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Ecosystem Resilience as a Determinant of Sustainable Human Well-being: A Socio-Ecological Perspective

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ABSTRACT

Ecosystem resilience is an important foundation for achieving sustainable human well-being. Healthy and resilient ecosystems provide food, clean water, climate regulation, and cultural benefits that strengthen human health, livelihoods, and social stability. However, when ecosystems lose their ability to recover from disturbances, societies face serious risks such as resource scarcity, increasing disasters, declining health, and economic insecurity. This narrative review clearly demonstrates that ecosystem resilience is not merely an environmental concern but also a social and economic necessity. Strengthening resilience requires effective policies, inclusive governance, and active community participation to ensure equitable and long-term access to ecosystem services. The findings indicate that healthy ecosystems and thriving societies reinforce one another. Understanding this deep connection is essential for promoting sustainable development, social equity, and long-term human security in a rapidly changing world.

Introduction

Human well-being is fundamentally intertwined with the health and stability of ecosystems. As the global community confronts unprecedented environmental challenges ranging from climate change and biodiversity loss to land degradation and resource scarcity the concept of ecosystem resilience has emerged as a critical framework for understanding and sustaining the relationship between nature and

society. Ecosystem resilience refers to the capacity of ecological systems to absorb disturbances, reorganize, and continue to provide essential services without collapsing into qualitatively different states. Ecological resilience has been extensively applied across diverse branches of applied ecology, including conservation biology (Curtin & Parker, 2014), restoration ecology (Bradshaw & Chadwick, 1980; Aronson et al., 1993; Suding et al., 2004), rangeland science (Westoby et al., 1989; Laycock, 1991; Briske et al., 2005, 2008), wildfire ecology (Moritz et al., 2011), fisheries management (Pope et al., 2014), and geomorphology (Brunsden & Thornes, 1979; Downs & Gregory, 1993; Phillips, 2009). Within these applied contexts, resilience is often understood as the ability of ecosystems to recover to a preferred state that is, to restore their characteristic structures, processes, functions, and feedbacks following disturbances or management interventions (Chambers et al., 2014; Pope et al., 2014; Trombore et al., 2015; Seidl et al., 2016).

Importantly, resilience is not confined to desirable states alone. Certain degraded or undesirable ecological conditions may also exhibit strong resilience, resisting management efforts aimed at reversing them or transitioning toward more favourable states (Zelmer & Gunderson, 2009). Thus, resilience management involves three complementary strategies: (1) sustaining or enhancing the processes, structures, and feedbacks of intact or desirable ecosystems; (2) deliberately weakening the resilience of undesirable states to facilitate transitions toward more beneficial alternatives; and (3) strengthening the adaptive capacity of ecosystems to withstand novel disturbance regimes and climate change (Pope et al., 2014). This adaptive orientation ensures that ecosystems continue to function under stress, thereby protecting the life-supporting services upon which human societies depend. Extending this framework beyond ecology, resilience-focused educational programs, mental health initiatives, and culturally sensitive social policies particularly for indigenous communities illustrate its practical relevance in safeguarding both ecological and human well-being.

The importance of ecosystem resilience lies in its ability to sustain provisioning, regulating, and cultural services that directly and indirectly promote human well-being. Provisioning services such as food, water, and raw materials form the material foundation of lively hoods, while regulating services including climate moderation, disease control, and disaster risk reduction protect societies from environmental hazards. Equally significant are cultural services, which contribute to psychological health, identity, and social cohesion by fostering connections between people and their natural surroundings. Together, these dimensions highlight the multifaceted ways in which resilient ecosystems underpin human flourishing.

However, the erosion of resilience due to anthropogenic pressures poses serious risks. Ecosystems with diminished resilience are more likely to reach tipping points, leading to irreversible changes such as coral reef collapse, desertification, or species extinction. Such transformations undermine the capacity of ecosystems to support human well-being, resulting in resource scarcity, economic instability, and heightened vulnerability to disasters. In contrast, ecosystems that maintain resilience provide a buffer against shocks, enabling communities to adapt and thrive even under conditions of uncertainty. This paper situates ecosystem resilience as both an ecological and socio-economic imperative. By integrating ecological theory with human-centered perspectives, it seeks to explore the mechanisms through which resilience contributes to sustainable well-being. The discussion emphasizes the need for resilience-oriented policies, conservation strategies, and community planning that recognize the interdependence of ecological integrity and human development. In doing so, the study underscores the urgency of fostering resilience as a pathway toward sustainable futures, where ecosystems continue to support human well-being amidst the challenges of global change.

Conceptual Foundations

The term ecosystem resilience was first popularized by C.S. Holling (1973), who defined it as the capacity of ecosystems to absorb disturbances and reorganize while retaining essential functions and structures. Since then, resilience has been understood not only as resistance to shocks but also as adaptability and transformability. Contemporary research emphasizes that resilience is dynamic, involving thresholds and tipping points beyond which ecosystems may shift into alternative states, often with reduced capacity to support human well-being.

Recent scholarship highlights the complexity of measuring resilience. Yi and Jackson (2021) review various approaches, noting that resilience can be quantified through indicators such as biodiversity levels, functional redundancy, and recovery rates after disturbances. They argue that resilience is best assessed through multi-dimensional frameworks that capture ecological, social, and temporal dynamics.

Socio-Ecological Systems Perspective

Resilience is not purely ecological; it is shaped by social institutions, governance, and cultural practices. Zhang et al. (2025) propose a reconciled framework that integrates resilience and sustainability, highlighting trade-offs between ecological integrity and human development. Herath

(2025) further stresses the importance of embedding resilience into spatial planning to address urbanization challenges, resource depletion, and climate-related hazards.

Quantifying resilience remains complex, but efforts are underway to measure socio-ecological resilience for better resource management. Studies by Frontiers researchers (2025) suggest that dynamic modelling can help identify resilience thresholds and guide adaptive strategies. Jamal et al. (2025) highlight resilience in urban ecosystems, advocating for interdisciplinary approaches that combine ecological science with social innovation.

Fu et al. (2025) argue that resilience and sustainability must be considered together, as resilience provides the buffer that allows societies to adapt to environmental change. Policies that foster diversity, redundancy, and connectivity are critical for maintaining socio-ecological resilience and ensuring long-term human well-being. Ecological perspectives provide deeper insights into resilience. Buergelt and Paton (2014) advance an ecological risk management and capacity-building framework that emphasizes the integration of environmental, social, and cultural dimensions in strengthening resilience. Similarly, Greenfield (2009) associates social change with developmental trajectories, illustrating how cultural and societal structures enable adaptive transformation. Extending these perspectives, recent empirical evidence highlights the tangible benefits of culturally attuned interventions: Heidari et al. (2024) reported resilience gains through a spiritual care program, while Williams and Buergelt (2021) demonstrated the adaptive advantages of collaborative structures in disaster response and recovery.

Ecosystem Resilience and Climate change of human Well-Being

Resilience is increasingly framed as a critical strategy for climate adaptation. Beck et al. (2025) emphasize that enhancing ecosystem resilience in developing countries is essential for mitigating climate risks. Their work illustrates how innovations such as community-based conservation, sustainable agriculture, and ecosystem-based adaptation can strengthen resilience while simultaneously supporting livelihoods.

Governance and Equity Dimensions

Beyond ecological processes, resilience is shaped by governance structures and equity considerations. The Community-Driven Ecosystem Resilience and Equity Framework (C-DERM) proposed by recent studies highlights gaps in existing resilience frameworks, particularly in addressing social justice and community participation. This perspective underscores that resilience is not only

ecological but also socio-political, requiring inclusive governance to ensure equitable distribution of ecosystem benefits.

The literature demonstrates that ecosystem resilience is multi-faceted:

- **Ecological dimension:** biodiversity, redundancy, recovery capacity.
- **Socio-economic dimension:** livelihoods, disaster risk reduction, climate adaptation.
- **Governance dimension:** equity, participation, and policy integration.

Together, these perspectives affirm that ecosystem resilience is indispensable for sustaining human well-being in the face of global environmental change.

Human Well-Being: Human well-being is broadly understood as the state of being healthy, happy, and prosperous. It encompasses both **subjective experiences** (how individuals feel about their lives) and **objective conditions** (measurable factors such as health, income, and security). Scholars often describe well-being as the ultimate goal of human life, reflecting quality of life and overall flourishing.

Integrative Perspective

- **Subjective well-being**: How individuals evaluate their own lives (happiness, satisfaction).
- **Objective well-being**: External conditions such as health, income, and security.
- **Community well-being**: Collective functioning and thriving of groups or societies.

Together, these dimensions highlight that well-being is not static but dynamic, shaped by personal choices, social structures, and ecological contexts.

Ecosystem Resilience and Human Well-Being

1. Empirical Evidence

Empirical studies across diverse ecological contexts demonstrate the interdependence of resilience and well-being:

- **Provisioning services:** Resilient agricultural systems enhance food security, while forest resilience supports water regulation and raw material supply.

- **Regulating services:** Wetlands and mangroves buffer communities against floods and storms; biodiversity maintains disease regulation. Loss of resilience in these systems correlates with increased disaster vulnerability and health risks.

- **Cultural services:** Access to resilient landscapes contributes to psychological health, identity, and social cohesion. Research shows that communities with intact ecosystems report higher levels of life satisfaction and reduced stress.

Case studies from coral reef systems, forest ecosystems, and agro-ecological landscapes illustrate that when resilience is eroded, tipping points occur leading to collapse in fisheries, desertification, or biodiversity loss. These transformations directly undermine human well-being by creating resource scarcity, economic instability, and heightened vulnerability.

Dimensions of Well-Being

- **Physical well-being:** Health, nutrition, and vitality.

- **Psychological well-being:** Happiness, resilience, and mental health.

- **Social well-being:** Relationships, community belonging, and social support.

- **Economic well-being:** Income stability, employment, and access to resources.

- **Cultural and spiritual well-being:** Identity, meaning, and values.

- **Environmental well-being:** Quality of surroundings, access to nature, and ecological security.

These dimensions are mutually reinforcing; for instance, environmental quality directly influences physical health, while social cohesion enhances psychological resilience.

Human well-being is a multidimensional construct encompassing both subjective experiences and objective conditions. Early frameworks emphasized material prosperity and physical health, but contemporary scholarship integrates psychological, social, cultural, and environmental dimensions. Diener et al. (1984) introduced the concept of subjective well-being, focusing on life satisfaction and emotional balance, while Sen (1999) capability approach highlighted the importance of freedoms and opportunities in shaping well-being. Together, these perspectives underscore that well-being is not merely the absence of illness or poverty but a holistic state of flourishing. Costanza et al. (2007) argue that ecological integrity is foundational to long-term human well-being, as ecosystems provide essential

services such as clean air, water, and food. The Millennium Ecosystem Assessment (2005) similarly emphasized that human well-being depends on ecosystem services, highlighting the risks posed by environmental degradation.

The literature demonstrates that human well-being is:

Multidimensional: spanning physical, psychological, social, economic, cultural, and environmental domains.

Dynamic: influenced by personal choices, social structures, and ecological contexts.

Interdependent with ecosystems: ecological resilience directly supports human flourishing.

This synthesis provides a foundation for exploring how ecosystem resilience promotes human well-being, situating ecological stability as a prerequisite for sustainable development.

Provisioning and Material Well-Being

Resilient ecosystems ensure the continuity of provisioning services such as food, water, and raw materials. Studies demonstrate that communities embedded in resilient agricultural and forest systems experience greater food security and reduced vulnerability to resource scarcity. Conversely, ecosystems with diminished resilience often face tipping points such as desertification or fisheries collapse that directly undermine material well-being.

Resilience also supports regulating services that protect human health and safety. Wetlands and mangroves buffer against floods, forests regulate climate through carbon sequestration, and biodiversity helps control disease vectors. Research shows that loss of resilience in these systems increases disaster risks and health burdens, thereby eroding human well-being.

Cultural and Psychological Dimensions

Beyond material benefits, resilient ecosystems contribute to cultural identity, spiritual enrichment, and psychological health. Access to green spaces and intact landscapes has been linked to reduced stress, enhanced social cohesion, and greater life satisfaction. Scholars argue that resilience in cultural landscapes sustains traditions and community values, reinforcing social well-being.

Conclusion

Ecosystem resilience emerges as a vital foundation for sustainable human well-being. Healthy and resilient ecosystems secure food, clean water, climate regulation, and cultural benefits that strengthen human health, livelihoods, and social stability. When ecosystems lose their capacity to recover from disturbances, societies face grave risks resource scarcity, escalating disasters, declining health, and economic insecurity. This review underscores that ecosystem resilience is not merely an environmental concern but a social and economic necessity. Strengthening resilience requires effective policies, inclusive governance, and active community participation to ensure equitable and long-term access to ecosystem services. The findings reveal that healthy ecosystems and thriving societies reinforce one another, forming a reciprocal relationship that sustains both ecological integrity and human prosperity.

Understanding this deep connection is essential for advancing sustainable development, promoting social equity, and safeguarding long-term human security in a rapidly changing world. The conclusion thus affirms that investing in ecosystem resilience is investing in the future of humanity itself.

Discussion:

This review highlights that ecosystem resilience is central to sustaining human well-being. Resilient ecosystems secure food, water, climate regulation, and cultural identity, while their degradation leads to social instability and economic insecurity. The findings align with broader scholarship emphasizing that ecological integrity and social equity are inseparable. Strengthening resilience requires adaptive governance, inclusive participation, and integration of traditional knowledge with modern science. Although this review is narrative in scope, it underscores the urgent need for measurable indicators and long-term monitoring. Ultimately, ecosystem resilience emerges as a cornerstone of sustainable development and human security.

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