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The truly disadvantaged? Assessing social vulnerability to climate change in urban India

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ABSTRACT

Vulnerability of marginalized groups has received significant attention in climate change and disaster literature, while there is much less academic interest on urban populations. There has also been limited consideration among policymakers and risk managers, who tend to concentrate on large-scale risk management. Drawing on the analysis of vulnerability of urban populations in India and its changes over three periods (2004–05, 2009–10, and 2011–12), this study contributes to filling these gaps as well as emerging discussion on urban risk management. For the purpose of our study, we have developed Composite Urban Vulnerability Index (CUVI) based on 13 indicators that shape the vulnerability of an urban society. The analysis reveals that at national level, social vulnerability has declined considerably over the study periods. There is clearly a heavy concentration of social vulnerability in central and eastern states, such as Madhya Pradesh, Chhattisgarh, Orissa, Jharkhand, and West Bengal, attributable to the high levels of poverty, inequality, and problems relating to unemployment, housing, and access to basic civic amenities like safe drinking water and sanitation. Only the urban populations in relatively prosperous Northern and Southern states are relatively less vulnerable to climate change. The results signify that while social communities in urban areas across India are, in general, developing resilience to climate change, large contrasts exist due to the socioeconomic and geographical differentiation among states.

1. Introduction

Climate change is very likely to impact the vast percentage of population living in urban areas of India as shown in the National Communication Reports of India to the United Nations Framework Convention for Climate Change (UNFCCC) (NATCOM, 2004, 2012). Predicted climate change impacts include increase in mean intensity of monsoon and spells of excessive rain (Ashrit, Kumar, & Krishna, 2001; Chung & Ramanathan, 2006), sea level rise and inundation of coastal cities (e.g. Mumbai and Chennai) (Brenkert and Malone, 2005), and extreme temperatures and heat spells in hot and dry cities (e.g. Delhi and Hyderabad) (NATCOM, 2012).

In India urbanization is often accompanied by unplanned urban growth and population concentration in potential hazardous places, such as slums or informal settlements with low living standards and poor basic services (Agarwal, Aravinda, Kaushik, & Kumar, 2007; Nath, 1994). As a result, the potential number of people affected in a disaster increases (Revi, 2008; Satterthwaite, Haq, Reid, Pelling, & Lankao, 2009). Under such circumstances, social vulnerability assessment becomes a key for urban risk management.

The main objective of this research is to assess and interpret the spatio-temporal patterns of social vulnerability of urban areas to climate change in India. We attempt to: (i) develop a composite

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index to measure social vulnerability of urban areas; (ii) develop a state-level social vulnerability profile applied to urban populations; and (iii) provide some interpretation on the developed index. The spatial scale of this study is the 29 major states[1] of India while the temporal period consists of the years 2004–05, 2009–10, and 2011–12. Under the '1956 Reorganization Act', India is divided into zones, states and union territories. According to the act, states are considered as economic planning regions. Most of the discussion in terms of national Five-Year Plans (FYP) and National Development Councils (NDC) deals with the concept of a region as state. Hence, in this study, regions are defined as states. India's rapid urbanization, great heterogeneity in socioeconomic conditions, and the scientifically observed patterns of increase in extreme weather events makes it an excellent case to explore social vulnerability of urban areas. This study takes forward the literature on social vulnerability by operationalizing this framework in an important arena of climate change in a rapidly urbanizing economy (Francis & Wadhwa, 2015).

2. Theory and analytical framework

2.1. Social vulnerability to climate change

Social vulnerability to climate change, influenced by natural hazards (Burton, Kates, & White, 1978; Cutter, 1996) and food insecurity (Bohle, Downing, & Watts, 1994; Sen, 1990) research has drawn some serious attention from scholars and policy-makers alike in the past two decades, leading to a large amount of literature on the topic (Adger, 1999, 2006; Brooks, 2003). It is 'socially constructed and exhibits with stratification and inequality among different groups of people and different places' (Chen, Cutter, Emrich, & Shi, 2013, p.169). It identifies the exposure of individuals or collective groups to livelihood stress as a result of the impacts of climate change, determines the local sensitivity to global environmental changes and examines the capacity to cope with the resulting threats (Adger, 1999; Su et al., 2015). Thus, social vulnerability provides a more comprehensive framework for climate change research than physical vulnerability, which focuses only on the probability of risk exposure.

Scholars have proposed different frameworks and conceptual models to assess social vulnerability in different geographical contexts (Chen et al., 2013; Firman, Surbakti, Idroes, & Simarmata, 2011; Nahiduzzaman, Aldosary, & Rahman, 2015). Under these frameworks social vulnerability is typically constructed as a function of exposure, sensitivity, and adaptive capacity. Exposure refers to the nature and degree to which a system is exposed to significant climatic variations, and sensitivity is the degree to which a system is affected, either adversely or beneficially, by climate-related stimuli (McCarthy, Canziani, Leary, Dokken, & White, 2001, p.995). Adaptive capacity is the system's ability to respond to a disturbance, to cope with the consequences of the disturbance, to take advantage of opportunities, and to survive (Brooks, 2003). Adaptive capacity, which involves taking proactive actions aimed at a vulnerable community for reducing the damage from actual climate impacts, is in fact one of the two societal responses to climate change, the other being mitigation. The lack of adaptive capacity, with high exposure and sensitivity can increase the vulnerability of a system. An interrelated concept to adaptive capacity is the concept of 'resilience'. Resilience focusses on the ability of a system to maintain its basic functions and return to the original state after a perturbation (Füssel, 2007). The lack of adaptive capacity, with high exposure and sensitivity can reduce the resilience of a system. On the other hand, improved adaptive capacity can increase the resilience of a system to a stress.

The differences between these terms can be applicable and illustrated through the context of understanding climate impacts on the urban poor. The houses of the poor, which are often very weak in terms of construction, are hit harder by an impact, say flood, than the stronger ones (sensitivity). Most of the time, the houses of poor, located in slums and other marginal areas (low-lying areas) are most susceptible to flooding (exposure). The families with the greatest resources, such as money, have a greater availability of means to repair water damage (adaptive capacity).

A variety of tools and methods, such as integrated assessment models, household surveys, and indicator approaches are used to measure social vulnerability. However, quantifying social vulnerability using indicator-based approach has become prominent in the recent years (Chen et al., 2013; O'Brien et al., 2004; Su et al., 2015). Social vulnerability assessment through indicator approach can enhance our understanding by identifying the drivers of vulnerability and systematically quantify questions such as what and who are vulnerable? what are they vulnerable to? and to what extent?

Reflecting on the above discussions, we argue that while a considerable literature on vulnerability to climate change in India has emerged over the years (Brenkert and Malone, 2005; Leichenko & O'Brien, 2010; O'Brien et al., 2004), the majority of it has focused on assessing vulnerability as whole and in a single time period. This study is unique and different from the previous studies on India as it provides an understanding on social vulnerability over a period of time (2004–05, 2009–10, and 2011–12) and specifically aimed at urban populations. With wide socio-economic variations and differences in physical and social environment, social vulnerability in India is likely to vary over time and across spatial scale. More explicitly, the analysis should cover rural and urban populations separately as there exists significant differences between them with respect to characteristics of vulnerability. The little existing literature on social vulnerability of urban populations in India is focused on descriptive approaches (Panda, 2011; Saroch, Palaniappan, Singh, & Seraydarian, 2011). Much work is needed in terms of using quantitative approaches and multiple social indicators at local, regional, and national scale. This dearth of literature comes as a surprise when one considers the fact that India is becoming increasingly urbanized, besides being at risk from climate-led but also natural hazards generally.

2.2. The conceptual framework

The wide variety of indicator approaches developed over the years indicate that there is no fixed method to measure social vulnerability (Chen et al., 2013; Cutter, Boruff, & Shirley, 2003; Su et al., 2015). Each of the methods was developed in the context of a specific research and geographical region. Considering the differentiated vulnerability among the different states in India, we use the 'Composite Urban Vulnerability Index' (CUVI) developed for the purpose of our study (Fig. 1). We consider the changing trends of 13 socio-economic indicators within the three components. Drawing lessons from previous studies, we argue that as urban areas are exposed to differential climate-led hazards, their exposure, sensitivity, and most importantly differential adaptive capacities are determined by the broader dimensions of people, their characteristics, and socioeconomic or non-climatic factors (Fig. 1) (Chen et al., 2013; Su et al., 2015; Swart et al., 2012).

The availability of public data also play a significant role in this research. In our study, the number of indicators, which represent

[1] With the bifurcation of the state of Andhra Pradesh into two states (i.e. Telangana and Andhra Pradesh) in June 2014, the number of major states in India is 30. However, in this study we considered 29 states as our spatial scale because the last available data was only until 2011–12.