Green Energy and Technology

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Green Equilibrium

Deciphering Earth's Ecosystems for Sustainable Tomorrow

Springer

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ISSN 1865-3529 ISSN 1865-3537 (electronic)
Green Energy and Technology
ISBN 978-981-96-3992-2 ISBN 978-981-96-3993-9 (eBook)
https://doi.org/10.1007/978-981-96-3993-9

This Springer imprint is published by the registered company Springer Nature Singapore Pte Ltd.
The registered company address is: 152 Beach Road, #21-01/04 Gateway East, Singapore 189721, Singapore

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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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J. Gupta and A. Verma (eds.), *Green Equilibrium*, Green Energy and Technology,
https://doi.org/10.1007/978-981-96-3993-9_18

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.

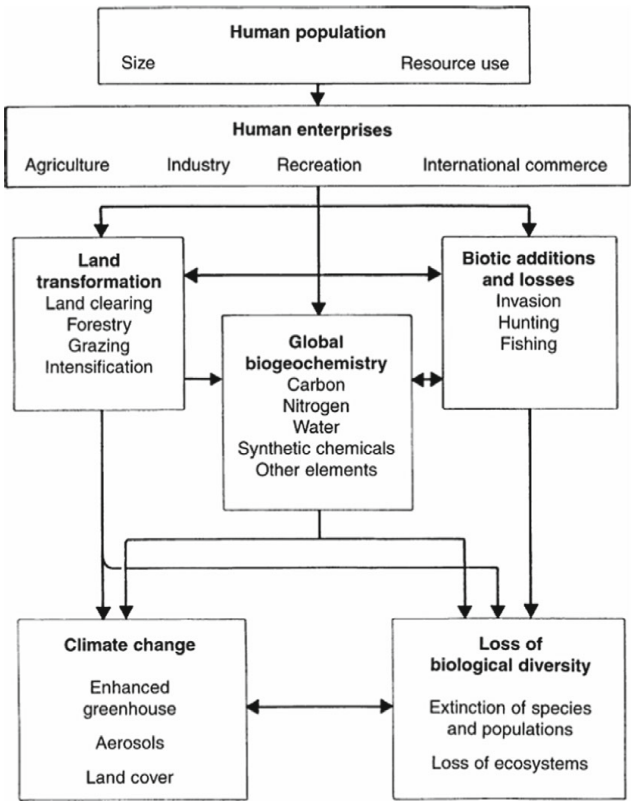

Fig. 1 An integrated model demonstrating urban development patterns, quantifying land patterns, influencing biophysical and human processes, and assessing environmental changes and feedback. (Ref. [2])