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Analysis of Climate Change and Vulnerability

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Abstract

Greenhouse gases are being emitted into earth's atmosphere by increasing usage of fossil fuels and changing the ways of using the land. These Greenhouse gases are the main reason for increasing heat over earth's surface. This heat in turn results in rise of temperature thereby resulting in global warming phenomenon. As a result of global warming, extreme events such as tropical cyclones, floods, droughts and heavy precipitation events are expected to occur even for a small change in temperature. Change in temperature indicates the climatic change. Climate change will have wide-ranging effects on environment, socio-economic and related sectors, including water resources, agriculture and food security, human health. This study is about impact of climatic change on agriculture and infrastructure. Vulnerability of a particular state is measured by the frequency of occurrence of extreme events such as cyclones and storms. The study attempts to construct a vulnerability index and rank the various states in terms of their performance on the index. The finding points out that the states of poor infrastructure are the region of maximum vulnerability. This paper suggests that climatic change policies have to be integrated with sustainable development strategies in general and poverty prevention measures.

Keywords: Climate, Vulnerability, greenhouse gases

INTRODUCTION

Climate change is associated with a myriad of socio economic and biophysical shifts, but potential and projected changes in climate variability, including increases in extreme event frequency or intensity, is well recognized as a central social concern. Climate change will have an impact on all countries around the globe. Developing countries are much more vulnerable to climate change than the developed world. Climate change aggravates the effects of population growth, poverty and rapid urbanization.

This has led to a growing body of research on the aggregate estimates of the economic and social costs of climate change in terms of human mortality and morbidity, GDP, infrastructure and capital resources that may be affected by extreme events. Although technical responses related to hazards and climate impacts have long been considered important, over the past decades attention has shifted to a focus on vulnerability and particularly on the role that climate change adaptation and disaster risk reduction can play in reducing vulnerability to climate variability, hazards and extreme events.

"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. The IPCC definition focuses on vulnerability can be high because of high exposure (severe hurricanes), high sensitivity (small islands), or low adaptive capacity (least developed countries). Of course, vulnerability can also be reduced as a result of high adaptive capacity. (IPCC 2007) The "vulnerability" component of risk may be considered as a combination of distinctive types of vulnerabilities: physical, economic, infrastructure and social. The physical vulnerability generally incorporates those indicators susceptible to biological sensitivity. Economic vulnerability includes damage indicators which can be expressed in monetary terms. Infrastructure vulnerability includes civil structure such as road networks, railways and road bridges. Infrastructure components are important to movement of population, communication and safety. Social vulnerability focuses on the reaction, response and resistance of a population to a disastrous event.

Heavily populated regions such as coastal areas are exposed to climatic extremes and large falls in sown areas in arid and semi-arid zones, of which nearly two-thirds are drought-prone. Large areas in Rajasthan, Andhra Pradesh, Gujarat and Maharashtra and comparatively small areas in Karnataka, Orissa, Madhya Pradesh, Tamil Nadu, Bihar, West Bengal and Uttar Pradesh are frequently by drought. About 40 million hectares of land is flood-prone, including most of the river basins in the north and the north-eastern belt affecting 30 million people on an average each year.

A mean sea level rise of 15-38 cm is projected along India's coast by the mid-21st century and of 46-59 cm by 2100. India's NATCOM 1 assessed the vulnerability of coastal districts based on physical exposure to SLR, social exposure based on population affected, and economic impacts. In addition, a projected increase in the intensity of tropical cyclones by 15% poses a threat to the heavily populated coastal zones in the country (Gol, 2004).

The comprehensive vulnerability index developed by the IPCC includes the following indicators as the proxy variables and tries to develop an index by taking the geometric mean of the various proxies after standardizing them. Table 1 lists the various proxies used by the IPCC.

Table 1: IPCC indicators for assessment of vulnerability

Sensitivity or Adaptive capacity category	**Proxy variables**
Sensitivity	Access to clean water and sanitation
Food security	Cereals production/area, Animal protein consumption per capita
Ecosystem Sensitivity	%Land Managed, Fertilizer use
Human Health Sensitivity	Completed Fertility, Life expectancy
Water Resource Sensitivity	Renewable supply and inflow, Water use
Economic Capacity	GDP (market)/ capita, Gini Index
Human and Civic Resources	Dependency Ratio, Literacy
Environmental Capacity	Population Density, SO_2/area and % Land Managed

This is done by including many indicators that serve as proxies to look at different aspects of vulnerability. In other words we assume that vulnerability can arise out of a variety of factors. In particular we look at four different sources of vulnerability. This includes the climatic factors, demographic factors, agricultural factors and occupational factors which are trivial in determining the overall vulnerability of an area. Table2 shows the variables undertaken to estimate the extent of vulnerability index.

Table 2: Sources and Dimensions of Vulnerability

Vulnerability Index	
Demographic Vulnerability	Density of population. Literacy rate
Climatic Vulnerability	Variance in annual rainfall. Variance in June-July-August Rainfall. Frequency of extreme events
Agricultural Vulnerability	Production of rice. Cropping intensity. Area under cultivation. Number of cattle and livestock
Occupational Vulnerability	Agricultural labourers. Manufacturing labourers. Non workers

In this background the present study attempts to construct vulnerability index for few selected states in India which are more exposed to extreme events and ranked them according to their value of index.

Methods of Analysis

The construction of the index is based on 10 states of India, these are, Maharashtra, Gujarat, Orissa, Andhra Pradesh, Tamil Nadu, Assam, Rajasthan, Bihar, West Bengal and Uttar Pradesh which are exposed to different extreme events in form of Flood, Drought, Cyclones, Earthquakes and Heat waves.

The methodology used to calculate the vulnerability index follows the basic approach developed by (Anand and Sen, 1994) for the calculation of the Human Development Index (HDI). To construct the vulnerability index for different states through following steps

Step 1: Calculate a dimension index of the each of the indicators for a district (X I) by using the formula

(Actual X I – Minimum X I) / (Maximum X I- Minimum X I)

Step 2: Calculate a average index for each of the four sources of vulnerability viz. Demographic, Climatic, Agricultural and Occupational vulnerability. This is done by taking a simple average of the indicators in each category.

Average Index i= [Indictor 1 +…..+ Indicator J] / J

Step 3: Aggregate across all the sources of vulnerability by the following formula.

$$N, \text{Vulnerability Index} = \left[\sum_{i=1} (\text{Average Index } i)^{\alpha} \right] 1/^{\alpha} / n$$

Where,

J = Number of indicators in each source of vulnerability

n= Number of sources of vulnerability (in the present case $n=\alpha=4$)

After the values of the index are calculated for all the states a ranking of various states can be carried out to identify the most vulnerable states in terms of the indicators used for measurement. This analysis will be repeated for different time period in order to see how the vulnerability profile has changed over the years for the states in terms of the indicators used to measure the vulnerability.

RESULT AND ANALYSIS

The following table shows the values of the vulnerability index at the two different time periods and the corresponding ranks of the states at the different time periods in the table a rank of one shows the maximum vulnerable states and the vulnerability decreases as we go on increasing the rank.

Table 3 gives state wide analysis of vulnerability index and their corresponding ranks. Higher value of index shows higher level of vulnerability and vice-versa. It is quite evident from the findings that few states are more vulnerable in both time periods like Bihar, Orissa, Andhra Pradesh and Tamil Nadu. The possible cause of high vulnerability in Bihar may be because of flood. However the other three states which are more vulnerable possibly because of super cyclone in 1999 in Orissa and also since they are the coastal states more exposed to cyclonic events like Tsunami. Although the states are having a decreasing trend from one time period to another still the differences in their vulnerability status is not significant.

Table 3: State wise Vulnerability Index and Ranks

States	Time period(1995)	Rank	Time period(2005)	Rank
Andhra Pradesh	0.068	8	0.064	8
Assam	0.027	4	0.031	4
Bihar	0.072	10	0.066	9
Gujarat	0.063	6	0.034	5
Rajasthan	0.013	1	0.011	1
Maharashtra	0.026	3	0.023	3
Orissa	0.071	9	0.070	10
Tamil Nadu	0.065	7	0.062	7
West Bengal	0.054	5	0.054	6
Uttar Pradesh	0.021	2	0.023	2

States with poor infrastructure are prone to maximum vulnerability. States like Orissa, Bihar and Assam are the classic case in the scenario. Demographic factor and poor infrastructure are guiding factors for vulnerability.

Here are the latest report mention's year of 2017 top 10 states as per their Gender Vulnerability index scores, Rank wise: Goa-0.649, Kerala-0.625, Mizoram-0.620, Sikkim-0.604, Manipur-0.603, Himachal Pradesh-0.595, Karnataka-0.592, Punjab-0.585, Maharashtra-0.580, Uttarakhand-0.573.

SUMMARY AND CONCLUSION

Hazards and extreme events themselves can after the context for economic and social development, which can in turn reduce the capacity to respond to future extremes. Cumulative effects of events such as cyclones, floods or droughts etc. not only damage or destroy material assets and human lives, but they may also influence the capacity and resilience of individuals to recover their sense of well-being.

Vulnerability reduction is thus recognized as an important strategy for reducing disaster risks and minimizing the impacts of climate change. However, despite increased emphasis on the importance of social, political and economic contexts, climate change adaptation and traditional disaster risk management activities remain largely delinked from vulnerability reduction. In fact, a synthesis of evaluation finding on humitarian responses to natural disasters found relatively few examples of good practices related to vulnerability reduction. There tends to be, instead, a disproportionate emphasis on relief and recovery processes that prioritize a return to 'normalcy', rather than focusing on the conditions that cause risk and vulnerability. In many cases, these 'normal' conditions are directly or indirectly contributing to risk and vulnerability.

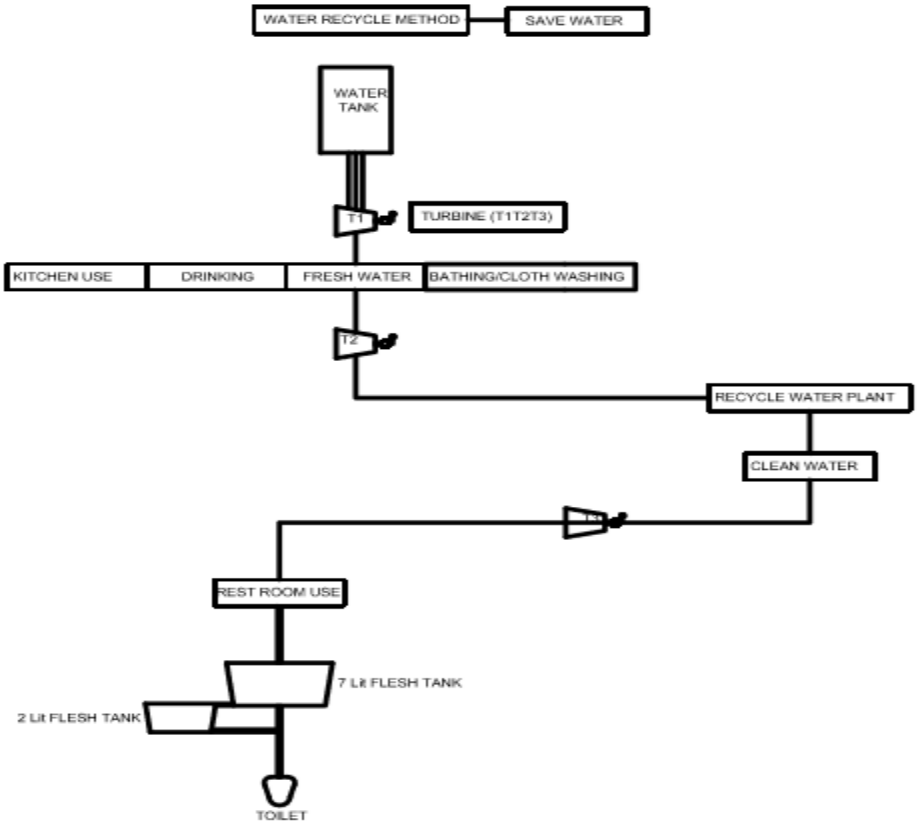

Figure 1. Water re-cycle layout.

Figure.1.shows where ever we are utilise the nature source completely in our domestic usage chance to extened the time period of water source. In this patern may came out to the practical life much helpful to extened the green house energy and water sources, in our domestic usage of water through by over head tank it's travel to the ground floor in this kinetic energy we can covert to electrical energy use by nano turbines and also we can reduce the water usage in this method like recycle of water to re-use to the rest room and gardening purpose. The design of the flush tank it's help's to reduce the cosumption of water when ever use for urine purpose. Save water give a life to our next Generation.

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