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Spatially- Explicit Structural Approaches to Measuring Hazard/Risk Assessment, Vulnerability and Resilience

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Abstract

This paper recalls approaches to measuring the most important and ranked elements when it comes up to a potential loss from environmental, economical, and social events. Those elements are stated as follows: hazard, risk assessment, vulnerability and resilience. The hazard profile includes the frequency of the hazard event occurring. The risk assessment is the estimating Hazard Losses. The vulnerability is related to harm in physical entities. The concept of resilience falls up into the capacity of a given system to absorb changes. The inter-connectivity between these three concepts provides an actual framework that measures the risks assessment level of hazards on vulnerable structures, based on maintaining its main characteristics. The purpose of this paper is to discuss the risk, vulnerability, and resilience; to implement an adequate scheme for upcoming construction projects, and anticipate future disasters.

Keywords: Risk assessments; Vulnerability; Resilience; Hazard; Disasters; System

Introduction

The discussion of assessing vulnerability tools used in describing state of susceptibility to harm and the physical systems, these terms are interchangeable depending on the physical and social system derived from unforeseen circumstances. For many professionals and scientists it is a known fact that human action and social structures are integral part to nature. Natural system is referred to social system that are made up of systematical tools and regulations interpreted from the human perspective [1]. Social ecological systems usually referred to the magnitude of disturbance that can be absorbed before system change in the physical state and taking the adaption of the change itself. As we look at the vulnerability, which is usually portrayed as a negative outcome, that produces negative results. We will summon a case study portraying the vulnerability and resilience of these outcomes.

Measuring Vulnerability

Vulnerability is a dynamic phenomenon often in a continuous state offlux both the biophysical and social processes that shape local conditions and the ability to cope are themselves dynamic [2]. The IPCC defines vulnerability to climate change as 'the degree to which a system is susceptible to, and unable to cope with, adverse effects of climate change, including climate variability and extremes. Vulnerability is a function ofthe character, magnitude, and rate of climate change and variation to which a system is exposed, its sensitivity, and its adaptive capacity [3]. Research on mapping vulnerability increasingly attempts to validate and triangulate data to derive more robust measures for both policy analysis and intervention [4-7]. Such mapping most often involves cross-national or spatially mapped comparisons of indicators. A common critique of comparative statistical research, particularly focused on country-level analysis, is that it fails to capture the sub-national spatial and social differentiation of vulnerability and local conditions that mediate the capacity to adapt [8]. A lot of studies has been done by researcher on the vulnerability (Table 1). These innovations in vulnerability methods attempt to capture the dynamics and spatial distribution of individual variables of concern and interactions between them [9,10].

The measures of vulnerability severity involve a measure of well-being that could be measured in a number of different ways. It could be objective material measures such indicators of mortality, income, wealth, or freedom from crime or access to education, depending on the nature of the vulnerability being measured. In addition, vulnerability as experienced could be measured directly through perceptions of those that are vulnerable [11].

Measuring Risk Assessment

Is defined as the process of assessing the risks associated with each of the hazards identified so the nature of the risk can be understood. This includes the nature of the harm that may result from the hazard, the severity of that harm and the likelihood of this occurring [12]. Risk is a total concept of likelihood of occurrence of identified hazards and the severity of possible impacts (Figure 1). The combination of severity and likelihood is termed the level of risk [11]. Risk assessment can be used to establish priorities so that the most dangerous situations are addressed first and those least likely to occur and least likely to cause major problems can be considered later [13]. Risk is explicitly defined as a function of the perturbation, stressor, or stress and the vulnerability of the exposed unit [14]. Pressure and release (PRA) Model (Figure 1) was used to .Unsafe conditions are the specific forms in which vulnerability is expressed in time and space, such as those induced by the physical environment, local economy or social relations [14]. Although explicitly highlighting vulnerability, the PAR model appears insufficiently comprehensive for the broader concerns of sustainability science [15]. Primarily, it does not address the coupled human environment system in the sense of considering the vulnerability of biophysical subsystems [16] and it provides little detail on the structure of the hazard's causal sequence. The model also tends to underplay feedback beyond the system of analysis that the integrative RH models included [17].

While there might be many ways of assessing risk, literature suggests using the two concepts of probability of occurrence and

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Vulnerability approach	Objectives
Antecedents Vulnerability to famine and food insecurity	Developed to explain vulnerability to famine in the absence of shortages of food or production failures. Described vulnerability as a failure of entitlements and shortage of capabilities.
Vulnerability of hazards	Identification and prediction of vulnerable groups, critical regions through likelihood and consequence of hazard. Application in climate change impacts.
Human ecology	Structural analysis of underlying causes of vulnerability to natural hazards.
Pressure and release	Further developed human ecology model to link discrete risks with political economy of resources and normative disaster management and intervention.
Successors Vulnerability to climate change and variability	Explaining present social, physical or ecological system vulnerability to (primarily) future risks, using wide range of methods and research traditions.
Sustainable livelihoods and vulnerability poverty	Explains why populations become or stay poor based on analysis of economic factors and social relations.
Vulnerability of social-ecological systems	Explaining the vulnerability of coupled human-environment systems

Table 1: Antecedent and successor traditions in vulnerability research.

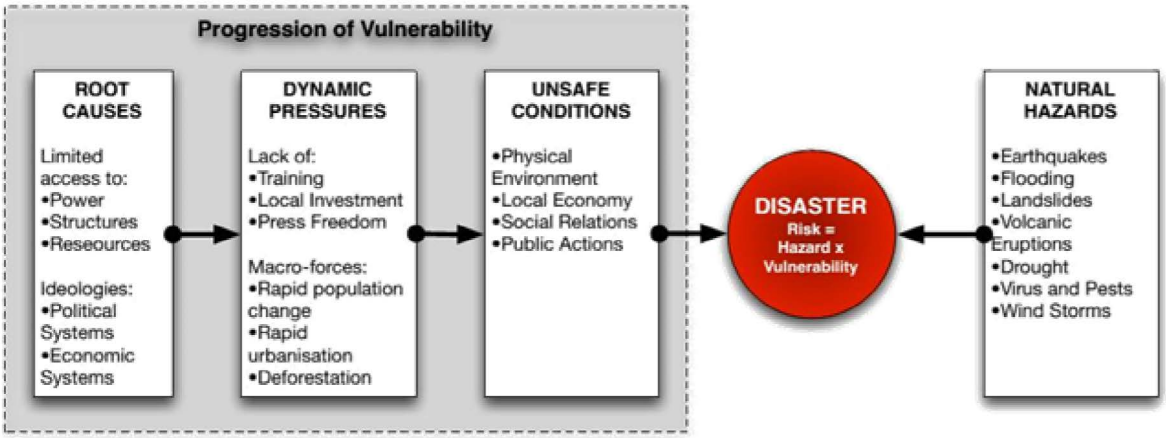


Figure 1: Pressure and Release (PAR) model showing the progression of vulnerability. The diagram shows a disaster as the intersection between socio-economic pressures on the left and physical exposures (natural hazards) on the right. Source: [14].

Source: http://www.deir.qld.gov.au/workplace/resources/pdfs/manage-whs-risks-cop-2011.pdf

Figure 2: The risk management process.

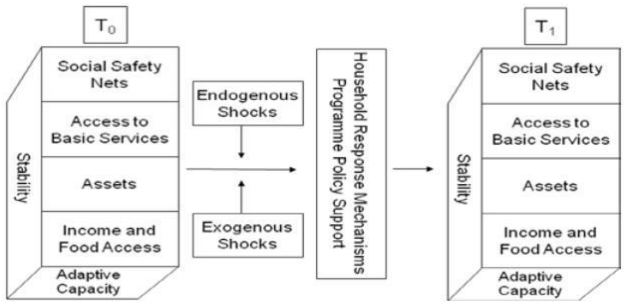
severity of effects [18,19]. The risk assessment process is clearly illustrated in Figure 2.

Measuring Resilience

Resilience is the ability of groups or communities to cope with external stresses an disturbances as a result of social, political and environmental change" [20]. In a food security context, resilience is defined as "the ability of a household to keep with a certain level of well-being (i.e. being food secure) by withstanding shocks and stresses". This depends on available livelihood options and on how well households are able to handle risks. This definition implicitly considers both (ex-ante) actions that reduce the risk of households becoming food insecure, and (ex-post) actions that help households cope after a crisis occurs [13].

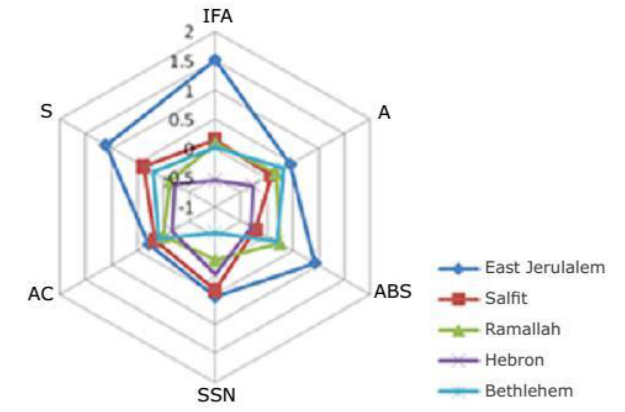
The insight of why and how people become food insecure suggests ways of preventing this from happening. If interventions are designed in ways that increase resilience by enhancing people's ability to manage risk over time, then the need for humanitarian interventions when hazards occur will diminish. However, resilience analysis should not be seen as an alternative to vulnerability analysis,but as a complement. Vulnerability analysis tends to measure only the susceptibility of people to damage when exposed to particular hazards or shocks. It oftenfocuseson one specific target variable, usually represented by the household consumption expenditure [13]. Figure 3 summarizes the rationale for measuring resilience to food insecurity. It assumes that the resilience of a given household at a given point in time, T0, depends primarily on the options available to that household for making a living. This includes its access to assets, income-generating activities, public services and social safety.

At time T0, each component is estimated separately to generate a composite index of household resilience. The different components observed at time T1 reflect how changes in these factors influence



Source: http://www.fao.org/docrep/013/al920e/al920e00.pdf

Figure 3: Summarizes the rationale for measuring resilience to food insecurity



Source: http://www.fao.org/docrep/013/al920e/al920e00.pdf

Figure 4: Components of Resilience in five West Bank's governorates (Palestine).

household resilience. In algebraic terms, the resilience index for household i can be expressed as follows:

$$R_i = f\left(IFA_i, ABS_i, A_i, SSN_i, S_i, AC_i\right)$$

R = resilience; S= stability; SSN = social safety nets; ABS = access to basic services; A= assets; IFA= income and food access; and AC= adaptive capacity.

The six components of the resilience framework each have a specific set of indicators. These are combined and weighted to come up with an overall index called the "resilience score". Radar charts are used to visualize relationships between the components and other variables such as location (Figure 3) or gender.

The methodology has been validated using the Classification and Regression Trees (CART). The validation process defines precise decision rules that will make it easier to classify household resiliency using simpler datasets built for monitoring purposes [13].

Conclusion

Many studies discuss vulnerability reduction by means of assessments and models, illustrating impact of such vulnerability on the local population. Most of the research is focused on socioeconomic, where most of funding is coming from Universities and International organizations. In the early 1980 and 1990 the entitlements concept was introduced when many droughts, floods, and other natural disasters struck and brought catastrophic devastation in crops, farms and famine [21]. From such catastrophic incidents the conception of entitlements and welfare was created by the each nation's government to help the local population and reduce the insecurity to its citizens. Governments around the world created such programs, in order to help its citizen provide security, and maintain order. The introduction of food stamps and other food subsidies, would decrease the vulnerability of its citizens and reduce stress at a local level. These scenarios equate to the impact of socio economic distress caused by physical conditions. Vulnerability can be caused by mankind such as wars and civil persecutions, which in terms makes it different type of vulnerability. The people are displaced because of violence, which creates a vulnerability towards political control and persecution of minorities. Some of the Vulnerability research has been applied to many other social economic programs such as Climate change (Figure 4). There are ways to reduce vulnerability by acknowledging stresses, introducing short team programs to reduce stress and insecurity that makes vulnerable to the local population. Certainly International Organizations must do more to reduce vulnerability by being present and ensure the local population observes the impact of their work, through social and economic programs.

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