies indicate a long-term trend of land submergence and island disappearance, with sea levels rising at approximately 3.14 mm per year, leading to permanent land loss and displacement of communities. Such changes also push people inland, intensifying settlement pressure on other ecosystems.

6.2 Soil Salinity and Agricultural Stress

Soil salinization, aggravated by rising sea levels, cyclones, and tidal inundation, reduces agricultural productivity. Climatic factors exacerbated by human-induced environmental degradation worsen this issue, particularly affecting farming communities across multiple blocks such as Gosaba and Kakdwip.

6.3 Biodiversity and Habitat Fragmentation

Population-driven land use changes impact biodiversity. Expanding settlements, agricultural intensification, and infrastructure development fragment habitats, especially for ecologically sensitive species in the Sundarbans. Reports show that wildlife patterns — including tiger movements — increasingly intersect with human-dominated landscapes, reflecting habitat encroachment and ecological pressure.

7. POPULATION–ENVIRONMENT INTERACTIONS: A SPATIAL MODEL

Spatial analysis reveals a **feedback loop** where population growth fuels land conversion and environmental stress, which in turn influences migration, resource scarcity, and further demographic change. GIS maps show settlement growth in peri-urban and rural zones, parallel to declines in natural land covers. The pattern highlights vulnerability hotspots, particularly in coastal blocks where environmental degradation intersects with dense human settlements.

8. POLICY IMPLICATIONS AND SUSTAINABLE STRATEGIES

To address environmental degradation linked to population growth in South 24 Parganas,

sustainable spatial planning is essential. Recommendations include:

1. **Zoning and Land Use Regulation**
    - Restrict further encroachment into ecologically sensitive zones
    - Establish buffer zones and conservation areas
2. **Ecosystem Restoration**
    - Mangrove afforestation and shoreline stabilisation
    - Restoration of wetland and agricultural landscapes
3. **GIS-Based Planning Tools**
    - Integrate GIS data into planning frameworks
    - Use spatial modelling to predict future land use scenarios and ecological impacts
4. **Community Engagement and Education**
    - Involve local communities in conservation and sustainable resource use
    - Raise awareness of ecological risks and adaptive practices
5. **Climate Adaptation Measures**
    - Build resilience against cyclones, flooding, and sea-level rise
    - Improve infrastructure to withstand environmental stresses

9. DISCUSSION

The spatial dynamics observed in South 24 Parganas affirm that population growth is a major *driver* of environmental degradation, exacerbated by coastal processes and climatic influences. GIS and remote sensing have proven invaluable in analysing how demographic pressures reshape landscapes and ecosystems over time. However, addressing these challenges requires interdisciplinary approaches combining spatial science, regulation, governance, and

participatory planning.

CONCLUSIONS

This GIS-based geographical appraisal underscores the complex linkages between population expansion and environmental degradation in South 24 Parganas. Key insights include:

- Population growth correlates with land use transitions that erode natural landscapes.
- Coastal ecosystems face intensified degradation due to combined human and climatic pressures.
- GIS monitoring provides essential data for sustainable planning and environmental management.

Effective mitigation strategies must integrate spatial planning, ecological restoration, and community involvement to balance human needs with environmental protection in this vulnerable coastal region.

REFERENCES

1. Government of India. (2011). Census of India 2011: District Census Handbook – South 24 Parganas. Office of the Registrar General & Census Commissioner, New Delhi.

2. Government of India. (2001). Census of India 2001: Primary Census Abstract – South 24 Parganas.

3. Government of West Bengal. (2020). District Statistical Handbook: South 24 Parganas. Bureau of Applied Economics & Statistics, Kolkata.

4. Ministry of Environment, Forest and Climate Change (MoEFCC). (2019). India State of Forest Report. Forest Survey of India, Dehradun.

5. West Bengal Pollution Control Board (WBPCB). (2018). Water Quality Status Report of Rivers in West Bengal.

6. National Remote Sensing Centre (NRSC). (2019). Land Use/Land Cover Atlas of India.

7. Ehrlich, P. R., & Ehrlich, A. H. (1990). The Population Explosion. Simon & Schuster.

8. Ramachandra, T. V., & Kumar, U. (2004). Geographic resources decision support system for land use, land cover dynamics analysis. Environmental Management, 33(5), 630–650.

9. Singh, S. (2018). Environmental Geography. Prayag Pustak Bhawan, Allahabad.

10. Chandna, R. C. (2016). Population Geography. Kalyani Publishers.

11. Savindra Singh. (2020). Environmental Geography: Physical Environment and Human Impact. Prayag Pustak Bhawan.

12. Ghosh, A., Schmidt, S., Fickert, T., & Nüsser, M. (2015). The Indian Sundarban mangrove forests: history, utilization, conservation strategies and local perception. Diversity, 7(2), 149–169.

13. Hazra, S., Ghosh, T., Dasgupta, R., & Sen, G. (2002). Sea level and associated changes in the Sundarbans. Science and Culture, 68(9–12), 309–321.

14. Mondal, M. S., & Sharma, N. (2013). Impact of climate change on future sea level rise in the Sundarbans delta, India. Theoretical and Applied Climatology, 114, 343–352.

15. Rahman, M. M., et al. (2011). Spatio-temporal changes of land use and land cover in Sundarbans. Environmental Monitoring and Assessment, 176, 291–302.

16. Chakraborty, S. (2019). Urban sprawl and land use change detection using GIS and remote sensing in South 24 Parganas. Journal of Geographic Information System, 11, 328–344.

17. Dasgupta, S., et al. (2019). Mangrove forest dynamics and climate change impact in Indian Sundarbans. Regional Environmental Change, 19, 1287–1301.

18. Lillesand, T., Kiefer, R. W., & Chipman, J. (2015). Remote Sensing and Image Interpretation. Wiley.

19. Jensen, J. R. (2016). Introductory Digital Image Processing: A Remote Sensing Perspective. Pearson.

20. Campbell, J. B., & Wynne, R. H. (2011). Introduction to Remote Sensing. Guilford Press.