

Discovering Vulnerability with respect to Climate Change

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ABSTRACT

Discussions on climate change has always been limited to impacts, however, with the passage of time, vulnerability studies gradually gained momentum. Vulnerability studies have a long tradition but because of its wide base applicability, it has also become a fuzzy concept. The present paper tried to explore the conceptual framework of vulnerability, with a special reference to climate change. Previously, works on vulnerability were limited to disaster research. It is of recent times that new facets were discovered. The latest definition by IPCC includes exposure, sensitivity and adaptive capacity as elements of vulnerability. The paper also covers few vulnerability assessment methods.

Key Words: Climate Change, Vulnerability, Exposure, Sensitivity, Adaptive capacity.

INTRODUCTION

Vulnerability is a nebulous concept with a universal usage. The term is transverse across subjects and has extensive range of meanings and connotations. But in general sense, The Oxford Dictionary defines Vulnerability as “the quality or state of being exposed to the possibility of being attacked or harmed, either physically or emotionally”. The concept of exposure is cardinal to vulnerability and further dimensions are added depending upon the ontology and methods of respective discipline and the particular research context (Hufschmidt, 2011).

Originally, vulnerability was rooted in the study of natural hazards (Hewitt, 1983, O’Keefe, et al., 1976). However, with the passage of time, various subjects from different streams like, from

economics, political science, international relations and sociology to psychology and engineering, use the term vulnerability. Geography, Environmental science and ecology have, in particular, theorized vulnerability to environmental change. Both of these disciplines have assisted in understanding social-natural systems and gave new insights on theories of social change and decision-making (Adger, 2006). According to Emrich and Cutter (2011as cited in Paul 2013, pp 61) "Vulnerability can be personal or individual level both in spatial and non-spatial realms. It can also take the form of Social vulnerability that includes susceptibility of social groups or society to potential losses from extreme events and the ability to absorb and withstand impacts".

Vulnerability is defined in different ways in the environmental change literature. The following table depicts it.

Authors	Definition
Timmerman (1981)	Vulnerability is the degree to which a system acts adversely to the occurrence of a hazardous event. The degree and quality of the adverse reaction are conditioned by a system's resilience (a measure of the system's capacity to absorb and recover from the event).
UNDRO (1982)	Vulnerability is the degree of loss to a given element or set of elements at risk resulting from the occurrence of a natural phenomenon of a given magnitude.
Liverman (1990)	Distinguishes between vulnerability as a biophysical condition and vulnerability as defined by political, social and economic conditions of society. She argued for vulnerability in geographical space (where vulnerable people and places are located) and vulnerability in social space (who in that place is vulnerable).
Downing (1991)	Vulnerability has three connotations: it refers to a consequence (e.g. famine) rather than a cause (e.g. are vulnerable to hunger); and it is a relative term that differentiates among socioeconomic groups or

	regions, rather than an absolute measure of deprivation.
Dow (1992)	Vulnerability is the differential capacity of groups and individuals to deal with hazards, based on their positions within physical and social worlds.
Cutter (1993)	Vulnerability is the likelihood that an individual or group will be exposed to and adversely affected by a hazard. It is the interaction of the hazards of place (risk and mitigation) with the social profile of communities
Watts and Bohle (1993)	Vulnerability is defined in terms of exposure, capacity and potentiality. Accordingly, the prescriptive and normative response to vulnerability is to reduce exposure, enhance coping capacity, strengthen recovery potential and bolster damage control (i.e. minimize destructive consequences) via private and public means.
Blaikie et al. (1994)	By vulnerability we mean the characteristics of a person or group in terms of their capacity to anticipate, cope with, resist, and recover from the impact of a natural hazard. It involves a combination of factors that determine the degree to which someone's life and livelihood is put at risk by a discrete and identifiable event in nature or in society.
Bohle et al. (1994)	Vulnerability is best defined as an aggregate measure of human welfare that integrates environmental, social, economic and political exposure to a range of potential harmful perturbations. Vulnerability is a multilayered and multidimensional social space defined by the determinate, political, economic and institutional capabilities of people in specific places at specific times.
Dow and Downing (1995)	Vulnerability is the differential susceptibility of circumstances contributing to vulnerability. Biophysical, demographic, economic, social and technological factors such as population ages, economic dependency, racism and age of infrastructure are some factors which have been examined in association with natural hazards.
Adger (2006)	Vulnerability is the state of susceptibility to harm from exposure to

	stresses associated with environmental and social change and from the absence of capacity to adapt.
Kelly and Adger (2000)	Vulnerability is the ability or inability of individuals and social groupings to respond to, in the sense of cope with, recover from or adapt to, any external stress placed on their livelihoods and wellbeing.
IPCC (2007a, p. 883)	Vulnerability is the degree to which a system is susceptible to, and unable to cope with, adverse effects of climate change, including climate variability and Extremes

Source: Paul (2013)

Birkman (2007) has traced the evolution of the different spheres of vulnerability concepts which are evolving. At first vulnerability was related to intrinsic risk factors, and then it was conceptualized as harm centered on human beings. Gradually it was associated with the “dualistic structure of vulnerability”, focusing on susceptibility and the coping strategies of individuals or communities exposed to adverse consequences. An addition to this dualistic structure of susceptibility and coping capacity was multi structure where elements like exposure and adaptive capacity were added. A final extension to this debate is a much broader multidimensional concept, encompassing physical, social, economic, environmental and institutional features. This shows that there has been a transition from narrow to definitions to wider encompassing elements.

The traditional research was centered on the physical aspects of vulnerability; however there has been a shift in this and different themes and parameters are taken into consideration (UN/ISDR, 2004). Many studies have also taken into account various other driving social processes that universal impact like globalisation and climate change (O'Brien and Leichenko, 2000). This indicates that the cardinality of vulnerability research has shifted from mere physical impacts analysis to a wider trans-disciplinary analysis of the multidimensionality of vulnerability.

Eakin and Leurs (2006) have also discussed three approaches for vulnerability. The first approach is the risk-hazard approach to vulnerability, which is evolved from the vast literature of natural hazards. The second approach is the political economy or political ecology approach

which emphasized on socio-political, cultural and economic factors that together explain differential exposure. It asserts the fact that “Vulnerability is not an outcome but rather a state or a condition of being.” The third approach is ecological resilience approach. Here, vulnerability is viewed as a dynamic property of a system in which humans are interacting constantly with their surrounding bio-physical environment. Resilience approaches concentrates on social and economic changes across the larger landscape, considering anthropogenic activities as just one of the driving forces.

Adger (2006) in order to explore the roots of vulnerability reviewed historical antecedent works. According to him, the current propositions of vulnerability are stemmed from two traditions: analysis of vulnerability as lack of entitlements and the analysis of vulnerability to natural hazards. Entitlements-based works focused on class, social status and gender and other social institutions. The second research tradition on natural hazards (Burton et al, 1978. 1993), by contrast has since its inception attempted to incorporate physical elements of exposure to hazards. Gaps between these two researches were bridged by “Pressure and Release” model of Blaikie et.al. (1994). They proposed that hazards along with social differentiation accentuates cumulative vulnerability. There is a departure from these vulnerability traditions and a renewed focus on systems approach. In a system approach, vulnerability is a product of exposure, sensitivity and resilience or adaptive capacity rather than outcome of a single hazard (Turner et.al. 2003).

Climate Change

Climate change is defined as a statistically significant variation in either the mean state of the climate or in its variability, persisting over an extended period (typically a decade or longer), It may result from natural internal processes within the climate system or from variations in the natural or anthropogenic external forces (IPCC, 2007).

Climate change has innumerable cascading impact and its effect does not discriminate between populations. However, how a certain group or individual will deal with it depends a lot on their socio-economic position and responding capacity.

With respect to climate change vulnerability is conceptualized from two perspectives: as starting point and as end point. As starting point, vulnerability is determined by combination of factors

like socio-cultural, political and physical. In this case, vulnerability provides a means of understanding how the impacts of climate change will be distributed, primarily to identify how vulnerability can be reduced.

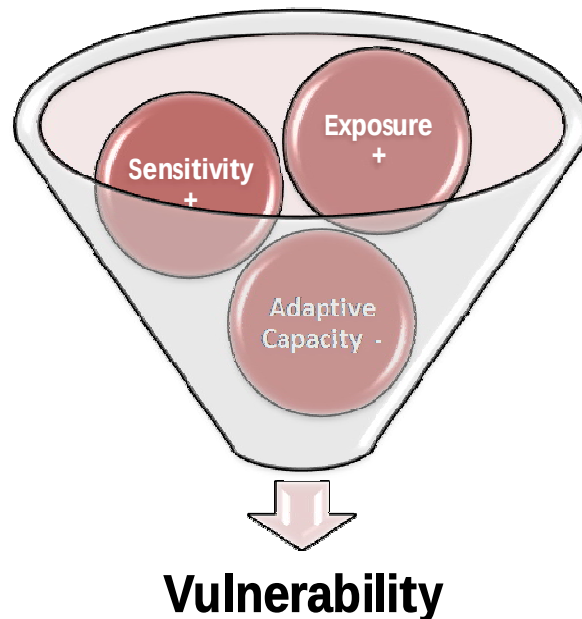
As indicated by Kelly and Adger (2000), the helplessness of any individual to any disaster is dictated by their current state, which is their ability to react to that danger, instead of by what might possibly occur later on. For this situation, vulnerability showcases how the effects of vulnerability will be dispersed and how it can be decreased.

Vulnerability as an end point concentrates on residual of climate change impacts minus adaptation (Kelly and Adger, 2000).

Vulnerability from climate change point of view is a collaboration of both physical science and social science approach. Physical sciences apply natural laws and their entire assumption is based on the exchange between energy and matter. But in social science, the entire process is seen from a systemic view where there is a constant interaction between system and actor. The passage of information and amalgamation of different factors shape decision making capacity (Füssel and Klein, 2006).

Combining both the perspectives IPCC defines vulnerability to climate change as “The degree to which a system is susceptible, or unable to cope with adverse effects of climate change, including climate variability and extremes, and vulnerability is a function of the character, magnitude and rate of climate variation to which a system is exposed, its sensitivity, and its adaptive capacity” (IPCC, 2007a, p. 883). Mathematically, it is expressed as (Brenkert and Malone, 2005):

Vulnerability= f (Exposure, sensitivity, adaptive capacity)



As seen from the above equation and the figure, it can be discerned that vulnerability is a function of exposure, sensitivity and adaptive capacity and it is directly proportional to exposure and sensitivity and indirectly proportional to adaptive capacity. This means that greater the exposure and sensitivity, greater is the vulnerability and higher the adaptive capacity, lesser the vulnerability.

Exposure as defined by IPCC is “the nature and degree to which a system is exposed to significant climatic variations” (IPCC, 2001, p. 987). It is expected that exposure to different hazards is escalated by climate change. If a group faces frequent exposure in terms of repeated hazards, it will result in devastation of ecological system, loss of people’s capital and in absence of adaptive mechanisms and resilience power, they have to face greater vulnerability (Ford et al., 2006).

Sensitivity is “the degree to which a system is affected, either adversely or beneficially, by climate variability or change” (IPCC, 2007a, p. 881). Adaptive capacity is “the ability of a system to adjust to climate change (including climate variability and extremes), to moderate potential damage, to take advantage of opportunities, or to cope with the consequences” (IPCC, 2001, p. 982).

Along with conceptualization of vulnerability as a theory, there has to be a proper defined way to measure. The way the concept of vulnerability was fraught with paradox, in the same way its measurement has also become a very contentious issue. Fussel (2007) defines climate change vulnerability assessment as “any assessment of how projected changes in the Earth’s climate could influence natural and human systems or activities, and/or how human actions could reduce adverse effects of climate change on those systems or activities, with the aim of assisting policy-makers to adequately respond to the challenges of climate change”

Vulnerability assessments are also commonly distinguished as either following top-down or bottom-up approaches (Dessai & Hulme, 2004). Top-down approaches start with an analysis of climate change and its impacts, while bottom-up approaches start with an analysis of the people affected by climate change. With respect to social science domain, it is important to follow the bottom up approach. Examples of different methods to measure vulnerability to climate change

Vulnerability measurement Frameworks	Approach	References
Indicator based methods	Uses a specific set or combination of indicators (proxy indicators) and measures vulnerability by computing indices, averages or weighted averages for those selected variables or indicators.	O’ Brien et al 2004, , Brooks et al. 2005, Sullivan and Meigh 2005, Luers et al 2003
Vulnerability-Resilience Indicator Prototype (VRIP)	National level proxies on sensitivity and adaptive capacity were scaled against global data to get the overall national baseline of vulnerability and resilience for each of the countries.	Moss et al ,2002, Brenkert and Malone, 2005
Livelihood Vulnerability Index (LVI)	Used several indicators to assess the impacts of climate change and variability among households.	Hahn et al, 2009

Dynamic International Vulnerability Assessment (DIVA)	The DIVA model is an integrated, global model of coastal systems that assesses biophysical and socio-economic consequences of sea-level rise and socio-economic development.	Hinkel, J. et al, 2009, Torresan et al , 2008
Multicriteria Decision Analysis (MCDA)	Development of indices of adaptive capacity and sensitivity through the analytic hierarchy process (AHP) and combine a livelihoods framework with MCDA to weigh household attributes according to their relative importance in driving household vulnerability.	
Econometric approaches	The econometric methods, which use household-level socio-economic survey data to analyze the vulnerability levels of different social groups, include three assessments: vulnerability as expected poverty (VEP), vulnerability as low expected utility (VEU) and vulnerability as uninsured exposure to risk (VER). All of these methods construct measures of welfare loss attributed to shocks.	Hoddinott and Quisumbing 2003.
Vulnerability as expected	This method is based on	Christiaensen and

poverty approach.	estimating the probability that a given shock or set of shocks will move household consumption below a given minimum level (such as a consumption poverty line) or force the consumption level to stay below the minimum if it is already below this level.	Subbarao 2004, Chaudhuri et al. 2002, Sarris and Karfakis, 2006
Vulnerability Scoping Diagram (VSD)	Overall assessment of vulnerability for a single exposure unit by facilitating indicators for the components of vulnerability. The outcome of populating a VSD is a set of components and measures (indicators) it involves statement of the structure of exposure, sensitivity, and adaptive capacity for a given coupled human–environment system	Polsky et al ,2007
Agent Based Modeling (ABM)	In an agent-based model (ABM) the effect of decision making upon behaviour is modelled using virtual agents. In this context, these agents can be used to represent either individuals or households and are programmed to act on the stimuli they receive throughout the simulation.	Lilibeth Acosta-Michlik, et al., 2008

Source: Panda (2013)

Indicator based method was one of the most widely used method for assessment of climate change. The indicator approach uses a specific set or combination of indicators (proxy indicators) and measures vulnerability by computing indices, averages or weighted averages for those selected variables or indicators. This approach can be applied at any scale (e.g., household, county/district, national). However, the major limitation of the indicator approach is its inability to capture the complex temporal and social dynamics of the various systems being measured (Panda, 2013).

According to Vogel and O'Brien (2004), collecting the different indicators was necessary for policy formulation. Other indexes were developed as well like Livelihood vulnerability Index (LVI), Sustainable Livelihood Framework (SLV).

Conclusion

The paper presents the various theoretical orientations of vulnerability. Vulnerability converts hazards into disasters. Vulnerability is the weakness or inability of an individual or a group against external shocks and stress. Shocks represent various extreme events and stresses are the impacts that affect for prolonged period. In case of absence of proper adaptive mechanism and coping strategies the adversity increases. Vulnerability not only has different meanings but assessment for it has also different methods. Different subjects have different frame of reference and different context for assessment of vulnerability. In case of climate change, assessment is intricate because vulnerability is felt across sectors in different manner. However, more than concentrating on physical impacts and physical vulnerability, more focus should be on addressing social vulnerability.

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