Understanding Social Vulnerability in Multi-Hazard Contexts

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Extreme events do not always strike alone. Hazards may overlap in space or occur in succession, and their combined effects can be represented through aggregate multi-hazard representations, temporal approaches that trace cumulative changes across successive events, or combinations of the two. These conditions can affect communities still recovering from earlier events. In this context, social vulnerability refers to the social, economic, demographic, and institutional conditions that shape how communities anticipate, respond to, recover from, and adapt to hazards. It provides a lens for interpreting how communities may experience the same multi-hazard setting differently. Its mapping is therefore sensitive to the choice of vulnerability indicators, spatial scale, and temporal representation.

Vulnerability indicators may be unevenly distributed across space, reflecting spatial heterogeneity. In addition, relationships between social vulnerability indicators and hazard exposure may differ from one location to another, reflecting spatial non-stationarity. Mapping approaches also vary in how they select and combine indicators, define spatial units, choose map resolution, and represent conditions at a single point in time or across successive events and disaster phases. A map produced at one spatial scale and point in time may show a different pattern of social vulnerability from one that captures local heterogeneity or follows change over time. These differences influence how social vulnerability is represented and how the resulting maps are interpreted.

Previous research has examined social vulnerability in different hazard contexts, including repeated events, multi-hazard exposure, and different phases of the disaster cycle. However, studies use different conceptualizations of multi-hazard conditions and make different choices about indicators, spatial scale, temporal representation, and the relationships modeled among variables. Some approaches summarize multiple hazards and vulnerability indicators as aggregate spatial patterns, whereas others examine changes associated with successive events. These approaches can provide complementary perspectives, but their differences may make direct comparison difficult. Differences between maps may reflect changing conditions, different geographic contexts, or the methodological choices used to construct and interpret the map.

This paper reviews methods used to model and map social vulnerability under multi-hazard conditions through four linked dimensions: the representation of spatial heterogeneity in vulnerability indicators; the treatment of spatial non-stationarity in relationships among

vulnerability indicators and between those indicators and hazard exposure; sensitivity to the spatial scale and resolution of analysis; and the representation of temporal change within and between disaster events. This paper considers what different approaches make visible, what they may not capture, and how their assumptions shape the resulting representations of social vulnerability.

This paper aims to provide a structured framework to understand mapping of social vulnerability in multi-hazard contexts. By making spatial, temporal, and methodological assumptions more explicit, it supports social vulnerability mapping and analysis and clarifies how mapping choices may influence which communities appear more or less socially vulnerable across places and disaster phases.