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Review Article

Operationalizing a concept: The systematic review of composite indicator building for measuring community disaster resilience

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ABSTRACT

The measurement of community disaster resilience through the development of a comprehensive set of composite indicators is becoming increasingly commonplace. Despite this growing trend, there is neither an agreement upon a standard procedure nor a comprehensive assessment of existing measurement frameworks in the relevant literature. To tackle these challenges, this study (1) proposes an overarching eight-step procedure for composite indicator building and (2) develops a meta-level assessment framework to allow for a systematic review of existing disaster resilience measurement frameworks in application of composite indicator building. This meta-level framework was established on the basis of the proposed eight-step composite indicator building procedure and qualified with the introduction of 19 dimensions and 36 metrics for quality assessment. In order to select relevant disaster resilience measures for this analysis, the study applied a systematic survey to collect measures based on four inclusion criteria: community-based, multifaceted, quantitative, and operationalized. Accordingly, 17 resilience measurement frameworks were chosen for further analysis in this review. The results of the quality assessment demonstrated that, from the theoretical perspective, resilience assessments originate from either the socio-ecological or engineering fields and can be classified into two main types of resilience indices and tools. This differs from results of the methodological perspective, which indicate that resilience measures can be characterized as deductive or similar to hierarchical and inductive assessments.

1. Introduction

The concept of community disaster resilience is becoming increasingly important within discourse on environmental changes and is frequently applied in response to multiple disasters at the community level and is used to promote proactive actions as well as the enhancement of inherent capacities instead of reactive responses [1,2]. While the term resilience has received attention from different academic fields [3,4], there is still considerable disagreement on resilience as a term in general and, in particular, agreeing upon standard mechanism for operationalizing it as a concept. Although the development of composite indicators of resilience - also called composite indices – has been employed by hazard scholars for operationalization and measurement of resilience [5–10], there is neither widely agreed standard procedure nor a comprehensive assessment of different measurement frameworks in the literature.

To address these knowledge gaps, this paper aims to (1) introduce a comprehensive standard procedure for developing composite indicators in order to operationalize the multifaceted nature of community disaster resilience, and (2) produce a quality assessment of current resilience measurement frameworks in application of composite indicator building (CIB) through the development of a meta-level framework. Achievement of the former objective can serve as a reliable guide for scholars to operationalize the concept of disaster resilience, as well as provide a basis for developing the meta-level framework for quality assessment of the measurement frameworks documented in this study. Achieving the latter objective can support practitioners, planners, scholars, and other users to optimize the selection of appropriate frameworks for their empirical studies, and can therefore underpin the achievement of their goals in understanding the contributing factors to build and enhance community resilience.

This paper is structured as follows: In continuation of the introduction, the background of disaster resilience measurement is discussed. The subsequent Section (2) details the methodology of the study, and is where an overarching procedure for CIB toward measuring disaster resilience as well as a strategy for selecting measurement frameworks are discussed and presented. In Section 3, the meta-level framework is developed and its quality dimensions and respective

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metrics are defined and formulated based on the introduced CIB procedure. In Section 4, the quality of selected measurement frameworks in measuring community disaster resilience are analyzed and assessed based on the developed meta-level framework, and the results of the quality assessment are depicted and illustrated. Section 5 concludes the paper.

1.1. Resilience: background and evolution

While it is often argued that the term resilience was first formulized in the field of ecology by Holling [11], it has been used since the 16th century [12]. However, after more than four decades of valuable scientific work on the topic of resilience, the debate on its various conceptual frameworks and theories since first theorization and progress in ecology and socio-ecological systems [11,13–15] until subsequent developments in other disciplines such as sustainability [16–19], mitigation and adaptation [20–22], and more recently, disaster risk reduction [8,23–25], is controversially ongoing. Resilience is now considered to be a hot topic in international academic and policy circles [4,26,27], and carries similar influence within environmental changes to the weight carried by term 'sustainability' in environmental planning during 1980s and 1990s.

Resilience, specially the concept of community resilience, encompasses the way in which communities face the increasing complexity and growing changes in global dynamics in order to better perceive, manage, and govern complex socio-ecological systems, while also increasing their inherent capacity to cope with, adapt to, and shape change [9,28,29]. Over the decade 2005–2015, the concept has been enriched by scholars from various fields, including engineers [8,30], socio-economists [31,32], geographers [25,33] and most recently, urban and regional planners [34–36]. Community resilience is best defined as a concept that "enhances the ability of a community to prepare and plan for, absorb, recover from, and more successfully adapt to actual or potential adverse events in a timely and efficient manner" [29]. Although the theory behind community resilience is still challenging and the term is constantly evolving [37], there is a consensus among hazard scholars that the first step toward community disaster resilience should be focused on understanding how it can be measured and operationalized [2,38].

1.2. Community disaster resilience measurement: necessity and challenges

Although increased attention is being paid to the measurement of community disaster resilience, these endeavors are in their infancy and there remains little empirically-based research on community disaster resilience measurement [39]. Resilience is an abstract concept and it is difficult to quantify the concept in absolute terms [29,40,41]. Hence, understanding the characteristics that contribute to resilience is a major milestone toward enhancing resilience and predisposes decision-makers, stakeholders, and other end-users to prioritize those actions that are needed to build and sustain resilience [5,9,25,34]. Conceptual frameworks of disaster resilience are abundant and include a number of approaches that have been developed to operationalize resilience of communities, regions, and systems. These range from those that consider resilience as a set of engineering functionality [8,23,42], community capitals [5,43], community capacity index [33], or place-based [7,9,29] measurements (see Table 2). Despite these endeavors, debate on characteristics that contribute to resilience and transition from merely theoretical frameworks to empirical assessments of community resilience is ongoing [29,41].

While constructing composite indicators has often been employed to operationalize the concept of community disaster resilience in existing literature, finding a standard procedure for developing composite indicators is challenging. This is partially because there are significant discrepancies in the conceptual orientations of different measurement approaches that view resilience as a process-oriented phenomenon (dynamic concept) or a result-oriented (static premise) concept. These theoretical perspectives on resilience impact the decision of what should be measured, using what indicators (resilience of what), for what purpose or why (as a dynamic concept or astatic premise), when (long-term process and capacity building or short-term persistence and result), and resilience for whom (resilience of individuals, specific groups, or communities). Another challenge is that each framework applies different procedure for CIB including data transformation [44,45], multivariate assessment for categorization and factor retention [46,47], weighting [7,48], aggregation [49], visualization [5], and validation [9,29]. As a result, there is no universal procedure for operationalizing the concept of community disaster resilience. Furthermore, there is currently no quality assessment of composite indicators which has been cited as sufficiently comprehensive by multiple scholars within the literature. In efforts relevant to the area of disaster resilience, quality assessments have mainly been limited to broad review of resilience measurement frameworks (see Irajifar et al. [40], and Winderl [50]) as opposed to operationalizing the concept of disaster resilience through the procedure of CIB and defining metrics based on said procedure, and then assessing the existing resilience measurement frameworks respectively. For instance, Sharifi [4] assessed 36 general resilience frameworks based on six criteria, including dimension range, cross-scale relationships, temporal dynamism, uncertainties, type of methodology, and operationalization. He concluded that environmental dimension has been neglected in most of the reviewed frameworks and there exists no comprehensive model that covers all these criteria together. Cutter [2] also evaluated 27 disaster resilience tools/indices with regard to four metrics, namely focus of theory, spatial orientation, type of methodology, and domain area. She concluded that there is no dominant framework across these attributes because the factors that contribute to resilience are place specific and multi-scalar, and appear within or between natural, social, and built-environmental systems. In other words, different spatial characteristics of the term resilience necessitate multiple, contextually-specific place-based models.

Therefore, this study deals with an ongoing challenge in the measurement of community disaster resilience. It compiles and introduces a synthesized procedure for CIB to serve both as a guideline in operationalizing community disaster resilience and as a basis for developing a meta-level framework for quality assessment of existing measurement frameworks. The review aimed to understand the quality of current resilience measures that can be used to identify weaknesses and limitations of current disaster resilience measures and to improve them where needed, in order to meet the risk preparation and planning needs of stakeholders, decision makers, and urban planners.

Table 1
Top list publishers with their respective databases/libraries.

Publisher	Number of journals	Respective scientific journals databases / libraries
Elsevier	2571	Science Direct
Springer-Verlag	2209	Springer Link
Taylor and Francis	1803	Taylor & Francis Online
John Wiley and Sons	1604	Wiely Online Library

2. Survey methodology

From methodological perspective, the study first intends to explore the existing literature on CIB in order to compile an overarching procedure for CIB toward disaster resilience measurement. It then (Section 2) provides a list of selected measurement frameworks through a systematic survey. Next, (Section 3), based on the proposed procedure, a meta-level framework (including its quality dimensions and metrics) is developed in order to conduct a systematic review of selected disaster resilience measures. Finally, the developed meta-level framework is