

Green Energy and Technology

Juhi Gupta  
Akarsh Verma *Editors*



# Green Equilibrium

Deciphering Earth's Ecosystems  
for Sustainable Tomorrow

 Springer

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Sustainable Tomorrow

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*Editors*

Juhi Gupta  
Amity University  
Noida, Uttar Pradesh, India

Akarsh Verma  
Department of Mechanical Engineering  
University of Petroleum and Energy Studies  
(UPES)  
Dehradun, Uttarakhand, India

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# Invasion of Humans into Ecology: Studying Urban Patterns and Ecological Functions for Resilient Ecosystems



Ambrina Sardar Khan  and Prateek Srivastava 

## 1 Introduction

### 1.1 *Urbanization and Ecological Disruption: A Global Overview*

Urbanization drives major environmental and ecological alterations, with over 56 percent of the total world's population now have moved to urban setups. This tendency of the migration from rural to urban sectors or the increase in urban population is likely to continue, with nearly 70% of the population probable to reside in urban areas by 2050 [48]. This unexpected urban expansion is characterized by the transformation of natural landscapes into densely constructed environments, resulting in significant alterations to the structure and function of ecosystems. Urbanization disrupts ecological systems by altering land use, degrading natural habitats, and introducing novel species and pollutants, causing a reduction in biodiversity, essential ecosystem facilities, and support that sustains our environment [23].

The swift expansion of urban areas is not limited to developed nations but is increasingly prevalent in developing regions, including the Indian subcontinent, where urban growth is outpacing the capacity for sustainable management. For instance, in India, urbanization is accelerating at an annual rate of 2.3%, with cities such as Delhi, Mumbai, and Bangalore experiencing significant ecological pressure [52]. This has led to the fragmentation of land and habitats. The fragmentation, loss of innate species, and increased vulnerability to environmental stressors underscore

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A. S. Khan (✉)

Department of Environmental Sciences, Integral University, Lucknow 226026, Uttar Pradesh, India

e-mail: [ambiikhan@gmail.com](mailto:ambiikhan@gmail.com); [ambrina@iul.ac.in](mailto:ambrina@iul.ac.in)

P. Srivastava

Department of Botany, University of Allahabad, Prayagraj 211002, Uttar Pradesh, India

the need for resilient urban ecosystems that can sustain ecological functions in the face of ongoing urban expansion.

## 1.2 Integrating Humans into Ecology

Urbanization represents a multifaceted socioeconomic process with profound implications for society, the environment, and biodiversity, making metropolises and inner-city areas vital mechanisms for worldwide sustainability. These metropolitan areas have spearheaded essential changes in energy conservation, climate resilience, and community-based innovation. Urban ecology highlights the role of cities as emergent entities shaped by local-scale interactions between socioeconomic and biophysical factors. Earth's ecosystems have been profoundly impacted by human actions, including landscape transformation, resource exploitation, habitat modification, and alterations to water systems, energy pathways, and nutrient cycles. Additionally, human influence has extended to shape evolutionary processes, which are increasingly driven by anthropogenic forces. Figure 1 illustrates the impact of human intervention on urban development patterns, quantifying land-use trends and elucidating their effects on both biophysical and human processes.

**Fig. 1** An integrated model demonstrating urban development patterns, quantifying land patterns, influencing biophysical and human processes, and assessing environmental changes and feedback. (Ref. [2])

