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Analysis of socioeconomic vulnerability for cyclone-affected communities in coastal Odisha, India

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ABSTRACT

This research is based on the assessment of vulnerability for six of the most cyclone prone coastal blocks in the state of Odisha, India. The necessary primary data were collected from 450 sample households through a structured questionnaire survey. The secondary data related to the demographic profile of blocks were taken from the published census reports. The socioeconomic vulnerability score for each block is developed using a set of 29 indicators selected from the literature review and in consultation with experts. The selected indicators cover the IPCC dimensions of vulnerability (adaptive capacity, sensitivity, and exposure to climate change led hazards). Results of this research conclude that among the six blocks, Soro block is the most vulnerable and Rangeilunda block is the least vulnerable. The most influential factors for socioeconomic vulnerability in the study area include population density, population growth rate, percentage of rural population, distance of cyclone shelter, unemployment, adequate toilet facility, frequency and impact of flood and cyclone, and lack of logistics supports during cyclone. The findings of this study advocate that the interventions for vulnerability reduction and development of adequate coping mechanism should be made for the communities living in such areas.

1. Introduction

In recent years, Asia, compared with other parts of the world experienced a disproportionately high number of natural disasters. India, one of the Asian countries with a huge territory, unique geo-climatic condition, and the enormous population is one of the most naturally disaster-prone countries in the world. In the last three decades, India has experienced many extreme events like floods, land sliding, cyclones, earthquakes, droughts, etc. that have created huge devastations in various parts of the country. The country is surrounded by large water bodies on three sides, the Bay of Bengal in the south-east, the Arabian Sea in the south-west, and the Laccadive Sea in the south. The coastal belt of India that spans over 7516 km and has been affected by various meteorological disasters includes tropical cyclones, tsunami, storm surges, river floods, high tides etc. The coastal population of the country depends on agriculture, forestry, salt farming, and fishery, etc. for their livelihood, which is highly influenced by the ecosystem. Climate variability is adding another dimension to the risks that communities are already exposed to [1]. Hence, the increasing trends of climate change led disasters will certainly affect the livelihood of vulnerable population living in these coastal areas. In fact, these natural disasters are pushing more and more people below the poverty line, making them landless, homeless and depriving them of their livelihood. The vulnerability of the households residing in coastal areas is aggravated due to their limited coping capacities to naturally occurring disasters and rapidly growing population. Thus, the vulnerability analysis for the coastal population has become a requirement for effective planning and development of coping mechanisms at the communities' level those who are frequently exposed to climate change risk [2,3].

In this paper, a focused socioeconomic vulnerability index (SeVI) has been developed to address the progression of vulnerability in coastal blocks of Odisha, an eastern coastal state of India. Odisha is known as one of the most vulnerable regions in the world to violent tropical cyclones [4,5]. As per the National Disaster Management Authority (NDMA) of India, approximately 80% of coastal areas in India are cyclone prone specifically the eastern coast of India [6]. Broad-scale assessment of the population at risk suggests that an estimated 32 crore people, which accounts for almost a third of the country's total population, are vulnerable to cyclone-related hazards [6]. Considering the impact of recent cyclones on population living in coastal region of India, this study is intended to explore the socio-economic vulnerability indicators and their relative scores using the contributing indicators selected from the studies of Siagian et al. [3],

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Cutter et al. [7], Ahsan and Warner [8], Brouwer et al. [9], Balica et al. [10], Bahinipati [11], Hossain [12], Qasim et al. [13], and Mazumdar and Paul [14]. Subsequently, following a brainstorming session with disaster management expert, 29 relevant indicators have been finalised and categorised into three dimensions of vulnerability i.e. sensitivity, risk exposure, and adaptive capacity. These three dimensions are taken from the IPCC definition of vulnerability. As per IPCC [15] vulnerability is "the degree to which a system is susceptible to or is unable to cope with adverse effects of climate change including climate variability and extremes, and it is the function of the character, magnitude, and rate of climate variation to which a system is exposed, its sensitivity and its adaptive capacity". The necessary primary and secondary data for indicators have been gathered for six cyclone affected blocks from the three most vulnerable districts of the Odisha. The necessary secondary data for all the six blocks were obtained from the Census of India, 2011. While necessary primary data were collected through a structured questionnaire survey from 450 sample households living in these six cyclone prone coastal blocks. These primary data were collected during the time period ranging from August 2015 to February 2016. The socioeconomic data of a household covers family structure, education, housing condition, occupation, dependency on natural resources for livelihood, population below the poverty line, availability of agricultural land, cattle, capital loss due to disasters, etc. Thereafter, relative score of each contributing indicator and each IPCC dimension have been calculated. The findings of calculated results indicate the most influential factors for socioeconomic vulnerability in the areas under study. The indicators with major contribution in SeVI of the study areas include housing condition, education level, unemployment, dependency on natural resources, frequency and impact of flood and cyclone, less capacity and fewer numbers of shelters and lack of post-disaster supports.

The rest of the paper is organised as follows. Section 2 provides an overview of theoretical background on vulnerability assessment. Section 3 introduces the area of study and selection of indicators. Section 4 discusses the sampling and data collection procedure. Section 5 presents the various results from data analysis. Discussion of the finding is presented in Section 6, while Section 7 is dedicated to a conclusion and further work scope.

2. Theoretical background

Most of the coastal regions in the world are at risk from natural disasters and meteorological disturbances originating from climate changes. These coastal regions are highly dynamic and geomorphologically complex systems, which respond in various ways to extreme weather events. Frequent exposure to such events and their effect on socioeconomic characteristics of the population living in that system develop the concept of vulnerability [16] and involve varying magnitudes depending upon the coping capacity of people. As per Wisner et al. [17], the most important root causes responsible for the progression of vulnerability are demographic, socioeconomic pressure and unsafe physical and environmental condition. These affect allocations and distribution of resources, livelihood opportunities, social rights and access to institutions for different groups of people. Vulnerability also covers the groups or affected communities waiting for relief to restore their livelihoods following a disaster, and this, in turn, makes them more vulnerable to the effects of subsequent events following that disaster. According to Cutter et al. [7] vulnerability is classified into three major criteria; first, as exposure (conditions that make people or places vulnerable to hazard), second, as a social condition (a measure of resilience to hazards), and third, as the integration of potential exposures and societal resilience with a specific focus on places or regions [18]. The Intergovernmental Panel on Climate Change (IPCC) [15] definition of vulnerability provides a holistic interpretation and covers the economic, social and environmental domains of an area or population at risk [19]. As per IPCC, vulnerability covers the three dimensions of a system i.e. exposure, sensitivity and adaptive capacity. For example, communities facing frequent disasters with less preventive measures, communities living in rural areas with poor infrastructure facilities, poor social systems, high illiteracy rate, and high unemployment rate will be more vulnerable than others. As per these classifications of Cutter et al. [7] and IPCC [15], it can be linked that the vulnerability is closely connected with the socioeconomic condition of a household or a community and in order to minimize the negative influence of such factors and identify appropriate actions, their contribution must be measured [20]. Since, assessment can explain why some communities experience and suffer from a hazard event differently than others [3]. Cutter et al. [7] identified the factors affecting social vulnerability, which include, Lack of access to resources, limited access to political power and representation, social capital, including social networks and connections, beliefs and customs, and type and density of infrastructure and lifelines. Birkmann [19] claimed that the concept of social vulnerability should not be restricted to social fragilities, but should also cover social inequalities regarding income, age or gender. Brouwer et al. [9] concluded that the households with lower income and less access to natural assets face higher exposure to the risk of disasters. Hossain [12] confirmed the significant role of physical and socioeconomic factors in human vulnerability at the household level. Balica et al. [10] suggested that the ability of any human system to handle the impact of any disaster is highly correlated to its socioeconomic indicators. Chhotray and Few [21] concluded that the combination of recurrent hazards, poor grassroots adaptive capacity, and weak institutional support are the major contributing factors to the ongoing social vulnerability. The study of Bahinipati [11] included demography, agriculture, and economic capacity as the major cause of increasing socioeconomic vulnerability.

Thus it can be seen that vulnerability is a combination of the social, economic, physical, and risk exposure factors. Vulnerability of regions can be defined considering these parameters. Many studies have assessed the vulnerability of specific regions across the globe and especially the regions and communities are at risk from the natural hazards. It is evident that despite high vulnerability to meteorological disasters, India lags in the assessment of vulnerability based on socioeconomic parameters. Most of the studies [22–27] conducted in the Indian context have analysed the vulnerability using physical parameters and included limited number of social indicators [14]. Few studies [11,14] have explored the socioeconomic factors of vulnerability, but have only considered secondary data for the analysis. Hence, the scarcity of research on the socioeconomic vulnerability assessment with primary data can be considered a potential research gap. This research tries to bridge the gap by exploring potential indicators for socioeconomic vulnerability assessment and developing an index in the Indian context. In addition, the decision taken by sample households to save their lives during the event of Phailin, a cyclone of acute severity that occurred in 2013, is also explored and presented in the subsequent sections.

3. Area of study

Odisha, one of the east-coast states of India is known as one of the most vulnerable regions in the world to violent tropical cyclones [4,5]. It is located between 17°49′N and 22°34′N latitudes and 81°27′E and 87°29′ E longitudes [28]. The state covers an area of 156,000 km^2 and has a total population of 41.94 million and a population density of 269 [29]. It covers 30 districts, including six coastal districts spanning a coastline of 480 km [28]. Climate-induced natural disasters such as floods, droughts, and tropical cyclones occur on a frequent basis in Odisha. Between 1998 and 2002, more than 30,000 people in Odisha lost their lives as a result of climate-induced hazards such as droughts, floods, and cyclones [30]. During the last decade, Odisha has faced one or other forms of disasters like flood, cyclone, and drought every year