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Exploring the plexus of context and consequences: An empirical test of a theory of disaster vulnerability

Michel Dückers [a,*], Georg Frerks [b,c,d], Jörn Birkmann [e]

[a] Impact - National Knowledge and Advice Centre for Psychosocial Care Concerning Critical Incidents, Partner in Arq Psychotrauma Expert Group, 1112 XE Diemen, The Netherlands
[b] Conflict Prevention and Conflict Management, Centre for Conflict Studies, Utrecht University, 3512 BS, Utrecht, The Netherlands
[c] International Security Studies, Faculty of Military Sciences, Netherlands Defense Academy, 3509 AA, Utrecht, The Netherlands
[d] Disaster Studies, Sociology of Development and Change, Social Sciences Group, Wageningen University, 6706 KN, Wageningen, The Netherlands
[e] Institute for Environment and Human Security, United Nations University, 53113 Bonn, Germany

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ABSTRACT

What determines the disaster vulnerability of countries? In this study a theoretical model was tested, linking disaster vulnerability to physical hazards and cultural and historical factors. Associations between the World Vulnerability Index and Hofstede's cultural dimensions scores were explored using quantitative methods, while taking exposure to natural hazards into account. Data of 60 countries could be matched. Less exposed countries in this sample are significantly less vulnerable. Culturally, particularly countries with a lower power balance and a higher level of individualism are less vulnerable as well; two features linked to higher levels of wealth. Approximately 70% of the variance in vulnerability could be explained in this way. These results should, however, be interpreted with some caution as longitudinal data were unavailable and disaster vulnerability itself may be seen as a cultural derivate, making it impossible to clarify causal mechanisms. Despite these and other limitations, the study points at interesting associations that, firstly, should be expanded and replicated in larger samples, allowing more advanced analysis, and secondly, encourage a more thorough examination of different local contexts and cross-level interactions than was possible in this exploratory endeavor.

1. Introduction

1.1. Increase in disaster vulnerability

Examining disasters through the lens of vulnerability confers real insights at the time when both the frequency and magnitude of such events are increasing. The total number of reported natural and technological disasters rose from 368 in 1992 to an average of about 650 per year for the period 2004–2013 [1]. Likewise, the growth in the number of natural disasters over the last decade was over 50% compared to the previous decade. The number of affected people by disasters rose to an average of 200 million people per year for the years 2004–2013, mostly in Africa and Asia and the damage averaged about US$ 167 billion annually. The average number of deaths per year is more or less stabilising at 106,000 for the period 2004–2013 [1]. There are of course huge variations: in 2012 the number of casualties was 15,585, much lower than the peaks of over 250,000 in 2004 (the year of the tsunami in the Indian Ocean) and over 300,000 in 2010 (the earthquake in Haiti). Fluctuations are interesting; more important however, is that the increase shown in the number and overall impact of natural and anthropogenic disasters is expected to continue as it is associated with the increased complexity and interdependency of societies [2], leading to cascading effects and mega-disasters [3]. Moreover, urbanization, environmental degradation, climate change, mismanagement of natural resources, conflicts and state failure, and 'bad' governance are considered worldwide drivers for increased disaster vulnerability [4].

1.2. Understanding vulnerability

Disaster vulnerability has many different connotations, depending on the research orientation and perspective [5]. It is common to define vulnerability as the "characteristics and circumstances of a community, system or asset that make it susceptible to the damaging effects of a hazard." [6]. Vulnerability is usually a socially constructed potential for harm, expressed on a scale from no damage to total loss. Since losses vary geographically, over time, and among different social groups,

* Corresponding author.
E-mail address: m.duckers@impact.arq.org (M. Dückers).

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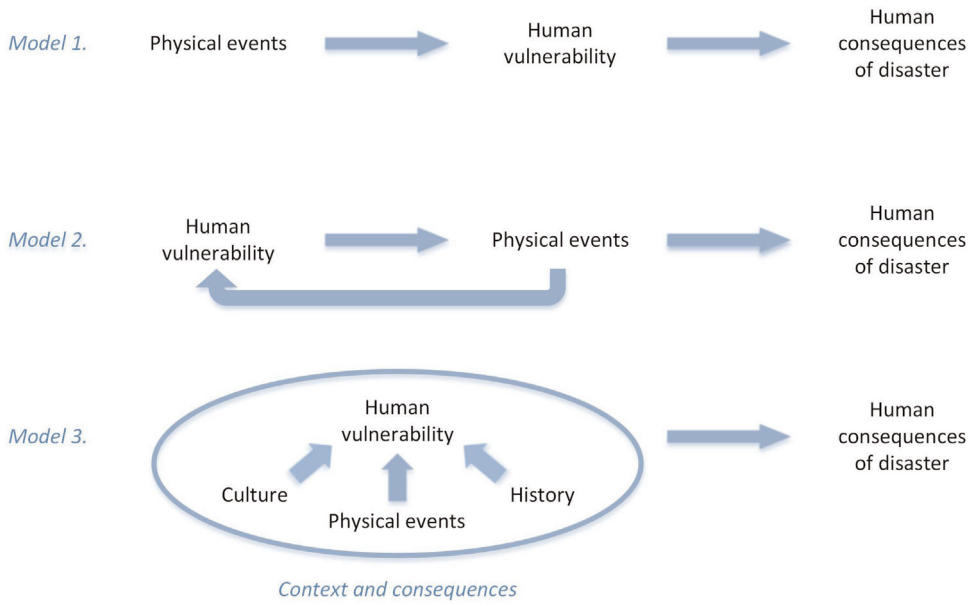

Fig. 1. Three models of disaster (Source: [9]).

vulnerability also varies over time and space [5]. This makes vulnerability a dynamic concept, which can only be understood in relation to its causes and consequences. White provides a convenient starting point. He employed a human ecology approach to study natural hazards, initially with a focus on flood hazards where he realised that it is not only the hazard that should be adjusted but also the human exposure to the hazard [7]. The result is a linear model, portraying how the influence of physical events on the human consequences of disaster is mediated by human vulnerability. This first model (Fig. 1) however, does not explicitly recognize the viewpoint that the causes and the phenomenology of disasters are defined by social processes and structures as well. Thus it is not only a geo- or bio-physical hazard, but also the social context that is necessary in order to understand "natural" disasters [8]. The so-called "radical critique" argues that, in the explanation of disaster, vulnerability carries more weight than hazard. As a result of feedback loops, hazard can be regarded as a trigger for the social processes that create vulnerability, which is the principal determinant of disaster potential [9]. According to Alexander the increasing knowledge of disasters and the social processes involved, and the complexity of life in the early 21st century demand a new model: "the vulnerability of human socio-economic systems is acted upon by physical hazards (whether natural or anthropogenic), as well as cultural and historical factors. The plexus of the context and consequences of these associations is what determines the form, entity and size of any ensuing disaster" [9,10].

1.3. Study objective

Alexander's model summarizes a complex interaction between elements, so broad and multifaceted that it can hardly be captured in words, let alone be measured. Nevertheless, the thought that the combination of culture, physical hazards and historical factors influences vulnerability serves as the point of reference for this study. Human societies can be analysed at different levels. The objective of this study is to test associations between elements of the model at the level of countries, operationalized using a combination of information from two sources: disaster vulnerability data and exposure data from the World Risk Index [11,12] and Hofstede's cultural dimensions scores [13–15]. A quantitative study of this type is rare and contributes to knowledge about the empirical associations between cultural features, exposure to natural hazards and disaster vulnerability.

The nature of the key concepts, the main data sources and a number of expected relations are described hereafter, followed by a description of the results of the analysis, some critical reflections on how to interpret the results, and the main conclusions.

2. Key concepts, data sources and expected relations

2.1. Disaster vulnerability

Considerable research attention has been focused since the 1960s on components of biophysical vulnerability and the vulnerability of the built environment. Relatively more recently, the social, historical and political aspects of vulnerability received scholarly attention. These aspects are sometimes ignored because of the greater difficulty in quantifying them [5]. A person's individual vulnerability is still quite easily described using individual characteristics (age, gender, income, race, education, employment, psychosocial resilience), but wider issues at the community level or derived from political economy or power relations [16] are obviously often more difficult to grasp. Social vulnerability is partially the product of social inequalities—those social factors that influence or shape the susceptibility of various groups to harm and that also govern their ability to respond [17].

To date, there has been little research effort focused on comparing the social vulnerability of one place to another. The vulnerability index by Cutter and colleagues is an important example of an assessment tool. At a global level the World Risk Index is the most comprehensive tool to assess the disaster risk that a society or country is exposed to by external and internal factors [11,12]. The index is based on multiple indicators. Matrices are calculated for 173 countries; detailed information is publicly available and described in the World Risk Report 2012. The data collection required for its calculation is freely available and can be reliably accessed via the Internet, ensuring transparency and verifiability. In order to be mathematically aggregated into indices, the indicators are transformed in dimensionless rank levels between 0 and 1, i.e. they can be read as percentage values. The index illustrates that a country's disaster risk may depend on several factors, so that a country also has several means at its disposal to reduce risks [18]. Disaster vulnerability comprises the components