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Short Communication

Ecosystem services, landscape restoration and human well-being: Integrating pollination, biodiversity and environmental health

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Ecosystem services, including pollination, biodiversity support, carbon sequestration and water regulation, are fundamental to human well-being. Anthropogenic land-use change, habitat degradation and climate variability have disrupted these services, leading to declines in ecological resilience and human health outcomes. Landscape restoration offers a powerful strategy to recover ecosystem functions and enhance service provision. This article synthesizes current knowledge on the interactions between pollination services, biodiversity conservation and environmental health in restored and modified landscapes. It emphasizes the role of ecological restoration in promoting human well-being, highlights multiscale monitoring approaches and underscores the importance of integrating social-ecological systems into management strategies. By linking ecological functions with societal outcomes, this synthesis provides a framework for sustainable landscape management and informed conservation policies.

Keywords: Ecosystem services, Pollination, Biodiversity, Landscape restoration, Environmental health, Human well-being, Habitat recovery, Sustainability, Social-ecological systems, Landscape management.

Introduction

Ecosystem services—the benefits humans derive from natural ecosystems—are increasingly recognized as essential for human survival and well-being. Services such as pollination, nutrient cycling, climate regulation and water purification underpin agricultural productivity, food security and public health. However, anthropogenic pressures, including deforestation, urbanization, intensive agriculture and pollution, have disrupted these services, leading to biodiversity loss, ecosystem degradation and reduced resilience to environmental stressors. Landscape restoration has emerged as a strategic response to these challenges. Restoration initiatives aim to recover ecological structure, function and connectivity, thereby supporting the return of essential ecosystem services. In particular, restoration has been shown to enhance pollinator diversity, facilitate species recolonization and improve soil and water quality. Such interventions have direct implications for human well-being, linking ecological recovery to nutritional security, disease regulation and psychological health. This explores the nexus of ecosystem services, landscape restoration and human well-being, focusing on the integration of pollination services, biodiversity and environmental health (Guo X, et al. 2023). It highlights how ecological and social factors interact to influence service provision and discusses frameworks for sustainable landscape management. Pollination is a critical regulating and supporting ecosystem service that underpins global food production. Insect pollinators, including bees, butterflies and beetles, facilitate reproduction in approximately 75% of crop species. Land-use change, monocultures and pesticide use have significantly reduced pollinator diversity and abundance. Restoration efforts, such as replanting native flora and creating pollinator corridors, can enhance pollination efficiency, increase crop yields and strengthen ecosystem resilience.

Description

Biodiversity enhances ecosystem service provision through complementary and synergistic interactions among species. Diverse plant and microbial communities regulate nutrient cycling, soil fertility and pest suppression. In restored landscapes, higher species richness supports more stable and resilient ecosystem functions (Zhang W, et al. 2022). For example, actively restored quarries demonstrate faster convergence of pollination and soil services toward natural reference states compared to spontaneously regenerating areas. Healthy ecosystems contribute directly to human health by filtering pollutants, regulating water quality and maintaining air quality. Wetlands, forests and riparian buffers mitigate flood risks and reduce exposure to waterborne pathogens. Green spaces provide opportunities for recreation, reduce stress and enhance mental health. Disruptions to these services through land degradation can exacerbate public health challenges, highlighting the importance of ecosystem management for societal well-being.

Restoration of floral diversity and habitat heterogeneity supports the recovery of pollinator populations. Incorporating native plant species, reducing chemical inputs and establishing ecological corridors can enhance pollination services, contributing to agricultural sustainability and food security (Chen Y, et al. 2022). Reforestation, grassland restoration and microbial inoculation improve soil fertility, carbon storage and nutrient cycling. Restored microbial communities enhance decomposition and organic matter accumulation, promoting long-term soil health and ecosystem productivity. Wetland restoration improves water quality, nutrient retention and flood mitigation. Vegetation type, hydrological management and connectivity are critical factors influencing restoration outcomes. Inundation experiments demonstrate that carefully managed wetlands can simultaneously regulate greenhouse gas emissions and support biodiversity (Adebiyi JA, et al. 2022). Restoration projects are more effective when they consider social dynamics, stakeholder engagement and local knowledge. Participatory planning, education programs and incentives align ecological objectives with human needs, ensuring sustainable and equitable outcomes.

Assessing ecosystem service recovery requires long-term monitoring of biodiversity, microbial function and social outcomes. Advances in remote sensing, environmental DNA and citizen science can help overcome these gaps, providing scalable and cost-effective solutions. Restoration may involve trade-offs, such as prioritizing agricultural yield over biodiversity or water quality. Multi-objective planning and stakeholder engagement are critical to balancing ecological and societal goals. Global environmental change introduces uncertainty in restoration outcomes (Tschoeke H, et al. 2019). Drought, heatwaves and extreme precipitation events can alter ecosystem function and service provision. Incorporating climate-adaptive species and flexible management strategies enhances the resilience of restored landscapes.

Conclusion

Ecosystem services, biodiversity and human well-being are intricately linked. Land-use change has disrupted these relationships, but landscape restoration provides an opportunity to recover ecological function and enhance societal outcomes. Integrating pollination services, biodiversity conservation and environmental health into restoration planning is essential for sustainable landscape management. Adaptive, participatory and multiscale approaches enable the recovery of ecosystem services while supporting human well-being. Future research should continue to explore the connections between ecological function and societal health, providing evidence-based frameworks for conservation and sustainable landscape management. These changes not only degrade ecological integrity but also negatively impact human health and livelihoods. For instance, reductions in pollinator diversity can lower crop yields, while degraded wetlands increase vulnerability to flooding and waterborne diseases.

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Conflict of Interest

The authors declare no conflict of interest.

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