Climate Change and Vulnerability: Evidence from Indian coastal districts

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Introduction:

- Vulnerability encompasses exposure to risk, hazards, shocks and stress, difficulty in coping with contingencies, and access to assets.
- Vulnerability refers to a situation when certain groups in society are more vulnerable than others to shocks that threaten their livelihood and/or survival.
- This has two elements:

1. the severity of the impact of the shock (the more severe the impact if the risk is not managed, the higher the vulnerability), and
2. a person's resilience to a given shock (the higher their resilience, the lower their vulnerability), in other words, resilience is in indicator of adaptive capacity.

Introduction contd.:

- Vulnerability therefore arises from a lack of opportunity to manage risk.
- The vulnerable thus would include not only those who are poor but also those sections of the non-poor who are potentially exposed to severe shocks and have little ability to manage risk.
- Vulnerability and adaptation to climate change are urgent issues among many developing countries.

Objective:

- Make a socio-economic assessment of vulnerability of populations living in coastal districts in India with respect to frequency of occurrence of extreme events (storms and severe storms).

Studies pertaining to assessment of vulnerability:

Study	Year	Vulnerability Arising From
Watson et al.	1995	IPCC Indicators
Zeidler	1997	Sea Level Rise
Rosenzweig & Parry / Dehn & Buma	1994 / 1999	Landslide Activities
Blaikie et al.	1994	Human Dimensions (Pressure and release model)
Wisner	1999	Earthquake, Hurricane
Watts and Bohle	1993	Famines
Adger and Kelly	1996,2001	Entitlement approach in terms of access to resources
O'Brien and Liechenko	2002	Climate Change and Access to resources
Smit and Pilifosova, Bohle, Downing	2002	Vulnerability = f(Exposure to a stimulus, capacity to adjust to it)
Ghazala Mansuri and Andrew Healy	2002	Probability of future poverty
Ethan Ligon and Laura Schecter	2002	Loss associated with different sources of uncertainty
Shubham Chaudhuri	2001	Household Vulnerability to poverty
M.A. Chen	1991	No of income or food generating techniques available area
W.E. Riebsane, S.A. Changnon Jr. and T.R. Karl	1991	Vulnerability reduction Strategies
Gunther Fischer, Mahendra Shah, and Harriz van Valthuizen	2002	Crop Modeling and GIS framework

Measures of Vulnerability:

For the purpose of this paper, vulnerability is derived from:

- exposure to risks and shocks and
- an inability to manage these risks and shocks (adaptive capacity)

We construct a picture of socioeconomic context of vulnerability in costal zones of India, by focusing on indicators that measure both the state of development of the region as well as its capacity to progress further.

Measures of Vulnerability:

- The first aspect is reflected through agricultural development
- the second through infrastructure

In other words we will be studying the impacts via Infrastructure, Agriculture and Demography.

Profile of coastal zones of India:

- The coastal zone is an important and critical region for India, which is endowed with a coastline of over 7500 km. 3 of the 4 major Indian metropolitan areas are located in the coastal region (Mumbai, Kolkata and Chennai).
- The total area occupied by coastal districts is around 379610 sq. km, with an average population density of 455 persons per sq. km, which is about 1.5 times the national average of 324.

Profile of coastal zones of India:

State	population density (per sq. km.)
West Bengal	904
Orissa	236
Andhra Pradesh	275
Tamil nadu	478
Kerala	819
Karnataka	275
Maharashtra	314
Gujarat	258

Profile of coastal zones of India:

- the districts on the eastern coast of India are far more vulnerable than the western coast in terms of exposure to severe storms, storms and depressions.

Infrastructure Development

- Infrastructure plays a key role in influencing vulnerability and enhancing adaptive capacity.
- For comparing the infrastructural development of the coastal districts in India an infrastructure index has been developed based on integration of some key variables.
- The index is built at four time periods 1980, 1985,1990 and 1995, which corresponds to the planning periods of India.

Infrastructure Development

The following indicators were used in the calculation of Infrastructure Index:

- Finance: Number of Banks (Scheduled Commercial including regional rural banks)
- Education: Total number of Schools (Primary and Secondary) and Total number of Teachers (Primary and Secondary)
- Health: Total medical institutions (Hospitals and Dispensaries) and Total medical beds available
- Transport: Number of motor vehicles

Infrastructure Development

- In general districts in Maharashtra have high level of infrastructure growth followed by other states like Andhra Pradesh, Karnataka, Orissa and Kerala.
- Looking in detail Maharashtra does well in terms of number of banks followed by Andhra Pradesh and Kerala.
- In terms of number of schools the districts of Orissa perform better than other states followed by districts of Maharashtra and Andhra Pradesh.
- If we look at the indicators of health than districts of Andhra Pradesh and Karnataka are generally better than the other districts.

Infrastructure Development

- Broadly there are three sets of clusters in the time periods 1980 and 1995 and two sets of clusters in the time period 1985 and1990.
- The compositions of districts in the clusters are also more or less same at the four time periods.
- For the year 1995 we have three clusters with districts of Kerala in the first. The second cluster is a mixture of districts from all of the coastal districts and the third cluster is of districts from Orissa.
- The districts in the first cluster have a high value of infrastructure index followed by the districts in cluster two and three.
- Since infrastructure development is determined by state policies and economic growth, there is high variability in percentage change in infrastructure across coastal districts.

Agricultural Development:

- The variables that have been analyzed include crop production and area for major crops, cropping pattern changes, fertilizer consumption and net area irrigated.
- The time period covered for assessing changes in agricultural variables is 1966-1994. This has been further subdivided into two subsets; the first period covers data from 1966 till 1980 and the second period from 1981 to 1994. This division corresponds to the pre and post green revolution periods in India.

Agricultural Development:

- Mixed results for growth rates for all the indicators across the districts.
- Results from cluster analysis for the entire period points out the presence of five clusters of districts.
- There is a regional trend that is seen from the various clusters. In other words the districts that form the clusters are either from a particular state or have similar regional characteristics with a few exceptions.
- Looking deeper into the growth rates we will see that districts in specific clusters have a similar pattern of growth.

Demography and Literacy:

- Here we will be looking at four indicators population, literates, literacy (number of literates divided by the population of a particular district) and sex ratio.
- The demographic structure of coastal districts in India is characterized by large population growth in the last decades and the density of population is quite high in these districts.
- The average decadal growth rate in population across the districts has been around 20-25 percent.
- The highest growth rate is observed in Thane district followed by Surat which is due to the large-scale migration of people from all other states to this part.

Demography and Literacy:

- Average growth rate of literates is 40-45 percent which highly overweighs the growth rate of population.
- The sex ratio we see many negative values implying that the sex ratio has decreased in many of the districts.
- There are five clusters with two big clusters and three small clusters.
- Cluster 5 show a high rate of growth of population and exhibit similar trends in terms of literacy, literates and sex ratio. Cluster 2 is characterized by moderate to high growth in population and literacy but high growth in literates and positive growth in sex ratio. Cluster 1 shows positive growth in terms of sex ratio and average growth in terms of other indicators

Conclusions:

- In our framework of assessment of vulnerability and adaptive capacity in coastal zones of India we have tried to include qualitative as well as quantitative indicators.
- A state can be a coastal state but a larger part of it can be non-coastal. Therefore by doing our analysis on a district level we increase the accuracy of our study.
- Agricultural production in these coastal areas is heavily dependent on climatic conditions, as despite the availability of irrigation facilities they are heavily dependent on rainfall.
- The settlements in coastal areas of India have a high percentage of people whose income is derived from climate sensitive sectors like agriculture, fisheries, forestry and farming. Since these activities are the primary producing sectors and a major source towards the GDP of the country, the GDP is also affected in an indirect way.

Policy Implications:

- The impacts of climate change on infrastructure and to the population take place through a variety of ways. Physical infrastructure is directly affected by climate related changes. The economy of the area in concern can also be affected in an indirect way.
- In terms of our analysis we see that the most vulnerable areas to climatic changes as accounted by the frequency of storms, severe storms and depressions perform very low in terms of infrastructure.
- We conclude by saying that a suitable development and mitigation strategy should incorporate climate change policies with social and physical infrastructure development, and reducing vulnerability contexts.