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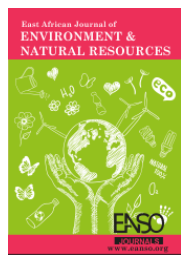
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Original Article

Diversity at Landscape Level to Increase Resilience. A Review

Benson Turyasingura^{1*}, Prof. Majaliwa Mwanjalolo, PhD² & Natal Ayiga¹

¹ Kabale University, P. O. Box 317, Kabale, Uganda.

² Makerere University, P. O. Box 7062, Kampala, Uganda.

*Correspondence email: bturyasingura@kab.ac.ug.

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Date Published: ABSTRACT

23 Jun 2022 Tree species increases the number of ecological niches and associated species such as understory plants and animals hence, increased landscape ecosystem diversity.

Keywords: Rapid environmental and economic changes are posing serious dangers to ecosystems and economic systems around the world. This has resulted in the extinction of species, droughts, and price fluctuations in agricultural products. The aim of this review is to document landscape diversity and ecosystem resilience as a tool for natural resources management. The species from one ecosystem's functional group may temporarily support a functional group in another ecosystem, significant variety can help to maintain ecological stability. Hence, building on these insights, diversity at landscape level is paramount to promoting resilient livelihoods as a means of improving the health and functioning of socio-ecological systems, as well as a mechanism for achieving food security. The study concludes that there should be involving many actors in a landscape management aspect to stimulate knowledge exchange and training.

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INTRODUCTION

Rapid environmental and economic changes are posing serious dangers to ecosystems and economic systems around the world. This has resulted in the extinction of species, droughts, and price fluctuations in agricultural products (Schippers et al., 2015). Over time, various scholars have defined landscape in ways that are specific to their field of study. According to (Scherr et al., 2013), landscape is defined as a socio-ecological system made up of a mosaic of natural and/or human-modified ecological systems with a distinctive topography, vegetation, land use, and settlements that is influenced by the area's ecological, historical, economic, and cultural processes and activities.

Agricultural fields, woodlots, catchment areas, riparian corridors, woodland, forests, rivers, lakes, and settlements are all examples of landscape components (Seddon et al., 2018). These landscape components are used by a variety of stakeholders (foresters, community, non-governmental organizations, civil society, business enterprise, fishers, to name a few) (Stanišić et al., 2021). It simply displays a geographic area with spatially heterogeneous interests (Oldfather et al., 2020).

Landscape variety is significant in a particular ecosystem because production is dependent on ecosystem functioning, which is defined by interactions among biological communities of both wild and domesticated species, as well as biophysical processes like water regulation and nutrient cycling (Liu et al., 2018). Hence, ecosystem function assures the supply of

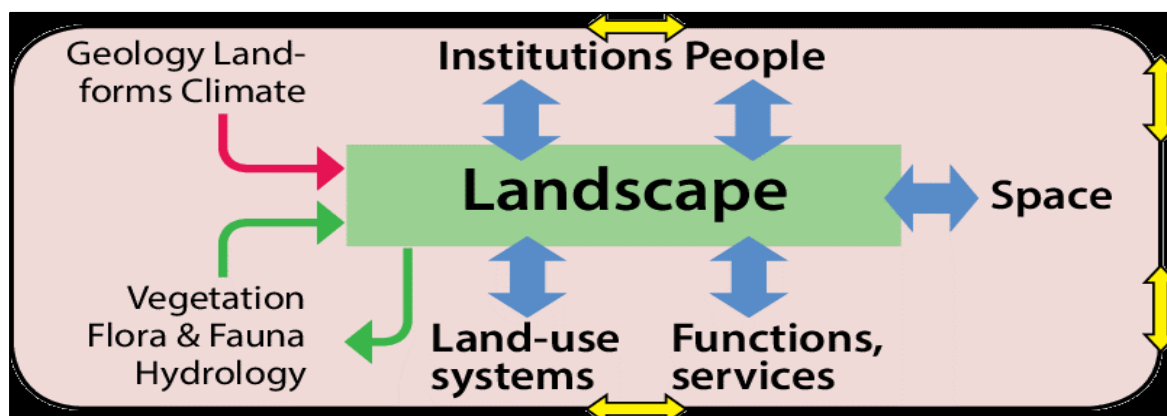
ecosystem services in an environment (Du Toit et al., 2018).

Resilience is defined as a system's ability to cope with a potentially dangerous occurrence, trend, or disruption by responding in ways that preserve the system's basic function, identity, and structure while also allowing for adaptation, learning, and transformation (Sinclair et al., 2019). Landscape approaches at the community or national level can play an important role in building resilience if national systems are designed as comprehensive programs that exploit the synergies between various instruments in order to cover the specific needs of various groups, particularly the most vulnerable, and to be easily scaled up to address any kind of shock (Briassoulis, 2019).

THE CONCEPT OF DIVERSITY

The degree of variation of living organisms present in a given ecosystem is referred to as diversity (Powell & Rillig, 2018). In a biological sense, diversity refers to the diversity of life forms found in various environments (Rolls et al., 2018). Biodiversity's scope encompasses (but is not limited to) genetic diversity, ecological diversity, species diversity, phylogenetic diversity, crop diversity, and functional diversity (Sayol et al., 2021).

The landscape of interest depends on the management goals. It may be a national park and its surrounding areas when one's objective is to conserve large mammals, while it may be a watershed when the objective is to provide clean water to urban residents (Jenkins et al., 2021).

Figure 1: Interaction between human actions, ecosystems, and the abiotic factors at landscape level

Source: (Farida et al., 2013).

The Concept of Resilience

Elmqvist et al. (2019) and Shammin et al. (2022, p. 19) proposed that resilience is based on the adaptive and transformative capacities of subsystems across time and scales, rather than just recovery from disruptions. Tanner et al. (2015, p. 3) defined livelihood resilience as people's ability to maintain and improve their livelihood prospects and well-being despite environmental, economic, social, and political disruptions across generations.

Human agency and empowerment, individual and community action, and human rights, all of which are embedded in dynamic social change processes, enable such resilience. Jordan (2015), for example, looked at case studies of specific communities in Bangladesh's southwest coastal region and discovered a complex relationship between social capital and climatic resilience, and thus a gap to be filled by this study.

Natural and social systems share the trait of resilience. However, in recent decades, the phrase has come to include not only ecological systems, but also social, economic, and infrastructure systems. The linkages and dynamism between four landscape aspects and scales: agro ecosystems, ecosystems, livelihoods, and institutions are highlighted in a resilience framework (Martin et al., 2019). Management strategies within each component of the landscape system aim to reduce vulnerabilities and promote

adaptive capacities while promoting fairness and equity in accessing the resources generated through the production and maintenance of agricultural, livelihood, ecological, and institutional diversity (Simensen et al., 2018).

Furthermore, livelihood resilience necessitates the advancement of women's and children's social and economic status (Po & Hickey, 2018), such that women receive an equitable share of the benefits of economic activity (including access to productive resources) and children are provided with educational opportunities, including the dissemination of local knowledge about cultural and agricultural traditions and practices (Nigussie et al., 2021).

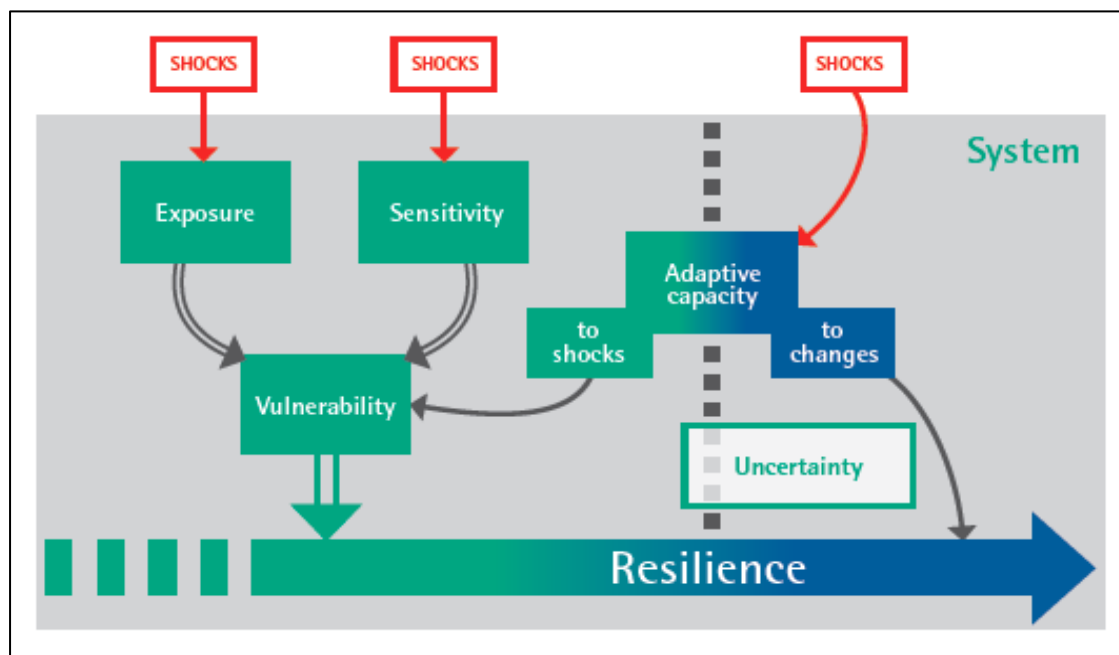
Nowadays, the term "resilience" is most often used to describe interconnected networks of ecosystems, institutions, agents, and species, or "social-ecological systems" (Caniglia & Mayer, 2021). As a result, socio-ecological resilience focuses on various and interconnected scales as well as adaptive processes that enable systems to not only endure but also recover from shocks, hence strengthening their capacity to cope with and manage future shocks (Carr, 2019). The link between social and ecological systems is particularly obvious in the context of rural livelihoods (Knickel et al., 2018). As stated by Friedman et al. (2020), households and communities meet their material requirements through directly or indirectly engaging with

ecosystems, impacting natural processes and, as a result, social interactions.

In a dynamic perspective, resilience emphasizes a system's ability to recover and transform itself

over time, as well as adapt to its changing environment. It indicates that not just shocks as a change relative to an average, but also the change in the average itself, must be considered (Scherr et al., 2013, p. 28)

Figure 2: The concept of resilience



Source: (Gitz & Meybeck, 2012).

Landscape Diversity and Ecosystem Resilience

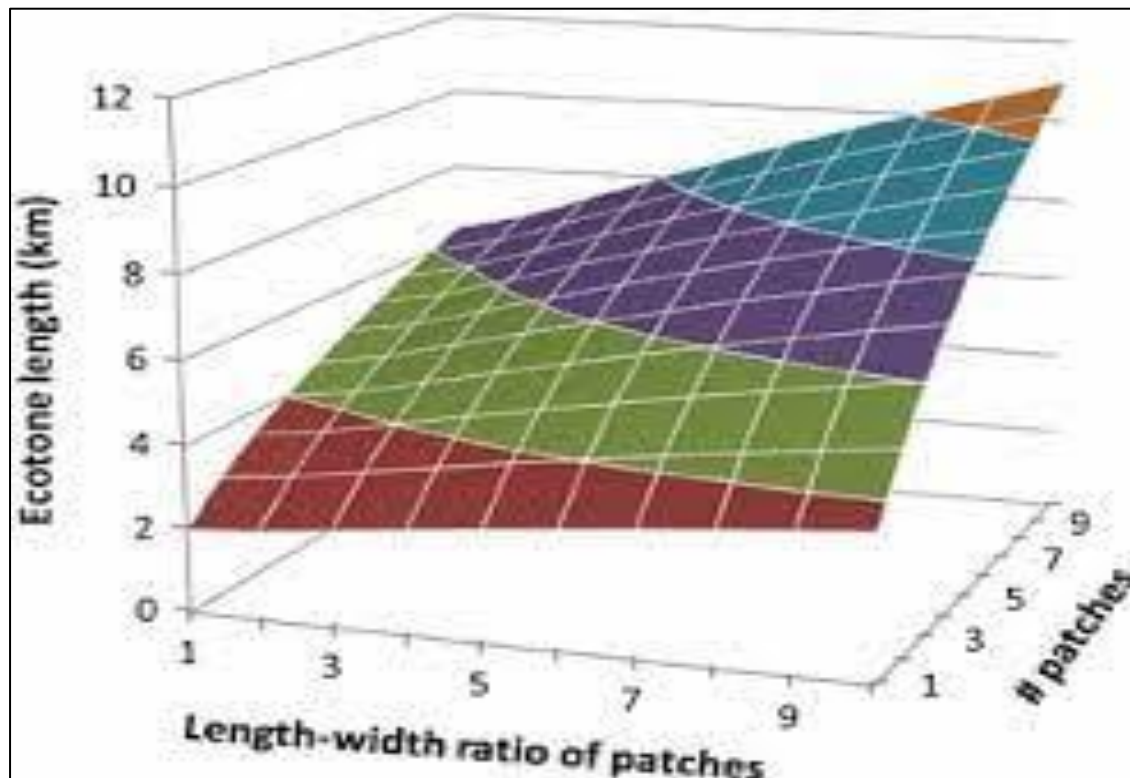
A higher number of tree species increases the number of ecological niches and has also been shown to increase the number of associated species such as understory plants and animals hence, increased landscape ecosystem diversity in a given area (Cadman et al., 2010). Hence, to increase ecosystem resilience, there should be planting many tree species not only to preserves more trees but also organisms (Larjavaara, 2008).

Landscape diversity could have a big impact on ecological and economic resilience. A fine-grained landscape with several tiny and diverse ecological components is referred to as a diversified landscape (Schmidt, 2022). Hence, a

diverse landscape contains more ecosystem types per unit area, resulting in more species diversity. The species from one ecosystem's functional group may temporarily support a functional group in another ecosystem, significant variety can help to maintain ecological stability (Siebert & Dreber, 2019).

Furthermore, in a diverse and small-scale environment, the cumulative edge length between ecosystem members is greater. Ecotones, or environmental condition gradients, are represented by edges, allowing for a lot of variety (Ghazinoory et al., 2021). Ecotones may increase the resilience of an ecosystem by enabling more species to live there, increasing both functional and response variability (Liu et al., 2021).

Figure 3: Ecotone



Source: (Schippers et al., 2015, p. 196).

Another benefit of a diversified terrain is that it allows animal species that require distinct habitats to live to thrive (Wang et al., 2021). Many amphibians, for example, rely on water for reproduction, but they also require terrestrial environments for feeding and hibernation (Bókony et al., 2018).

As a result, a diverse landscape with a variety of ecosystem elements is more resilient to ecosystem stability than a large-scale landscape that is homogeneous and uniform (Zymaroieva et al., 2021). The ecosystem elements, on the other hand, should be of a particular minimum size to allow for long-term ecosystem functioning. Therefore, building on these insights, diversity at landscape level is paramount to promoting resilient livelihoods as a means of improving the health and functioning of socio-ecological systems, as well as a mechanism for achieving food security.

CONCLUSION AND FUTURE PROSPECTUS

Rapid environmental and economic changes pose substantial dangers to ecosystems and economic systems in today's globe. Diversity is crucial for resilience because it lowers the risk of production losses due to climatic stresses and increases local people's access to a wider range of food, feed, and employment options, which is especially significant during times of extreme weather.

As a result of these perspectives, landscape variety is important for supporting resilient livelihoods as a means of improving the health and functioning of socio-ecological systems, as well as a mechanism for ensuring food security. Ideally, governance systems based on the concepts of the landscape approach enable the 'co-design' of a landscape in a collaborative process involving public, corporate, and civil society actors, allowing for ongoing learning and adaptation.

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