VULNERABILITY ASSESSMENT OF CUDDALORE COAST, TAMIL NADU,INDIA:THE SCIENCE POLICY INTERFACE

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ABSTRACT

About one-third of Indian population is estimated to be living in the coastal region, of which, more than 250 million people live within 50kms of the coastline and are dependent on its resources as coastal region offers many livelihood opportunities. Coastal zone is frequently exposed to natural hazards including cyclones and tsunamis, causing storm surges, erosion/ accretion, landslides, and coastal flooding which are constantly affecting the shorelines, beaches and headlands, that often have resulted in loss of human life, damage to ecosystems and to property.

Natural hazards such as cyclones, storm surge and coastal flooding need not necessarily have to become natural disasters. Magnitude and risk of disasters are directly proportional to the sensitivity and degree of resilience of the exposed community. To mitigate the ill effects of hazards, a thorough understanding of the vulnerability causing factors and community's coping capabilities is needed, for which vulnerability analysis is essential. A comprehensive vulnerability analysis would help in appropriate planning and adequate management of vulnerability with stakeholders' involvement, that would result in significant risk reduction besides improving the coping capacity of vulnerable community.

Tamil Nadu, situated on the south east of peninsular India, has high risk exposure to recurrent coastal hazards including cyclones. The cyclonic rains bring in huge runoff coupled with tide and storm surge, cause flooding of rivers which overflow their banks and result in flood-related damages. Studies carried out in the Cuddalore region of South India reveal that this low lying coastal zone suffered significant erosion during the last century,

especially during tsunami of 2004 and cyclonic storms. In response to these impacts, a variety of coastal defence measures and adaptation strategies have been implemented in this region, although with only limited success.

Analysis of changes along the shoreline using the information extracted from the satellite imageries between the years 1972 and 2011 indicated that the average net rate of shoreline change was +0.15 m $year^{-1}$. Of the total length of 42 km studied for shoreline changes, about 40.5% of the coastline is accreting, while, 15.72 % of the coastline is medium to highly eroded and 18.23% is classified under low erosion zone. The flood hazard mapping study undertaken for a stretch of ~14 km along the Cuddalore coastline for 1-in-100-year extreme flood level, including local mean sea level and global sea-level rise indicated maximum inundation level to be ~3.62 m form MSL for the Cuddalore coastal region. Assessment of multi-hazard vulnerability along the Cuddalore coast suggests that river systems act as the flooding corridors that carry larger and longer interlard inundation. The composite hazard line drawn on the GIS map shows that seventeen habitations (coastal settlements) in the study area are vulnerable to storm surge coastal flooding generated by one in 100 year return period storm surge (~3.62 m height).

The study directly supports the Integrated Coastal Zone Management (ICZM) Plan of the Tamil Nadu State through identification and assessment of coastal hazards and the overall vulnerability to coastal flooding and erosion. The composite hazard line identified in the study with a coastal flooding return interval of less than 1 in 100 years would help in taking protection measures against coastal hazards. The key results from this pilot study may be used directly by the State of Tamil Nadu in the protection of the coastal livelihoods, better ecological conservation measures and sustainable development along the coast. This study is a step toward mapping the hazard line for the entire coast of India that helps in protecting human lives and property.

The study further attempts to draw a comprehensive vulnerability framework by combining Geo-Physical-Natural factors with Socio-Economic-Institutional factors responsible for causing vulnerability at habitation and household levels to construct Composite Vulnerability Index (CmVI) and Household Vulnerability Index (HVI) along with the major dimensional indices for the identified seventeen vulnerable habitations. CmVI of 17 habitations in study area has been developed on a scale of *'one'* to*' five'* by considering nine broad dimensions of vulnerability viz., geographic, demographic, institutional, natural, social, safety infrastructure, physical, livelihood and economic, each expressed by five indicators, using a total of seventy five variables of vulnerability, with weightage of 22.20%, 13.19%, 13.34%, 13.35%, 9.20%, 6.24%,5.89%, 9.83% and 6.77% respectively, arrived through Analytic Hierarchy Process (AHP). The CmVI range has been classified in to Level *4* (CmVI >4: *extreme level), Level 3*(CmVI between 3 and 4: *acute level), Level 2* (CmVI between 2 and 3: *high level)* and *Level 1* (CmVI<2: *moderate level).*

The results indicated that two habitations have CmVI in acutely vulnerable (level 3) category viz. Samiyarpettai (3.18) and C. Pudupettai (3.10) and rest of the 15 habitations have CmVI in the highly vulnerable (level2) category. Dimension-wise vulnerability indices appear to differ considerably among different habitations. Institutional vulnerability is in a lower range owing to a better prepared coastal community after 2004 Tsunami. CmVI construction enables the policy makers to devise a suitable strategy for vulnerability reduction of habitations. The habitation vulnerability mapping provides information for prioritization of the interventions for risk reduction and resilience enhancement and is a very useful tool for developing effective policy framework to reduce vulnerability at habitation level.

The household vulnerability index constructed for every household in each of the vulnerable habitations in study area would help in identification of those households which are more vulnerable and need better preparedness and priority attention compared to other stakeholders to cope-up with the identified disaster. HVI was constructed on a scale of *'one'* to*' five'* and households were classified in four categories of vulnerability viz. Extreme Level (HVI>4), Acute Level (HVI3-4), High Level (HVI 2-3) and Moderate Level (HVI<2), by considering seven dimensions of vulnerability viz., geographic, demographic, social, safety infrastructure, physical, livelihood and economic, each expressed by two to five indicators, using thirty two vulnerability variables, with weightage of 22.73%, 16.42%, 15.28%, 11.64%, 8.39%, 15.28%, and 10.26% respectively, arrived through AHP.

The results indicated that out of 3193 households in the study area, 4 households (0.1%) are in emergency level, 395 (12.4%) households are in acute level, 2761 (86.5%) households in high level and 33 households (1%) are under moderate level category of HVI. The study suggests that eight out of the seventeen habitations namely Madhavapallam, Velingarayanpettai, Ayyampettai, Reddiyarpettai, Kumarapettai, Annappanpettai, Nanjalingampettai and Chinnur North are habitations with high priority for coastal vulnerability since they are having >90% of the households in high level and above category of HVI. The HVI mapping on GIS map has been done for every habitation using colour codes for different levels of vulnerability, which explains the spatial distribution of household vulnerability and provides information to prioritise the vulnerable households in developing efficient emergency response system and minimising the ill effect of disasters.

A web enabled decision support system was designed based on the vulnerability assessment framework developed to identify the vulnerability causing factors and to prioritise the 'at risk' of habitations and households in study area. This decision support tool would be useful for the administrators, policy makers and exposed communities to identify and prioritise various short term and long term vulnerability reduction interventions in improving the emergency response and reducing the impact of coastal hazard in order to make the coastal community safe.