A Simplistic Model Approach to Estimate the Storm Surge Inundation vis-à-vis Risk Zonation in Mahanadi Delta

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Introduction

The coast, along Mahanadi Delta of Odisha is one of the most vulnerable zones in Indian perilous weather extreme like tropical cyclones. The low atmospheric pressure combined with high speed wind of tropical cyclone leads to high sea surface - the storm surge. Storm surges become more disastrous when they combined with high tide phase. A long costline of flat terrain, shallow continental shelf, high population density, geographical location make the delta vulnerable to cyclone and its associated hazards like storm surge. The objective of the present study is to estimate the risk of cyclone induced storm surge in Mahanadi delta.

Study Area

Mahanadi Delta is one of the largest deltas on the east coast of India. Five districts have been taken based on the intersection of below 5 m elevation zone.

Population: Around 6 million (2011), Climate: Tropical with hot humid monsoon

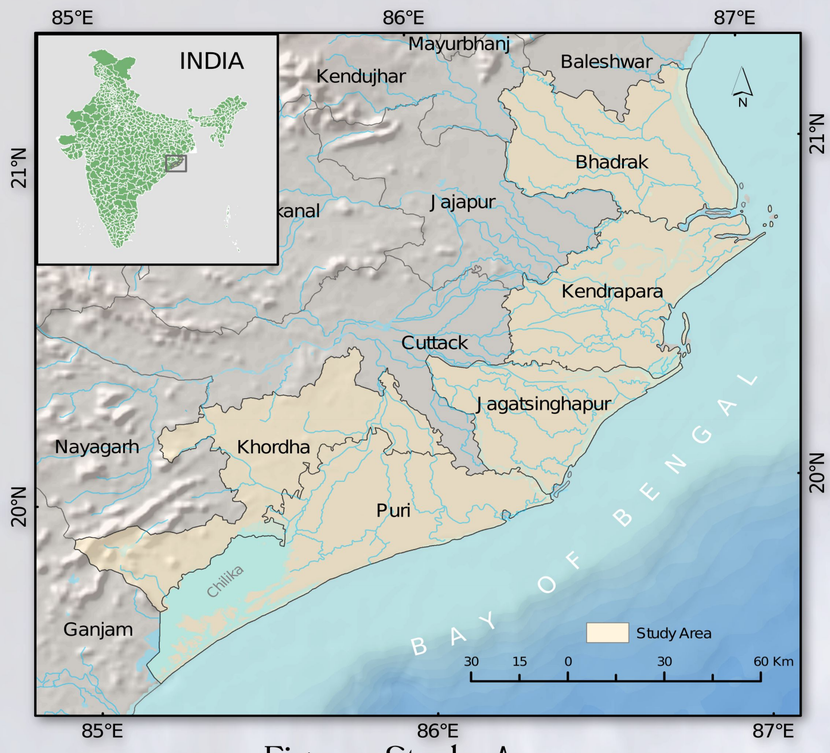

Figure: Study Area

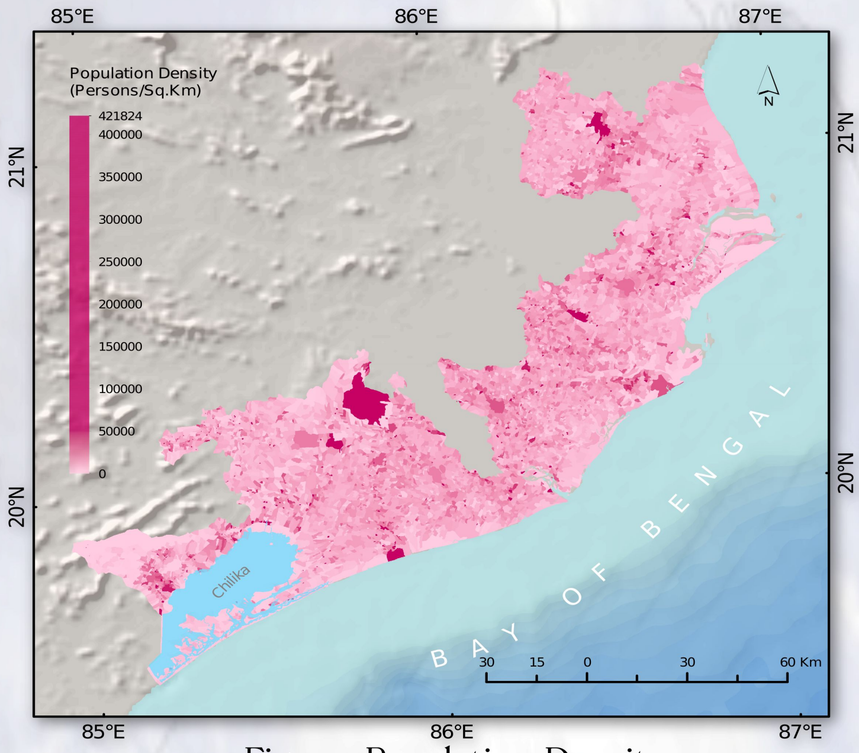

Figure: Population Density

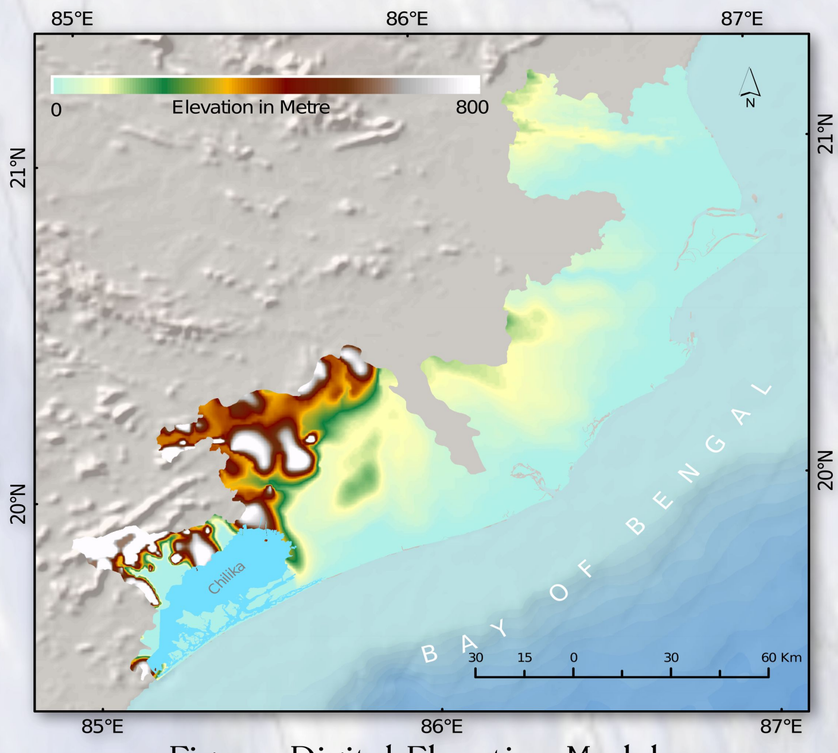

Figure: Digital Elevation Model

Methodology

Data Used: ASTER GDEM and SRTM, IMD Cyclone track data and reports, Village level population (Census of India)

In this study surge height was modelled as follows: Surge height remains constant for a distance of 1.5 km. Surge height decreases constantly (surge decaycœficient) Surge Decay Cœfficient (SDC) was used to calculate inundation depth. Surge height used in this study was taken from Dube S. K. et al. (2009).

The vulnerabity of the people to storm surge flooding was calculated by multiplying normalised population density and normalised inundation depth.

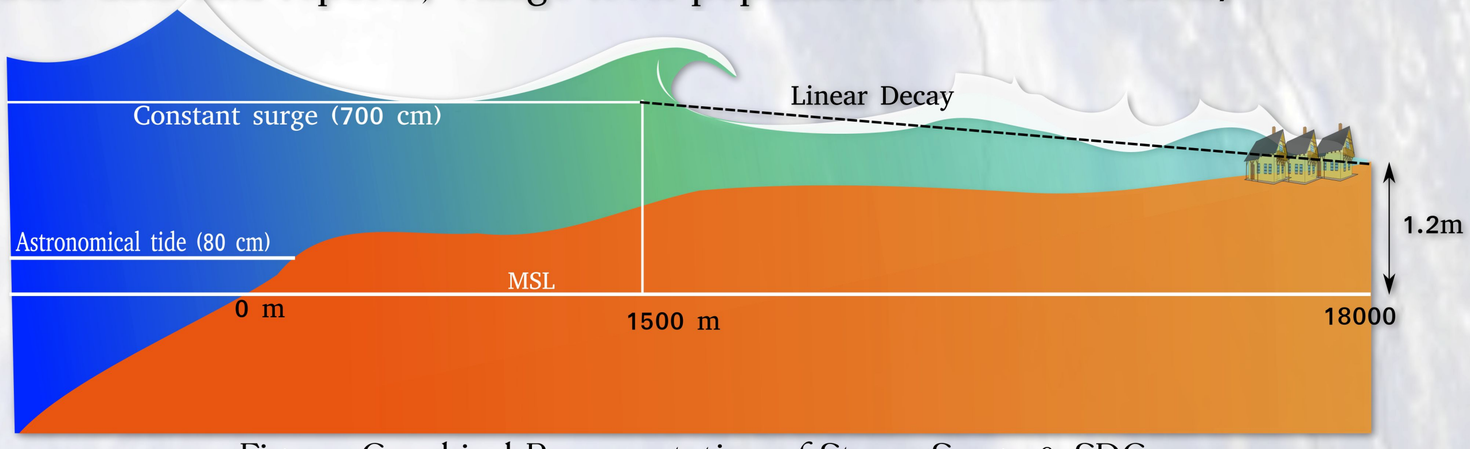

Figure: Graphical Representation of Storm Surge & SDC

$$SDC = \frac{\text{surge height - average elevation at the surge}}{\text{Extent of inundation - extent of constant surge}}$$

$$= \frac{700\text{cm} - 120\text{ cm}}{18000\text{m} - 1500\text{m}} = 0.35\text{ cm/m}$$

Results

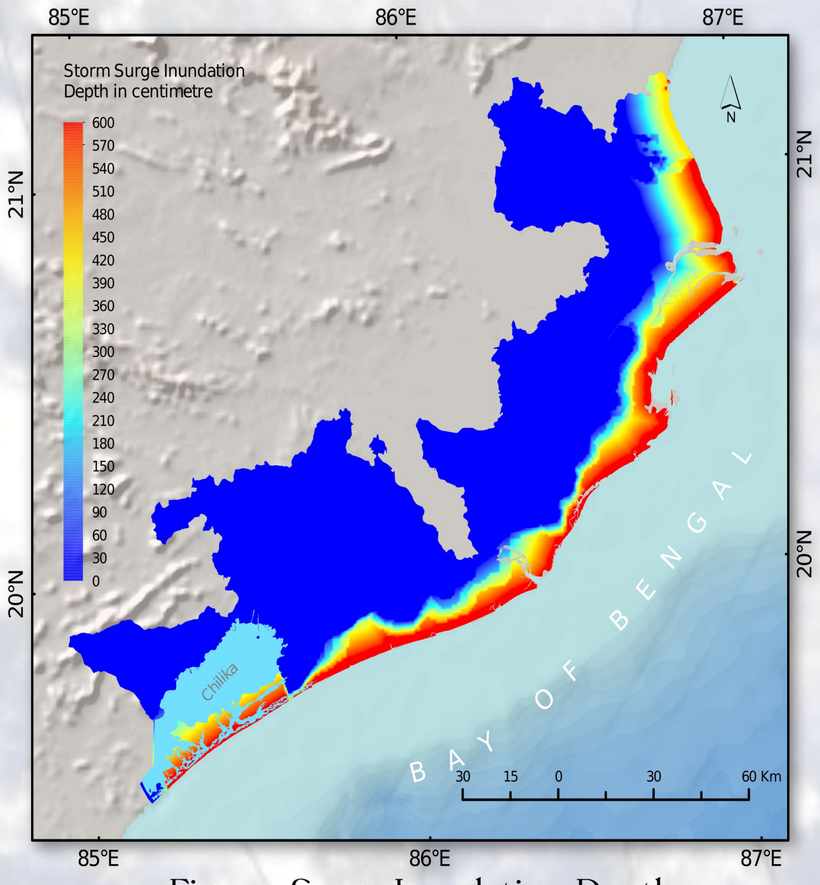

Figure: Surge Inundation Depth

Mapping of inundation depth gives an estimate of spatial extent of flooding due to storm surge. The vulnerability of people and property to storm surge can be predicted from such model. The flat extended landmass along the coastline is highly susceptible to storm surge flooding. Populated places along this region are highy vulnerable. The storm surge of 29-30 October 1999 across the Mahanadi coast inundated large extent of area and killed more than 10,000 people along with large scale damage of crop (1.8 million hectare). Early preparedness can reduce the loss of life and property.

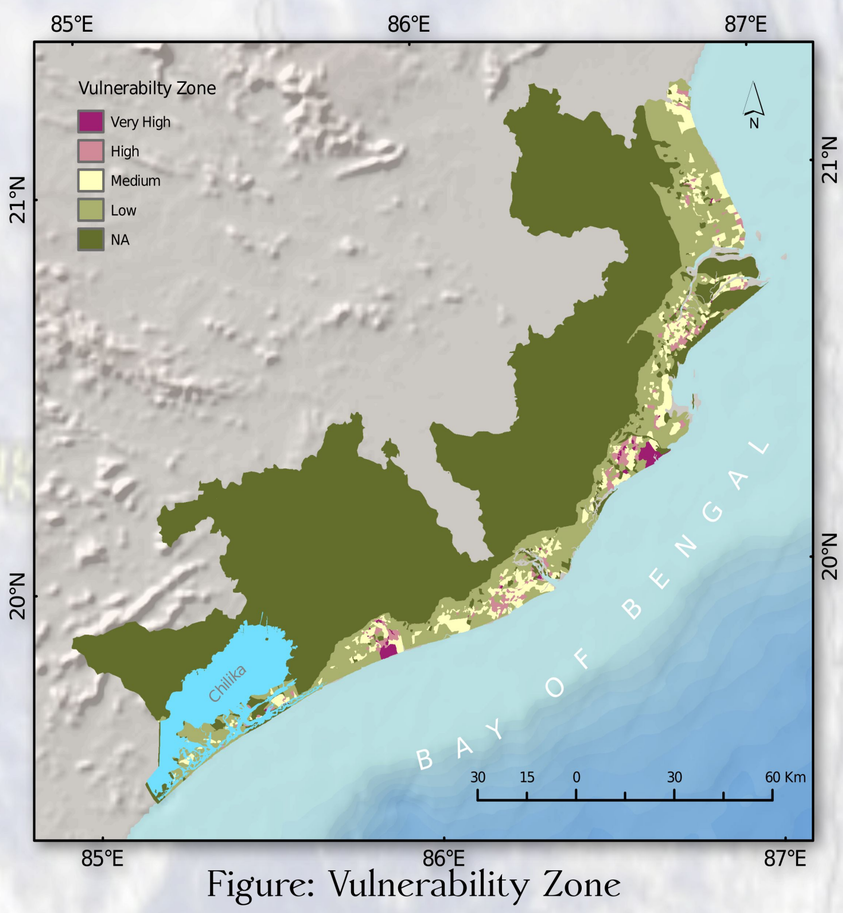

Figure: Vulnerability Zone

Reference

Dube, S. K., et al. "Storm surge modelling for the Bay of Bengal and Arabian Sea." Natural hazards 51.1 (2009): 3-27.

Dube, S. K., et al. "Storm surge in the Bay of Bengal and Arabian Sea: the problem and its prediction." (1997).

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