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AN ASSESSMENT OF FLOOD VULNERABILITY USING RISK MATRIX METHOD- A CASE STUDY OF KANAYAKUMARI DISTRICT, TAMIL NADU

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Abstract: *Kanniyakumari district is the southernmost part of Tamil Nadu which is prone to disaster and escalating disaster losses. An effective way of disaster mitigation is the foundation for proficient disaster response and rescues which results for reducing the degree of hazardous impacts on the population. Vulnerability is the term to which the populations capacity to anticipate and recover the impact of hazardous event. Vulnerability systematically estimates the damage that could be caused by a potential disaster. The main aim of this paper is to assess the flood vulnerability of region using risk matrix method. It highlights the identification of elements and stakeholders potentially at risk, identification of factors influencing on vulnerability and the mitigation measures to reduce the hazards.*

Keywords: Vulnerability assessment, Matrix method, Mitigation measures, Risk reduction

Introduction

Asia is the one of the most disaster-prone region in the world. Millions of populations are at risk to natural hazards such as typhoon, flood, landslides and fires. According to National Institute for Disaster Management (NIDM), the disaster is defined as a "catastrophic situation in which the normal pattern of life or ecosystem has been disrupted and extra-ordinary emergency interventions are required to save and preserve lives and or the environment. Their impacts are diverse in nature and also it leads to loss of life, injury and diseases and the destruction of property and other assets, disasters can also cause socio-economic and environmental disruption. In particularly, the hydrological hazards that affect an increasing number of people and cause increasingly large economic losses (United Nations Office for Disaster Risk Reduction-UNISDR). India is ranked as high-risk class, as per INFORM rating, with the risk management index of 5.7, whereas in terms of flood hazard index, the value is about 8.5 comparatively.

In general, the coastal region is one of the most dynamic zones on landscape which subject to various natural and anthropogenic processes that continuously changes the condition of the coastal region *(Natesan and Anitha 2010).* In fact, the coastal zones in India assumes importance because of high productivity of its ecosystems, density of population, utilization of renewable and nonrenewable natural resources, industrialization and spurt in recreational activities. Boundaries of the coastal zones are defined in different ways depending on the focus of interest and availability of data. Typically, a combination of distance to coast and elevation data is used. Different countries use different distance criteria for defining the coastal zone. In India, 500 m distance from the high tide line (landward) is taken for demarcating the coastal zone. Total coast line of the world is 3,56,000 km and the coastal area covers more than 10 percent of the earth surface. Due to its economic and natural enrich, the world's population of about 40 per cent lives within 100 km of the coast. About 10 percent of the world's population resides in low elevation coastal zone (<10m) making their lives highly vulnerable to coastal disasters. About 35 per cent of Indians live within 100 km of the country's coast line measuring 7,517 km. The statistical data of global disaster shows that the hazard and exposure of the country is in the index of 7.8, but it has to be highlighted that the disaster risk reduction (DRR) index in the value of 1.8 only. DRR is a systematic approach to identifying, assessing and reducing that risk. Specifically, the purpose of DRR is to minimize vulnerabilities and disaster risks throughout a society to avoid or limit (mitigate and prepare for) the adverse impacts of natural hazards, as well as to facilitate sustainable development. DRR is also recognized as a key climate change

adaptation strategy. There is a tremendous need of conceptual training and awareness programme for the disaster risk reduction in order to prepare the effective disaster management plan for the nation. *(Zhang, D. H. 2009).* Earthquakes and Tsunami can affect the coastal line communities and must be included in disaster risk reduction strategies and processes. The community people living along the coastal region can be easily destroyed by disastrous event and safe zones are difficult to reach by the people. Tsunami, Cyclone and Sea level rising involve vulnerable risk and have the potential to cause massive damage to the coastal communities *(Beevi, H. 2014)*. The study highlighted that 44 coastal fishing villages are partly located below the two meter contour line in Kanyakumari district and hence it is highly vulnerable to sea level rise. The study of natural disaster and its socio economic and environmental impact of Kanniyakumari district highlighted that the overall damages to be at 574.5 million dollars and losses at 448.3 million dollars, where the 75 percent of damage and losses were on the coastal region. Coastal landform configurations are dependent on the pre-existing coastal settings, geological structures and a variety of coastal processes.

Most of the landforms along southern coast of Tamil Nadu particularly on the south west coast of Kanniyakumari district have undergone morphological deformation due to the effect of Tsunami occurred on December 26, 2004. *(Saravan, S. 2009)*. Coastal zones are dynamic areas that are constantly undergoing change in response to a multitude of factors including sea level rise, wave and current patterns, hurricanes and human influences. Disaster leads follows restoration and augmentation principles which give more benefits to the low-income group of the coast. In the coastal region the higher is the loss of property, the lower is the tendency among the dwellers to invest which has a long-lasting effect on capital formation and social development. *(Juntunen, L. 2005).* The main aim of this paper is to assess the vulnerability of coastal region using risk matrix method. Remote sensing and GIS can be used as an effective tool to identify the areas that are vulnerable to coastal erosion along the coast.

Study Area

The study area is taken for the study is the southernmost district of Tamil Nadu. The district lies between 77^0 15' and 77^0 36' of the Eastern longitudes and 8^0 03' and 8^0 35' of the Northern Latitudes (Figure 1). The Southeastern boundary is the Gulf of Mannar. On the South and the Southwest, the boundaries are the Indian Ocean and the Arabian Sea. The total area of Kanniyakumari district is 1,684 sq.km. The population of the district according to the Census 2011 is 1,870,374 and the population density is 1,111persons/sq.km. The district has four municipalities Nagercoil, Padmanabhapuram, Colachel and Kuzhithurai, which includes four taluks namely Thovalai, Agastheeswaram, Kalkulam, Vilavancode and these four taluks are further sub divided into nine blocks. The sea coasts, the sandy type of soil prevails and near the mountain ranges, gravelly soil is generally seen. In low lands, there is neither white sand nor sandy lam, while in the midlands and high lands there prevails fairly fertile soil of the fine type. Rainfall varies from 103 cm to 310 cm and elevation from sea level is 1829 m.

Objectives

The assessment on coastal vulnerability recognizes that whether in pre-disaster or post disaster follows that the vulnerability gets transformed (either reduced or increased) with the nature of development performance and design inputs. The main aim of this paper is to assess the flood vulnerability of region using risk matrix method. GIS can be used as an effective tool to identify the areas that are vulnerable to coastal erosion along the coast.

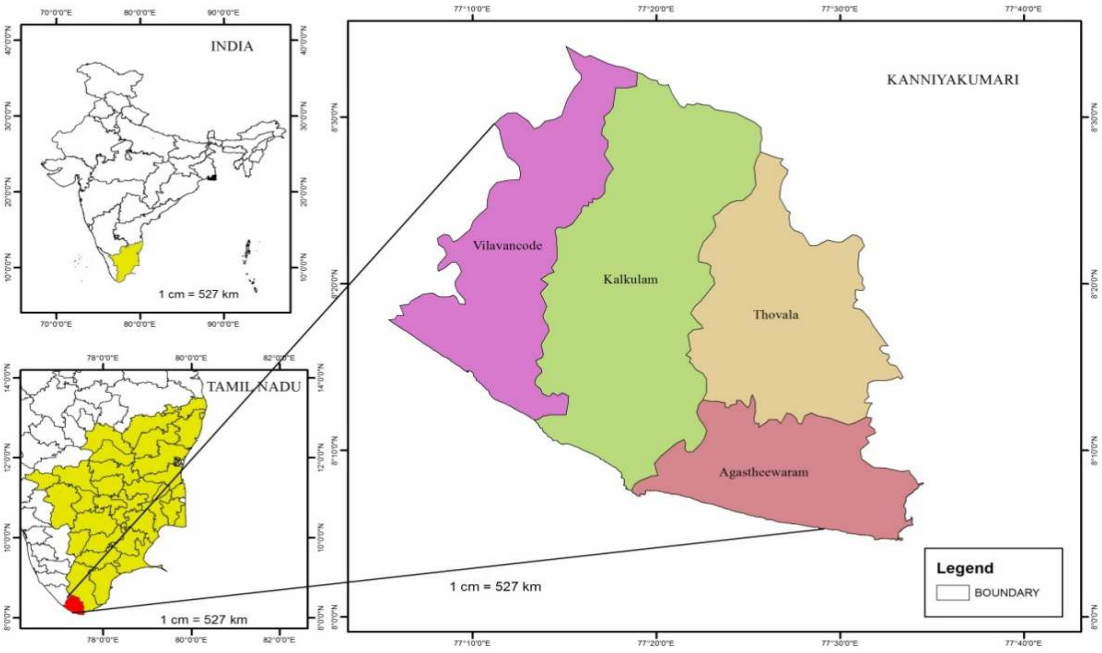
Methodology

Vulnerability Assessment

Vulnerability is the term to which the populations capacity to anticipate and recover the impact of hazardous event. Vulnerable populations usually include those with low incomes, individuals who may be chronically or terminally ill, physically or mentally disabled, homeless, or uninsured or underinsured; and the elderly, children, and pregnant women. One ongoing area of vulnerability is the surge capacity for large-scale events. During the response phase, (96 hours after the disaster occurs), the affected communities are coupled with stress that need immediate and specialized first aid services. A Vulnerability assessment is the significant step in the emergency response to

a disaster. It shall methodologically evaluate the degree of impact and provide background information to create a targeted disaster mitigation plan.

Figure 1: Study Region



Social Vulnerability

Social vulnerability refers to the resilience of communities when affected by external stresses on human health, such as natural or human-caused disasters, or disease outbreaks. When there is disastrous event some citizens such as children, elderly people and other physically challenged people may be unable to protect them or evacuate if necessary. The concept of vulnerability also involves socio-economic factors that affect community resilience.

Physical Vulnerability

According to UNISDR, the physical vulnerability may be determined by aspects such as population density levels, remoteness of a settlement, the site, design and materials used for critical infrastructure and for housing. The physical vulnerability of a region also depends on its geographic proximity to the source, meteorological parameters and origin of the disasters e.g. if region lies near the coast it makes the area more vulnerable to disasters as compared to an area that is far away from the origin of the disaster. The present study analyzed the rainfall pattern of the study area for two decades.

Capacity

According to NIDM the term capacity is the combination of all the strengths, attributes and resources available within a community, society or organization that can be used to achieve agreed goals. The process by which people, organizations and society systematically motivate and develop their capacities over time to achieve social and economic goals, including through improvement of knowledge, skills, systems, and institutions called capacity development. At Kanniyakumari region primary health care delivery system to the rural has been provided by 9 Block Primary Health Centers, 27 additional Primary Health Centers, 6 Urban Primary Health Center and 267 Health Sub Centers. Through these health centers curative and preventive services are being extended to the rural community. Additionally, 27 numbers of sub primary health centers. The emergency ambulance service for the district is 9 regular ambulances and 1 neonatal ambulances of which totally 959 trips per month.

Hazards Profile

According to NIDM the term Hazard is the dangerous phenomenon, substance, human activity or condition that may cause loss of life, injury or other health impacts, property damage, loss of

livelihoods and services, social and economic disruption, or environmental damage. The study area taken for the study is prone to disasters due to a number of dynamics which includes both natural and human-induced, including adverse geo-climatic conditions, topographic features, environmental degradation, population growth, urbanization, industrialization, non-scientific development practices etc. Various hazards to which Kanniyakumari is prone to can be broadly divided into three categories viz. Hydrological or climate related; Geological and Technological hazards. Based on the above clarification the table.1 given below signifies the hazard profile of the district

Table 01: Hazard Profile Kanayakumari District

#	Coastal areas affected by flood	1992	2010	2016
1	Kanniyakumari	NA	✓	✓
2	Azhagappapuram	✓	✓	✓
3	Agsteeswaram	NA	✓	✓
4	Kottaram	NA	✓	✓
5	Thamaraikulam	✓	NA	✓
6	Nagercoil	✓	✓	✓
7	Vadiveeswaram	✓	✓	✓
8	Vadaseri	✓	✓	✓
9	Neenadakarai (Block - A)	NA	✓	✓
10	Vembanoor	NA	✓	✓
11	Suchindrum	✓	✓	✓
12	Theroor	✓	✓	✓
13	Kulasekarapuram	NA	✓	✓
14	Marungoor	✓	✓	✓
15	Eraviputhoor	✓	✓	✓
16	Parakkai	NA	✓	✓
17	Thengamputhoor	NA	✓	✓
18	Mathusoothanapuram	NA	✓	✓
19	Neendakarai (Block - B)	NA	✓	✓
20	Dharmapuram	NA	✓	✓

Source: Kanniyakumari Collector Office NA- Not Applicable

Risk Assessment

Risk assessment is a key parameter for disaster strategy planning. There are many non-completeness perpetual problems in disaster risk analysis and research. The implementation of risk assessment in the study area is usually limited due to the constraints of obtaining data in real applications. The risk is the amount of hazard that occurred to the vulnerability level at the existing capacity over a specific time period. The combination of probability of an event and its negative consequences is termed as risk. In fact, the amount of risk is usually categorized into a small number of levels because neither the probability nor harm severity can typically be estimated with accuracy and precision. In this case, there is need of quantitative assessment to evaluate the level of risk for any hazard events.

Risk = (Hazard x Vulnerability) / Capacity

In fact, the amount of risk is usually categorized into a small number of levels because neither the probability nor harm severity can typically be estimated with accuracy and precision. In this case, there is need of quantitative assessment to evaluate the level of risk for any hazard events. A combination of the impact of loss rating and the vulnerability rating can be used to evaluate the potential risk to the facility from a given events. A sample risk matrix is depicted in Table 2. High risks are designated by the red cells, moderate risks by the yellow cells, and low risks by the green cells.

Conclusions

The study of quantitative risk assessments of vulnerability along the coastal region has been conducted. It is noted that the proportion of population density and literacy rate is relatively high and hence, the communities and stakeholders along the coastal region are prone to moderate vulnerability. The rainfall pattern analysis helps to interpolate the physical vulnerability of the region which tends to be a flood severe zone. Finally, the methodology adopted for the risk matrix

indicates that the study region falls under the category 4C. Therefore, the result concludes that the region under the study have very high severity if the probability of occurrence is occasional. As suggestive measure it is to be noted that government and other organizations are ready to support the coastal area communities in terms of post disaster phase than in the pre-disaster phase. The community people around the district are reasonably suitable for handling the emergency situation. So, the community shall be provided with emergency mock drill or any awareness training programme for the reduction of disastrous situation.

Table 02: Risk Matrix for Kanayakumari District

		Severity				
Probability		Low	Medium	High	Very High	Catastrophic
		1	2	3	4	5
Frequent	A	1A	2A	3A	4A	5A
Probable	B	1B	2B	3B	4B	5B
Occasional	C	1C	2C	3C	4C	5C
Remote	D	1D	2D	3D	4D	5D
Improbable	E	1E	2E	3E	4E	5E

Source: Authors Compilation

Low Vulnerable
Medium Vulnerable
Highly Vulnerable

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