Synthetic Ecological Engineering
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Synthetic Ecological Engineering: A New Paradigm for Designing Resilient Ecosystems

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ABSTRACT

This editorial proposes *Synthetic Ecological Engineering* as a frontier sub-discipline within ecological engineering, aimed at constructing artificial ecosystems with resilience, adaptability, and service functions through systemic design, biomimetic technologies, and interdisciplinary integration. From addressing climate change to urban ecological restoration, this journal will drive theoretical innovation and practical applications in the field, building a bridge connecting ecology, engineering, and policy-making.

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1. Introduction:The Need for *Synthetic Ecological Engineering*

The world faces converging crises of ecosystem degradation, biodiversity loss, and climate change. While traditional ecological restoration has achieved significant successes, it struggles to address complex and unpredictable environmental disruptions. In this context, **Synthetic Ecological Engineering** emerges not merely as a technological innovation, but as a paradigm shift in ecological design. By integrating biomimetics, biotechnology, and intelligent systems, it aims to **proactively construct rather than passively restore** ecosystems, endowing them with core capacities for disturbance resistance, self-optimization, and sustainable service provision.

2. Definition and Scope: Beyond Traditional Ecological Engineering

This journal defines Synthetic Ecological Engineering as: The design, construction, and management of artificial or semi-artificial ecosystems, based on ecological principles and engineering methodologies, to achieve synergistic effects between biodiversity conservation, resource cycling, and human well-being. Its core scope includes:

1. Bio-inspired Ecological Design: Mimicking the structure and function of natural systems to develop highly resilient ecological infrastructure (e.g., self-repairing wetlands, artificial forests for carbon sequestration).
2. Ecological Technology Integration: Merging gene editing, microbiome engineering, and materials science to optimize the service efficiency of ecosystems (e.g., pollution-degrading bioinspired nanoparticles, enzymatic degradation of microbial biofilms, stress-resistant plant communities).
3. Intelligent Ecosystems: Enabling real-time monitoring and dynamic regulation of ecological processes through sensor networks and AI decision-making.

Compared to traditional ecological engineering, *Synthetic Ecological Engineering* places greater emphasis on **predictive design** and **system-level innovation**, moving beyond merely adaptive restoration of already degraded environments.

3. Cutting-Edge Applications: From Concept to Practice

3.1. Climate-Adaptive Urban Ecosystems

Case Study: Singapore's "Bishan-Ang Mo Kio Park," which integrates a convertible river channel and constructed wetlands, demonstrates the resilience of a **synthetic system** to extreme weather by combining flood regulation and habitat functions.

Journal Focus: Welcomes research on optimized grey-green infrastructure, ecological corridors for urban heat island mitigation, etc.

3.2. Bio-Augmented Ecological Restoration

Case Study: Utilizing gene-edited microorganisms to degrade soil pollutants or introducing symbiotic fungal networks to enhance plant stress resistance, achieving targeted ecological intervention.

Journal Focus: Encourages submissions involving synthetic biology, functional microbiome modulation, and related empirical studies.

3.3. Digital Ecological Simulation

Trend: Employing digital twin technology to create dynamic models of ecosystems, simulating the long-term impacts of design schemes to reduce practical risks.

4. Challenges and Responsibilities: Balancing Ethics and Sustainability

Synthetic Ecological Engineering is not a panacea, and the following concerns require vigilance:

Ecological Ethics: Artificial interventions may trigger irreversible changes in ecosystems, necessitating guidance by the "precautionary principle."

Social Acceptance: Public trust issues exist regarding genetically modified organisms and AI-managed ecosystems, requiring enhanced transparent communication.

Interdisciplinary Barriers: Knowledge gaps between engineers, ecologists, and policymakers may hinder technology implementation.

5. Journal Mission: Building an Interdisciplinary Innovation Platform

Synthetic Ecological Engineering is committed to:

1. Publishing Original Breakthroughs: Prioritizing comprehensive research integrating experimental data, modeling, and case validation.
2. Promoting Standardization: Collaborating with international organizations to establish design standards and ethical guidelines for Synthetic Ecological Engineering.
3. Facilitating Knowledge Translation: Featuring a "Policy Brief" section to translate cutting-edge findings into actionable policy recommendations.

6.Conclusion: A Design Revolution Towards a Symbiotic Future

Synthetic Ecological Engineering represents a shift in humanity's role from "ecological follower" to "ecological collaborator." We invite global scholars to join this exploration—learning from nature, using engineering as a tool, and guided by the principle of symbiosis—to collaboratively build a resilient, intelligent, and vibrant global ecosystem.

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