RALA-00147; No of Pages 7

Application of Vulnerability Assessment to a Grazed Rangeland: Toward an Integrated Conceptual Framework

By Valiollah Raufirad, Richard Hunter, Bryan A. Endress, and Setareh Bagheri

On the Ground

- Rangeland vulnerability assessments have the potential to function as conceptual tools for policymakers and rangeland users to ensure the sustainable management of vulnerable rangelands.
- This contribution reviews the different approaches to conceptualizing vulnerability assessments in order to introduce an initial framework for how to construct rangeland vulnerability assessments.
- We present a conceptual framework for designing a rangeland vulnerability assessment that captures a suite of both socioeconomic and biophysical variables.
- This framework also facilitates the incorporation of the local knowledge of rangeland experts and users for further refinement of a rangeland vulnerability assessment applied in a specific locale.

Keywords: vulnerability, sustainability, integrated approaches, biophysical indicators, socioeconomic indicators, Me-Bar and Valdez technique.

Rangelands xx(x):1–8
doi 10.1016/j.rala.2017.12.002

Rangelands account for around 75% of the world's land surface and many are experiencing severe degradation caused by overgrazing.[1–3] This problem is especially acute among rangelands located in arid and semi-arid zones where the effects of climate change and growing human populations are putting rangelands under increasing grazing pressure. Practical advancements in our ability to assess rangeland vulnerability are required to achieve sustainable rangeland management. Vulnerability assessments can reveal the extent to which an ecosystem is susceptible to degradation or a change of state because of perturbations in biophysical or socioeconomic variables. Assessing vulnerability is critical because an ecosystem's vulnerability level will suggest which activities are sustainable in relation to the interactions between the various structures and processes that give rise to the vulnerability.[4–6]

Vulnerability assessments can adopt a socioeconomic or a biophysical approach or an approach that integrates variables from both of those arenas. With the exception of a few studies,[7–10] the effects of both socioeconomic and biophysical variables on rangeland vulnerability have received relatively little attention. As a result, we lack a critical understanding of how rangeland vulnerability assessments can reveal the multifaceted complexities and consequences of land use in these ecosystems. This understanding is necessary to achieve the goals of policymakers, land managers, and rangeland users to achieve sustainable rangeland management.

In the remainder of this paper, we explore what is commonly meant by "vulnerability" and related terms. We then review previous work that underpins our current understanding of vulnerability assessments. Following that, we analyze the approaches and methods of vulnerability assessments to identify those most suitable for incorporation into a rangeland vulnerability assessment. Identification of the socioeconomic and biophysical indicators of vulnerability then allows us to construct a conceptual framework that quantifies rangeland vulnerability. This framework is structured around three essential dimensions of vulnerability (sensitivity, exposure, and adaptive capacity) in relation to three dimensions of sustainability (social, economic, and environmental). We conclude with a prospectus on research into rangeland vulnerability assessment.

Vulnerability and its Dimensions

The concept of vulnerability has appeared in a variety of research contexts to refer to the extent to which a system is likely to be harmed by potential stressors (e.g., biophysical

and/or socioeconomic changes).[11–14] The term vulnerability also addresses the sensitivity and exposure of an ecosystem to external stresses and its ability to adjust, resist, or cope with these stresses.[11,13,15] Exposure refers to the nature and degree to which a rangeland/rangeland user experiences biophysical and socioeconomic stressors. Sensitivity refers to the characteristics of rangelands that make it susceptible to the impacts of biophysical and socioeconomic stresses and their multiscale interactions.[14] Adaptive capacity refers to the capability of an ecosystem to overcome socioeconomic and biophysical stressors (Fig. 1).[15]

Designing a Rangeland Vulnerability Assessment

Vulnerability assessments that model the effects of global-scale biophysical and socioeconomic changes have limited ability to precisely measure exposure in specific ecosystem types at lower scales.[16] Even national-level gains/losses resulting from global changes may not be extrapolated easily or accurately to local areas within the same nation. Moreover, the exposure of particular economic actors, such as rangeland users within a rangeland ecosystem, cannot be described by vulnerability assessment models designed for global scales.[12] The Sustainable Livelihood Framework, developed by the Department for International Development (United Kingdom), describes useful analytical tools for evaluating vulnerability at local levels (Fig. 2).[17]

Although vulnerability is a highly complicated phenomenon that is difficult to measure, scholars have nonetheless been successful in developing methods to conduct vulnerability assessments.[13] One of the most common methods is to quantify vulnerability by running estimated values of predefined indicators through a mathematical formula.[18] Because an indicator method is relatively straightforward to understand and can be readily implemented by different stakeholders, especially in the area of natural ecosystems, this is an appropriate method upon which to base a framework for a rangeland vulnerability assessment. A critical step in creating such a rangeland vulnerability assessment is identifying the salient indicators of vulnerability for a particular ecosystem.

Socioeconomic Rangeland Vulnerability Indicators

Socioeconomic drivers are derived from variables such as level of education, sex, and variety types of capital (human, financial, social, physical, and natural).[13,19] Similar to the sustainable livelihood framework is the framework, developed by the DFID (2001), to classify the five capital groups.[17] This is a "pentagon asset" showing the different types of assets and the importance of their interrelationships (Fig. 3).

Human capital (e.g., education, age, labor) influences the integration of the rangeland users' production system into the market economy and its competition with other means of livestock production.[13,18,20] Social capital (e.g., social status, social unity, beliefs and values, the formal policies of institutions, and the informal practices of social networks) affects access to and use of rangelands, which bears directly on rangeland vulnerability.[5,6] Natural capital (i.e., rangelands and farmlands) has a special impact on developing specific livelihood-coping strategies for drought and other climatic hazards.[21,22] Access to physical capital (e.g., the basic infrastructure and services such as sanitation, electricity,

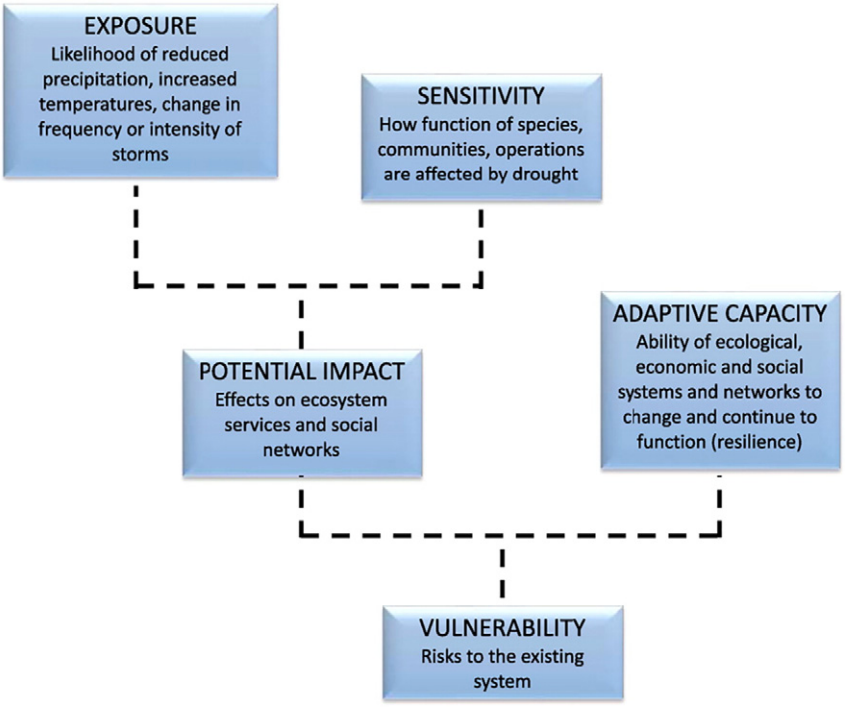

Figure 1. A vulnerability assessment framework for rangeland vulnerability.[15]