

## Chapter 66

# Vulnerability to Climate Change: Issues and Challenges towards Developing Vulnerability Indicator

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### ABSTRACT

*This paper is based on a detail review of literature available in the area of climate change, vulnerability and impact assessment. Methodological issues pertaining to vulnerability like; development of vulnerability indicators, process of indicator selection etc are the main focus in this paper. As discussed indicators are more acceptable, easy to understand and help in comparing across regions. However, indicators also possess a number of limitations. There are issues in selecting indicators and how to aggregate their values. The current study tries to overcome those issues through a primary study. The study region is Mumbai, India and 'Koli' fishing communities reside in the city. The socio-economic implications of climate change and vulnerability of communities depending on fishery are estimated by developing vulnerability indicators using Sustainable Livelihood Approach (SLA), and Analytic Hierarchy Process (AHP). Further experts opinions are considered while selecting indicators. Vulnerability indicators are derived from literature and validated through experts' opinion. Experts are chosen from higher learning institutes in the city. In the climate change literature vulnerability mainly divided into exposure, sensitivity and adaptive capacity. The indicators of sensitivity and exposure under vulnerability are combined here and categorized into two: livelihood and perceived changes. Similarly the indicators of adaptive capacity are of five categories comprising human, physical, financial, social and government policy related indicators. Thus a total 30 indicators are selected. Among five fishing villages surveyed, fishermen from Madh and Worli are found more vulnerable because of their high sensitivity and low adaptive capacity. The derived vulnerability scores are further compared and analyzed against the scores derived from experts. The overall result shows the experts value of indicators are similar with the indicator score derived in the study using simple aggregate method. This study further provides policy implications for reducing vulnerability of fishing villages.*

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## 1. INTRODUCTION

“Vulnerability” describes the degree or state of susceptibility or capacity to which a system is likely to experience harm due to the occurrence of a physical or natural event (Fussel, 2007). Vulnerability is used in two different connotations: a negative definition (e.g. risk, sensitivity and fragility) and a positive definition (e.g. resilience, adaptability, adaptive capacity and stability) (Brikmann, 2006). Vulnerability assessment studies are increasing not only in the field of climate change impact assessment and adaptation but also in the areas of hazard impact analysis, food insecurity, poverty and development economics.

However, the interdisciplinary nature of vulnerability often creates conceptual and methodological challenges. Vulnerability is not defined properly (Hinkel, 2008) and it has a variety of meanings and used differently within the climate change community (Brooks, 2005; Ionescu et al., 2005) as well as in other related disciplines (Senapati and Gupta, 2012). The methodologies for vulnerability assessments can be distinguished into “top-down” approaches and “bottom-up” approaches (Dessai et al., 2004; Fussel and Klein, 2006; Hinkel, 2008). The top-down methodologies have their roots in the fields of climate change and climate impact assessment. The focus lies more on the biophysical aspects of vulnerability. The methodologies for the same consist of developing climate scenarios, which are then fed into models of biophysical systems followed by a socioeconomic impact and adaptation assessment (IPCC, 1995; Feenstra et al., 1998). The “bottom-up” vulnerability assessment approach on the other hand focuses on the social aspects of vulnerability of individuals and communities to climate change and climate variability. The bottom-up methodologies have their roots in the fields of natural hazards, food security and poverty. This approach also analyses past experiences of how communities have coped with extreme events as a guide to future thresholds and adaptive behaviour. Generally, the methodologies for bottom-up approaches consist of conducting case studies at the level of local communities social conditions, institutions and the perception of vulnerability are thereby emphasized.

The vulnerability studies based on ranking and comparing across regions, countries, and populations have increased in number during the past decade. The main objective of these kinds of studies is the allocation of resources for vulnerability reduction by including decision making authorities like government bodies and other organizations. Indicators are especially developed in order to compare two regions (for example Human Development Index), however indicators have limited usage. Several studies have been attempted in developing national level indicators to describe vulnerability of social-human system, these studies dealt with various hazards and geographical regions (Moss et al., 2001; Adger et al., 2004). However, the construction of these indicators involves many uncertainties in finding appropriate scale, and appropriate criteria for aggregating indicators. For example, at national level the indicator of adaptive capacity depends on financial capacity and institutional capacity of a country for making resources available for the most vulnerable areas and people. Whereas at household level, the adaptive capacity of a person depends on his/her knowledge, perception towards climate change, and financial capability that helps in identifying new or modified livelihood opportunities and access to resources for achieving that level of adaptive capacity (Vincent, 2007).

Many of the vulnerability indicators developed so far are based on a data driven or inductive approach. The common methodologies used for this are factor analysis, principal component analysis, expert judgment, and correlation analysis. On the other hand, a theory-driven approach uses theoretical insights into the nature and causes of vulnerability for deriving the indicators. Hahn et al. (2009) used a deductive approach for selecting vulnerability indicators for Mozambique and developed a ‘livelihood vulnerability index’. The indicator selection method for this study is based on the literature survey related to the

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