International Journal of Disaster Risk Reduction 24 (2017) 119–128

Contents lists available at ScienceDirect

International Journal of Disaster Risk Reduction

journal homepage: www.elsevier.com/locate/ijdrr

Prioritization of flood vulnerability, coping capacity and exposure indicators through the Delphi technique: A case study in Taquari-Antas basin, Brazil

Mariana Madruga de Brito*, Mariele Evers, Britta Höllermann

Department of Geography, University of Bonn, Meckenheimer Allee 166, 53115 Bonn, Germany

ARTICLE INFO

Keywords:
Flood vulnerability
Delphi method
Participation
Consensus building
Indicators

ABSTRACT

This paper presents the outcomes of a participatory study that aimed to reach agreement among experts about flood vulnerability, coping capacity and exposure indicators through a Delphi survey. The objective was to collaboratively develop an index for the Taquari-Antas basin, Brazil, using the available data. A total of 117 scientists, policy makers, and practitioners were invited to prioritize 26 indicators, focusing on the pre-disaster phase. This survey was followed by a final selection in a focus group. The sensitivity of the ratings was analyzed by bootstrapping the original sample. The response rate was 86.32% and 79.20% in the first and second round, respectively. Overall, the highest rated items were related to coping capacity aspects of vulnerability and human and infrastructure exposure. The answers' deviation was reduced between rounds, thereby enabling the achievement of consensus on 21 indicators. The results revealed similarities in how vulnerability and exposure are perceived across the different professions and sectors investigated. The Delphi process allowed the collaboration of professionals with opposing views to prioritize a common set of indicators in a systematic and transparent way. Hence, this study is timely in describing a feasible alternative to reach agreement among stakeholders to build flood-related indexes. From a practical standpoint, this research provides decision makers with a core list of indicators to better understand the impacts of floods in the basin. We expect that incorporating input from end users in the creation of the index will enable it to reflect the local context and gain legitimacy.

1. Introduction

According to the Sendai Framework for disaster risk reduction the design and implementation of risk management strategies should be based on a holistic understanding of risk in all its dimensions, including vulnerability, coping capacity, exposure of persons and assets, hazard characteristics, and the environment [1]. While the understanding of hazard and exposure has significantly improved over the last decades, the analysis of vulnerability remains one of the biggest hindrances in flood risk assessment [2,3].

Part of this complexity arises from the fact that there is no consensus on the definition of vulnerability or on what should be included in its assessment. According to UNISDR [4], vulnerability is the physical, social, economic and environmental aspects, which make the exposed elements susceptible to the impacts of a hazard. A leading component of vulnerability is the coping capacity, which refers to the ability of people, organizations, and systems, using available skills and resources, to face and manage adverse conditions, emergencies or disasters.

Vulnerability reduction is critical to risk mitigation since hazards only become disasters if they impact a society that is vulnerable to their effects [5]. In other words, risk is only present if there is a vulnerable community or system. Therefore, a proper understanding of vulnerability is crucial to promote disaster-resilient societies, leading to more effective mitigation and preparedness strategies. For this reason, there is a need to consider not only the physical aspects of vulnerability, but to integrate all vulnerability dimensions (e.g. physical, social, economic, etc.) in an overarching framework by using indicators [6]. Indicator-based methods are flexible, transparent and easy to use and understand by decision makers [7]. Nevertheless, a major limitation is that it is difficult to choose the variables that contribute to vulnerability since their exclusion or inclusion can significantly influence the results [8,9]. Hence, the main challenge is to select a set of indicators which is, on the one hand, minimal and applicable, and on the other hand, explains the phenomenon as clearly as possible in a specific area [10].

Numerous flood vulnerability, coping capacity and exposure indicators can be found in the literature [e.g. 11–14]. Yet, a meta-analysis of 67 flood vulnerability studies conducted by Rufat et al. [15] found out that the selection of input variables is usually based on choices made in previous studies, disregarding the local conditions that influence the vulnerability. In several cases, no justification is provided at all.

* Corresponding author.
E-mail address: mariana.brito@uni-bonn.de (M.M. de Brito).

http://dx.doi.org/10.1016/j.ijdrr.2017.05.027
Received 24 January 2017; Received in revised form 30 May 2017; Accepted 31 May 2017
2212-4209/ © 2017 Elsevier Ltd. All rights reserved.

In addition to this issue, a review by Brito and Evers [16] highlights that insufficient attention has been given to the participation of multiple stakeholders in the construction of flood vulnerability indexes. Crucial aspects, such as the structuration of the index into sub-indices and selection of the indicators were usually constrained to researchers conducting the study. However, there is considerable agreement that the collaboration of researchers with non-academic stakeholders may yield better results in terms of results' acceptance. If practitioners are involved in creating an index that they find accurate and useful, it is more likely they will incorporate the index findings in local policy decisions [17].

Even when multiple stakeholders are involved, most studies have not tried to achieve consensus [16]. Nevertheless, consensus building is essential to derive meaningful outcomes that can be accepted by the majority, legitimizing participation as a learning process to solve complex problems. Therefore, using participatory and transdisciplinary methods in which stakeholders work together to prioritize vulnerability indicators and try to achieve consensus could foster such actions while assuring local context.

In light of these issues, this study aims to achieve agreement among expert stakeholders about a set of indicators to assess flood vulnerability, coping capacity and exposure in data-scarce areas, focusing on the pre-disaster phase. In addition, the study aims to investigate whether or not participants with different backgrounds and levels of knowledge rely on divergent rationalities. For this purpose, the participatory Delphi technique was applied given that it is a widely accepted approach for achieving convergence of opinion on complex problems in a systematic and transparent way. The applicability of this method is demonstrated in Taquari-Antas River Basin, Brazil, where limited information about the resistance of the elements at risk is available.

2. Vulnerability within the framework of disaster risk

Flood risk and its associated components have been studied from a variety of perspectives by researchers with different scientific backgrounds, leading to conflicting views and interpretations on how to assess it. In this study, we consider risk as the product of hazard, exposure, and vulnerability (Fig. 1). According to UNISDR [4], hazard is the probability of occurrence of a dangerous phenomenon (e.g., flood, drought, etc.) while exposure consists of the presence of people, property, and assets in hazardous areas.

Within this framework, vulnerability is one of the most ambiguous concepts, being used differently. Due to this plurality of meanings, there is no unique understanding of the definition of this term or of what should be included in its assessment. A common definition of vulnerability, introduced by UNDRO [18], is the degree of loss of a given element, resulting from the occurrence of a natural hazard and expressed on a scale from 0 (no damage) to 1 (total loss). Here

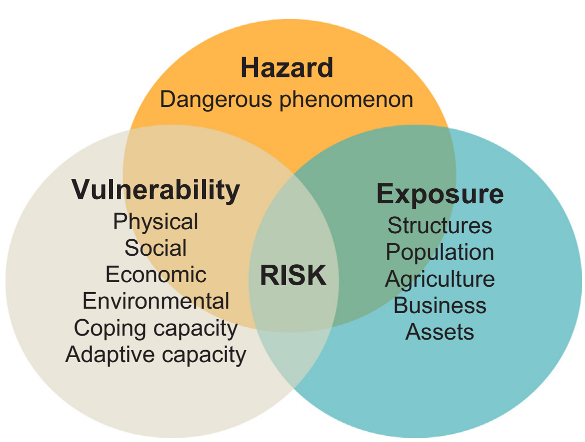

Fig. 1. Conceptual framework for disaster risk assessment [adapted from 21].

vulnerability is mostly related to the likelihood of buildings collapsing and infrastructure being damaged due to hazardous events. Nevertheless, several researchers [e.g. 6,19,20] argue that vulnerability should not be reduced to its physical component, but it should consider the social, political, economic and environmental susceptibility of the exposed elements to damages.

In this sense, it is important to emphasize that some communities, social groups, and ecological systems may cope better with the impact of disasters due to its inherent characteristics (e.g. age, disability, resilience, risk perception). This underlines the fact that vulnerability can also take into account the coping capacity of the potentially affected society [6]. Hence, in this paper, we will use a more integrative definition of vulnerability, which considers it as the physical, social, economic, environmental, coping and adaptive conditions and circumstances of a community, system or asset that make it susceptible to the damaging effects of a hazard [4].

3. Method

3.1. Study area

Given that vulnerability is site-specific [22], the Taquari-Antas River Basin was chosen to demonstrate the applicability of the Delphi technique to prioritize indicators. The basin is located in southern Brazil, within the coordinates 28º10'S, 49º55'W and 29º56'S, 52º38'W (Fig. 2), with an area of 26,470 km^2. The main river flows from a high basaltic plateau (ca. 800 to 1200 m) through deeply incised valleys until the lowlands, formed by alluvial deposits, with elevations ranging between 20 and 100 m [23]. The basin is characterized by torrential regimes of rapid runoff, which cause frequent floods in the lowlands. Due to its high susceptibility, 6 municipalities located within the basin are considered by the Brazilian Federal Government as a priority for disaster risk reduction [24].

Despite the significance of flood events in this area, limited information about hazard impacts and the resistance of the elements at risk is available. In some cases, the existing data are difficult to access as the information is not coordinated or some agencies are reluctant to release them. This restricts the applicability of quantitative approaches to measuring the vulnerability such as damage matrices and curves [19]. Hence, an alternative is to use indicator-based methods, which are flexible and feasible to apply in developing countries.

3.2. List of potential indicators

A list of potential indicators was created based on a recent systematic review conducted by Brito and Evers [16]. This was further supplemented with the outcomes of a meta-analysis of 67 flood vulnerability studies made by Rufat et al. [15] and a literature review of 106 vulnerability composite indicators by Beccari [25]. According to these studies, the most commonly used indicators are related with demographic and socioeconomic aspects of vulnerability, including variables such as the population density, elderly and children, gender, unemployment rate and GDP per capita. Due to data availability limitations and to allow comparisons over time and space, only indicators that could be obtained from the Brazilian National Census and other governmental agencies were considered. Based on this, 26 indicators encompassing demographic, socioeconomic, environmental and structural aspects were preselected and included in the Delphi questionnaire.

3.3. Identification of relevant experts

In this study, an expert is anyone with extensive and in-depth knowledge of flood vulnerability, acquired through practice or education [26]. In order to identify nationwide qualified experts, the snowball sampling technique was applied. During this process, initially sampled experts indicated other specialists, which in turn lead to other

Download English Version:

https://daneshyari.com/en/article/5116020

Download Persian Version:

https://daneshyari.com/article/5116020

Daneshyari.com