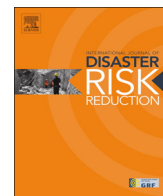




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Top-down assessment of disaster resilience: A conceptual framework using coping and adaptive capacities



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ABSTRACT

Assessment of disaster resilience using an index is often a key element of natural hazard management and planning. Many assessments have been undertaken worldwide. Emerging from these are a set of seven common properties that should be considered in the design of any disaster resilience assessment: assessment purpose, top-down or bottom-up assessment, assessment scale, conceptual framework, structural design, indicator selection, data analysis and index computation and reporting and interpretation. We introduce the design of an Australian Natural Disaster Resilience Index (ANDRI) according to the common properties of resilience assessment. The ANDRI takes a top-down approach using indicators derived from secondary data with national coverage. The ANDRI is a hierarchical design based on coping and adaptive capacities representing the potential for disaster resilience. Coping capacity is the means by which people or organizations use available resources, skills and opportunities to face adverse consequences that could lead to a disaster. Adaptive capacity is the arrangements and processes that enable adjustment through learning, adaptation and transformation. Coping capacity is divided into themes of social character, economic capital, infrastructure and planning, emergency services, community capital and information and engagement. Adaptive capacity is divided into themes of governance, policy and leadership and social and community engagement. Indicators are collected to determine the status of each theme. As assessments of disaster resilience develop worldwide, reporting of their design as standard practice will track knowledge generation in the field and enhance the relationship between applied disaster resilience assessment and foundational principles of disaster resilience.

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1. Introduction

Academic discourse on disaster resilience is diverse and active, arising partly from disciplinary treatments of resilience concepts. Viewed from a natural science perspective, resilience is a theory for understanding the non-equilibrium dynamics of coupled social-ecological systems, emphasising the adaptability and transformability of social actors in relation to system dynamics, of which natural hazards are a part [39]. In the social sciences, resilience arises from dynamic social, economic, behavioural and protective factors that influence the ability to cope with or prevent stressors, such as natural disasters, that disrupt fundamental expectations of normality [1,48,49,71,80]. Intersecting epistemological debates

have subsequently arisen about disaster resilience in relation to themes of vulnerability, risk, governance, sustainability and adaptation (e.g. [4,20,36,71,78]). Such debates are not unexpected given the multi-disciplinary mix of normative and positive interpretations of resilience [67] and the complexity inherent in the post-normal problem of managing natural hazards involving multiple values, multiple stakeholders, incomplete knowledge and high stakes [37,55].

Despite this contested academic discourse, resilience is increasingly the foundation of public policies and programmes in natural hazard and disaster management (e.g. [21,51]). The resilience perspective on natural hazard and disaster management is here to stay [54] but there is little consensus about how to operationalize resilience in practice [4,23]. The practice of disaster resilience is entering what will be a multi-decadal phase of reflective advancement. Applied research is beginning to examine the relationships between disaster resilience and elements of hazard

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and disaster management such as preparedness, social capital, mitigation and risk perception. However, the policy community tends to be ahead of the research community in the practice and application of resilience concepts [28] because public-policy and programme development often occur on shorter time-scales than research. Some congruence with resilience theory must be maintained as the practice and application of disaster resilience advances, to ensure that foundational principles of resilience are not diluted or, conversely, for practice-based disaster resilience evidence to challenge foundational principles.

Assessment of disaster resilience using an index and component indicators is often a key element of natural hazard management and planning. An index can summarize the state of disaster resilience, thereby providing a tool to identify priorities for improvement and monitor changes in resilience to natural hazards through space and time [51]. However, there is not one standard method to construct a disaster resilience index. An index can be top-down or bottom-up in approach, qualitative or quantitative, use secondary data or collect field-based data, and be measured at a local or national resolution [52]. The construction of an index also requires consideration of options related to the conceptual framework, analysis scale, component indicators and index computation [69]. Given the increasing use of indexes to assess disaster resilience [23], the design of an index should be documented to outline how the assessment relates to foundational principles of resilience (e.g. [26,54]). In this paper we introduce the design of an index to assess the resilience of communities to natural hazards at a large scale across Australia: the Australian Natural Disaster Resilience Index. We start with a brief review of prominent approaches to the assessment of disaster resilience being used worldwide. We then detail the properties that have emerged as being important to the design of a disaster resilience assessment. In the final section we outline the design of the Australian Natural Disaster Resilience Index and show how it aligns with the properties of disaster resilience assessment. The index advances current assessments by including indicators expressing the capacity for learning, adaptation and transformation.

Two clarifications of terminology are required. First, we use the term disaster resilience to mean resilience to natural hazards. We recognise that natural hazard events do not always turn into natural disasters, particularly in communities with high resilience. However, the term disaster resilience is understood by the public in a general sense, and is used worldwide. Second, the focus of the Australian Natural Disaster Resilience Index is resilience, defined as the capacity of communities to prepare for, absorb and recover from natural hazard events, and the capacities of communities to learn, adapt and transform towards resilience. Resilience and vulnerability are related, but not opposite, terms [24]. The vulnerability approach to managing natural hazards arose from observations of the susceptibility and vulnerability of developing countries to natural hazards [56]. The resilience approach to managing natural hazards has emerged more recently and contends that people have agency to prepare, adapt and transform given the presence of social cohesion, community involvement and trust [74]. However, resilience and vulnerability assessment have developed alongside one another and have similar considerations for assessment design.

2. Assessment of disaster resilience – a brief survey of the landscape

Several decades of conceptual and practical development underpin the index-based assessment of disaster resilience [10]. Scores of assessment approaches have been developed worldwide. Cutter [23] identified 27 disaster resilience assessment approaches

and evaluated how they differed in focus, spatial orientation, methodology (top down or bottom up) and domain area (characteristics to capacities). The evaluation concluded that there was no dominant approach across these parameters. Beccari [10] identified 106 composite indices for assessing disaster risk, vulnerability or resilience and documented component variables, index construction methods and geographic coverage. The evaluation showed great variation among indices but concluded that more attention needs to be paid to sensitivity and uncertainty analysis, and to ensuring that assessments are high quality and relevant to decision makers. In this section we briefly describe seven prominent disaster resilience, risk or vulnerability assessment approaches. It was not our intent to include the entire population of assessment approaches (readers are referred to Beccari [10], Cutter [23] and Winderl [77] for comprehensive reviews). Rather, we selected well-developed assessment approaches that inform national-scale government programmes or policy because of the similar role our assessment of disaster resilience may play in informing disaster resilience programmes and activities in Australia.

2.1. Index of social vulnerability

Based on a general consensus in the social science literature about the factors that influence social vulnerability, Cutter et al. [25] developed the Social Vulnerability Index (SoVI) to assess vulnerability to environmental hazards in US counties. A set of 42 variables were extracted from US Census data and reduced to explanatory factors representing wealth, age, economic dependence, housing, race, ethnicity and infrastructure characteristics [25]. Factors were added to produce an overall SoVI score and arrayed spatially to show the vulnerability of all US counties relative to each other [25] and through time [27]. The SoVI has also been used as part of integrated multihazard mapping [68].

Further research by Susan Cutter and her colleagues shifted the focus of assessment from vulnerability to resilience. The Disaster Resilience of Place model [26] describes disaster resilience as the place-specific associations between antecedent conditions in social, built and natural environments and the capacity of the community to absorb hazard or disaster impacts using coping responses [26]. The antecedent conditions for disaster resilience were assessed using indicators of social resilience, economic resilience, institutional resilience, infrastructure resilience and community capital, derived from archival data [28]. Indicators were combined to produce an overall community resilience score and arrayed spatially to show the vulnerability of Florida counties relative to each other [28].

Also in Florida, Burton [17] assessed disaster resilience using indicators of social resilience, economic resilience, institutional resilience, infrastructure resilience, community capital and environmental resilience. This work builds on Cutter et al. [28] by including environmental resilience, but also by using a different composition of indicators. Burton [17] validated indicators against Hurricane Katrina recovery data before deriving a comparative index of disaster resilience in the gulf coast counties. The validation of indicators showed that some variables were more strongly associated with actual recovery than others and thus were better proxies of resilience.

2.2. The resilience scorecard approach

The resilience scorecard approach is a toolkit for communities to assess their disaster resilience. Disaster resilience is assessed using a set of questions related to community connectedness, available resources, planning and procedures and risk and vulnerability [6]. The questions are arrayed as a scorecard and

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