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A View from the Top: Vulnerability in Mountain Systems

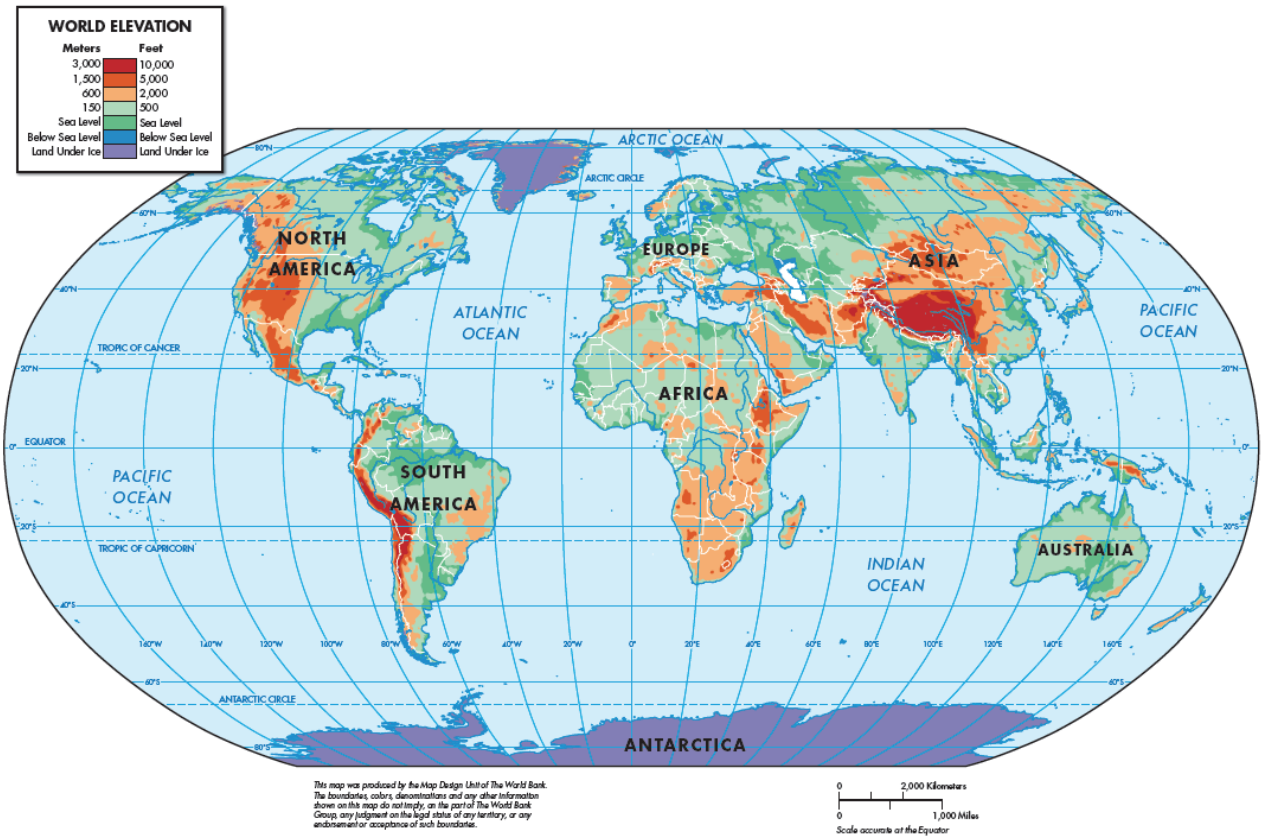
It is well recognized that mountain ecosystems and their inhabitants are among the most vulnerable to climate change. Measuring the nature and scope of these vulnerabilities remains, however, a work-in-progress. This note develops an analytical framework that builds upon two existing approaches: The IPCC climate change vulnerability concept and its components of exposure, sensitivity, and adaptive capacity; and the mountain specificities framework, which offers a set of vulnerability criteria that are particularly prevalent in mountain settings. The framework also provides a number of sample indicators which form the basis for scalable vulnerability assessments to inform adaptation policies and measures.

Mountains and Climate Change

Mountains are home to almost 17% of the world's population, most of which are poor and marginalized: 80% live below the poverty line and an estimated 270 million are food insecure with about half of those being chronically hungry. These vulnerabilities are likely to be exacerbated by the impacts of climate change.

Various projections show that mountains are experiencing disproportionate warming. For instance, in the Tibetan Plateau the average temperature increase per decade over the last 50 years was in the range of 0.2 to 0.6 degrees

Figure 1: World Elevation Map



centigrade. Similar figures exist for the Andes and other high mountain environments.

Climate change and environmental degradation in the mountains have started showing some profound impacts. Mountain communities are experiencing unusual climatic phenomena, such as longer and relatively warmer winters, abrupt and untimely rainfall, and unusual snowfall accumulation. Such changes in long-term patterns can have profound livelihood repercussions: For instance, malaria is now being reported in the highlands of Asia, Central Africa, and Latin America. Not all impacts are negative: Recent research shows that due to rising temperatures and a longer summer season parts of the Himalayan rangelands have become more productive.

The changes will not only stress the adaptive capacities of mountain inhabitants but will also challenge lowland communities who depend on the mountains' ecosystem services such as freshwater for their livelihoods. In order to capture, assess and monitor the complex and overlapping vulnerabilities, different assessment approaches have been developed and applied at different scales.

Vulnerability Assessment Approaches

While multiple vulnerability assessment frameworks exist, this note seeks to integrate two of them in order to develop more effective climate change adaptation strategies: 1) the IPCC Vulnerability Framework, and 2) the Mountain Specificities framework developed by N. S. Jodha (1992).

IPCC Framework on Vulnerability

The IPCC framework has emerged as a key foundation for discussions about climate change vulnerability within the international community. It builds on both risk hazard approaches, which examine the impacts of a single event, often a disaster, and livelihoods approaches, which situate vulnerability in the broader social fabric (Ribot, 2009).

The IPCC defines vulnerability as a function of the character, magnitude, and rate of climate variation to which a system is exposed, its sensitivity, and its adaptive capacity. Within this definition: *exposure* is defined as "the nature and degree to which a system is exposed to significant climatic variations;" *sensitivity* is defined as "the degree to which a system is affected, either adversely or beneficially, by climate-related *stimuli;*" and *adaptive capacity* is defined as "the ability of a system to adjust to climate change (including climate variability and extremes), to moderate potential damages, to take advantage of opportunities, or to cope with the consequences."

While the IPCC framework provides a comprehensive point of departure for vulnerability assessments it lacks the necessary level of detail and specificity to make it a useful operational tool.

Mountain Specificities

The concept of "mountain specificities" is tailored to capture the particular challenges of mountain ecosystems (Jodha 1992). These specificities are classified as either constraining features, such as *accessibility*, *marginality,* and *fragility*; or enabling features, such as *diversity*, *niche*, and *human adaptive capacity*. The boundaries between these categories are often fluid: For example, while physical isolation often represents a major handicap it can also trigger adaptive approaches through diversification or filling an economic niche.

Within the mountain specificities framework the term *accessibility* captures elements of distance, mobility, and availability of risk management options. *Marginality* refers to the relative "endowments" of a system. In a mountain system marginality is often very evident and is created by slope/altitude, low resource productivity and reinforced by lack of social and political capital. Mountain communities are often faced with difficulties in securing tenancy rights over land and forests and gaining access to social services (e.g. credit, education, and health), partly because of the problem of the tough terrain and partly due to their inadequate representation in policy-making bodies.

Fragility can best be understood as the diminished capacity of a social or ecological system to buffer shocks. Ecologically, mountains

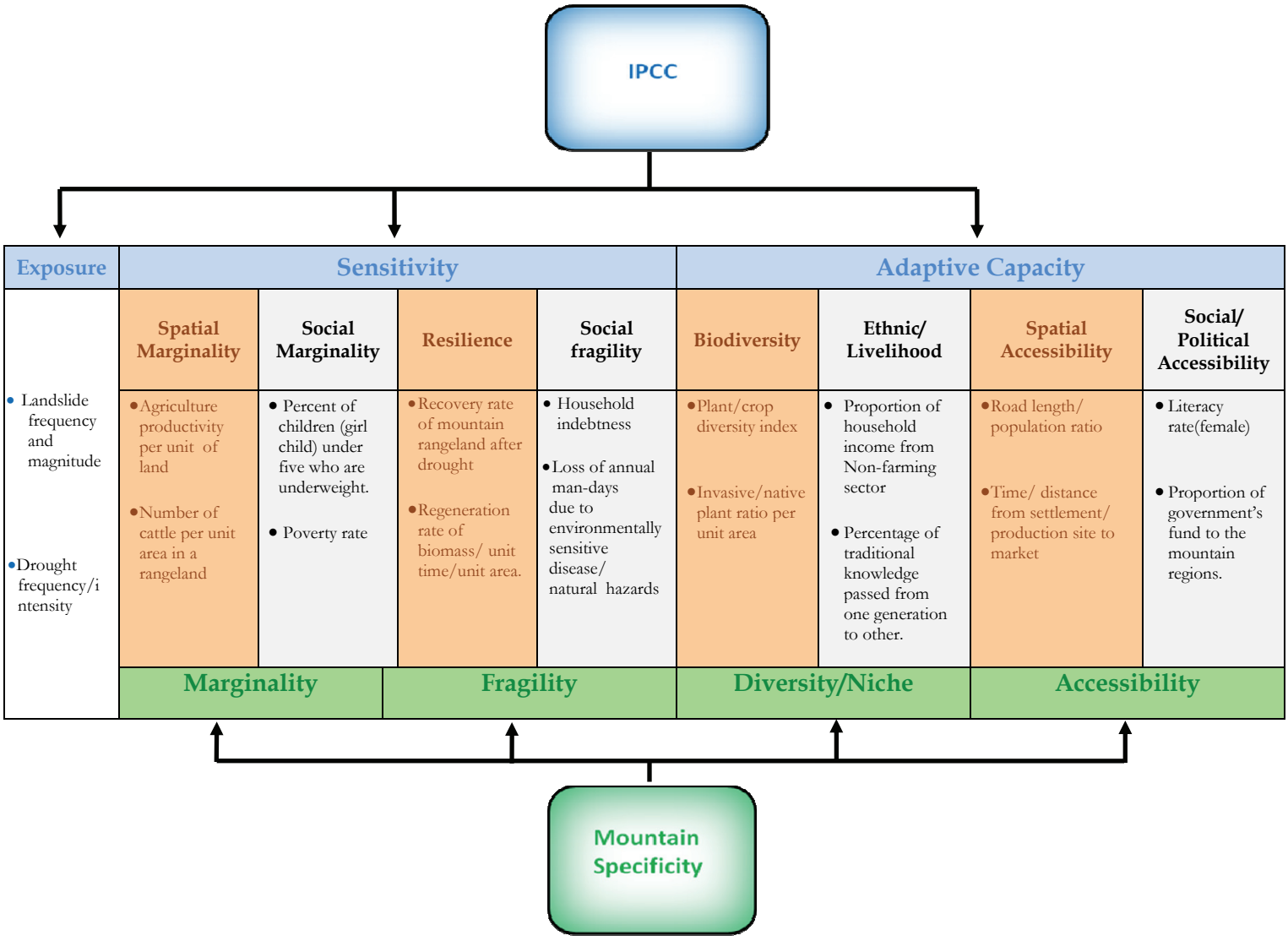
are fragile due to low carrying capacity, slope and relief. Fragility has social dimensions as well, because people live precariously on scattered, scarce and periodically unavailable livelihood resources.

Diversity, niche and adaptive capacity capture different coping abilities and strategies that emerge from natural resource management patterns, livelihood endowments, and cultural practices.

Mountain Vulnerability Framework

Both the IPCC and mountain specificities frameworks have intrinsic strengths and weaknesses, and we propose to combine and expand on them in order to have a tool that can be utilized in the various vulnerability assessments the World Bank and others are currently engaged in. The table (figure 2) gives a schematic overview of the combined framework. In addition, the table expands on this synthesis by introducing biophysical and socioeconomic components as well as a set of sample indicators that can be used.

Figure2: Mountain Vulnerability Framework:



Conclusion

The Mountain Vulnerability Framework merges and aligns the IPCC and mountain specificities frameworks, thereby integrating global criteria for describing vulnerability with more contextual parameters for mountain ecosystems. It highlights the importance of both biophysical and socioeconomic factors in assessing vulnerability, and offers sample indicators that can be modified or expanded depending on the specific focus of the assessment. In addition, the framework is scalable both in terms of time and space and can thus be employed for different assessment purposes, from project to country level. Hence, this framework would allow for the development of more tailored adaptation strategies that take into account the impact of climate change and socio-economic determinants. Furthermore, the framework can serve as an essential tool in not only ameliorating and reducing the impact of climate change on mountain communities but also to help these communities achieve comparative advantages and build social equity.

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