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The Potential Impacts of Sea Level Rise Along the Coastal Zone of Okha Taluka in Gujarat, India

KEYWORDS

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ABSTRACT *Climate change associated with sea level rise (SLR) is one of the major environmental concerns of today. This paper presents an assessment of the impacts of sea level rise on the coastal zone of Okha Taluka in Gujarat, India . Digital Elevation Model (DEM) combined with overlay techniques in GIS are used in determining the inundation zones along the coastal region. The analysis evaluated the impact on coastal fishing villages, tourist spots and sensitive areas under threat. The vulnerability of the coastal areas in Okha to inundation was quantified, based on the projected sea level rise scenarios of 0.5 and 1 m. the land area of Okha would be permanently inundated due to SLR. This would result in loss of land, alteration of the coastal zone and affects coastal ecosystem. From the study, the mitigation measures (engineering measures) and Coastal Zone Management practices that can be taken to protect human life and property from sea level rise are suggested.*

Introduction
Climate change is an important issue nowadays. Various human activities are making the world hot to hotter. The ultimate result is global warming, i.e. climate change. Rising temperature in the atmosphere causes sea level rise and affects low lying coastal areas and deltas of the world. In 1990, Intergovernmental Panel on Climate Change estimates that with a business-as-usual scenario of greenhouse gas emission, the world would be 3.3C warmer by the end of the next century, with a range of uncertainty of 2.2 to 4.9C (Warrick et al., 1993). With rise in temperature, sea level will rise because of thermal expansion and ice melt. The global mean sea level has risen at a rate of 1 to 2 mm per year during last century (Church and White 2006). Analysis of tide-gauge data indicates a rate of global-mean sea level rise during the twentieth century recently updated to 17 cm (±5 cm) by the IPCC (2007). IPCC show that the temperature increases during 2090–2099, may range from 1.1°C to 6.4°C and sea level rise from 0.18 to 0.59 m. Reductions in the polar ice volume lead to 4–6 m sea level rise (IPCC 2007).

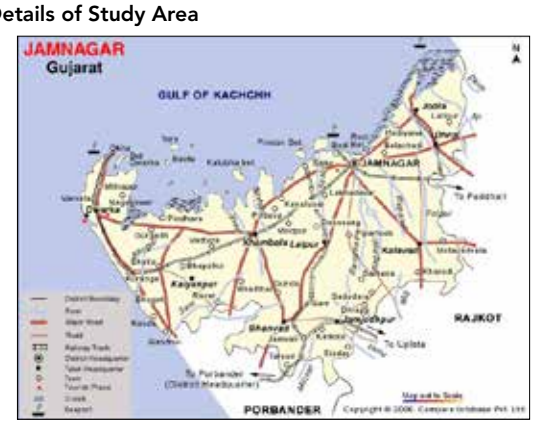
Sea level rise has various impacts on coastal area of Gujarat, which has longest cost line as compared to other coastal state of India. It has affected coastal area by land erosion, salinity intrusion and loss in biodiversity. Its potential threats are coming even strongly in the future. Sea level rise will cause river bank erosion, salinity intrusion, flood, damage to infrastructures, crop failure, fisheries destruction, loss of biodiversity, etc. along this coast.

Impact of sea level rise
- Inundation of the coastal area
- Salt water intrusion
- Soil erosion
- Population of the coastal area
- Infrastructure
- Tourism
- Impact on health
- Impact on ecosystem

Objective of the study
The objectives of this paper were to identify and quantify the vulnerable low lying coastal areas to the adverse effects of sea level rise for study area.

We have employed four projected sea level rise scenarios for assessing the impacts of sea level rise for the study area. In this study, we assessed the impacts on the coastal fishing villages, sensitive areas and tourist spots that may be at risk. The results derived from the study can be used for taking policy decisions and adaptation measures regarding the climate change and sea level rise issues.

Details of Study Area



Jamnagar district lies between 21° 47′ and 22° 57′ north latitude and68° 57′ and 70° 37′west longitude in the peninsular region in the North West, in the state of Gujarat, India, known as Kathiawar or Saurashtra. This district is bound on the North by the Rann and Gulf of Kutch, on the East by Rajkot district, on the South by Junagadh district and on the West by the Arabian Sea. Jamnagar district measures about 128.75 km. from North to South and about 167.37km. from East to West. The area of the district is 10,921 sq. km.

Data collection
We have employed GIS software to overlay the inundation zones with the 2D building foot print of study area for the projected sea level rise of 1 m at an interval of 0.5 m. Study area boundary, coastal villages and contours were obtained from the Survey of India topographic maps. Population data were collected from Census of India, 2001.

Methodology
The procedure details were followed as:
1) Preparation of study area boundary and coastal villages: In order to create GIS database, point and region vector data were used. Study area boundary and coastal villages were extracted from the topographic maps in the scale of 1:25,000 by manual digitizing methods.

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2) Preparation of contours: Contours were obtained from the topographic maps of the scale 1:25,000 at an interval of 5 m.
3) Generation of DEM: The effort to analyze the impact of coastal inundation requires data on the land surface elevations (Titus and Richman 2001). DEM data of the coastal area of Okha were derived from the elevation data in GIS software using interpolation method.
4) Computing the inundation zones: Inundation zones were derived from the DEM by setting the value 0.5 m and 1 m for the SLR scenarios.
5) Identification of the inundated areas: Inundated areas were identified by overlaying the inundation zones with 2D building footprint.

Results

Results for the inundation level are included in the analysis. Coastal zone elevation to sea level rise is illustrated by using DEM and GIS models. About 20% coastal area of Okha are partly located below 2 m contour line in Okha taluka, and hence it is highly vulnerable to sea level rise. These villages have significant values of fishing and agricultural production. There is a great need to identify those areas that are most vulnerable to the impacts of sea level rise. The rise in sea level by 6m will inundating the most of area of the Okha. The identification should focus on densely populated low lying areas.

Mitigation measures

Special attention should be paid to the low-lying coastal zones that are vulnerable to sea level rise and the critical areas should be delineated as high risk zones. Highest priority should be given to mitigate the effects of sea level rise mainly due to anthropogenic activities. Preventing the development near the coastal areas is the best mitigation option. Measures that can be taken to protect the coastal regions were creation of wetlands or mangroves and construction of engineering facilities like dikes or coastal barriers to reduce the effects of sea level rise along the sensitive areas. Improving the coastal monitoring systems (tide-gauge measurements) and utilizing the satellite data measurements, inundation zones were calculated and awareness can be created towards the people. Finally suitable policy decisions and adaptive responses can be established in order to mitigate SLR.

Conclusion

The extent of inundation of the coastal plain of Okha taluka was identified using digital elevation model. Even if greenhouse gas emissions were stabilized in the near future, thermal expansion and melting of glaciers would continue to raise the sea level for many decades. Expected SLR would impact on the vulnerability of the coastal areas of Okha taluka and become a potential hazard to those areas both physically and economically. Broad range of population and infrastructure will suffer from extended coastal inundation due to SLR. Disaster preparedness and mitigation measures at all government levels, such as potential hazard and loss assessment program on the coastal area must also concern the possible impacts of SLR. The result provided from the study is used for the state governments to develop the adaptation plans and appropriate policies to avoid the losses in future.

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