The Scientific Temper (2024) Vol. 15 (1): 1685-1688
E-ISSN: 2231-6396, ISSN: 0976-8653
Doi: 10.58414/SCIENTIFICTEMPER.2024.15.1.16
https://scientifictemper.com/

RESEARCH ARTICLE

Assessing the impact of cyclonic storm Tauktae on shoreline change in Mangaluru coast using geospatial technology

Poojith K. D. P.*, Somashekhara, Dasharatha P. Angadi

Abstract

Cyclones are natural events that occur with atmospheric pressure variations. Compared to the eastern coast of India, the western coast has less cyclonic activity. Even though some of the cyclonic events turn into severe cyclonic storms and cause a huge impact on ecological and anthropogenic activities. This research focuses on the impact of cyclone Tauktae on the Mangalore coast. Cyclone Tauktae, one of the most powerful to pass through coastal Karnataka, caused significant damages, affecting 121 villages and resulting in four casualties. Utilizing geospatial techniques, this study employs Sentinel-2 satellite images to analyze shoreline changes during pre and post-cyclone Tauktae. A GIS technique involves the extraction of shorelines using 10-meter resolution images, with manual digitization excluding natural and man-made structures. Transect lines are generated with the help of DSAS to measure shoreline movement, distinguishing accretion and erosion. Rainfall conditions during the cyclone period are mapped using gridded rainfall data. The study area, encompassing ten coastal villages from Someshwara to Sasihithlu, is characterized by its vulnerability to cyclones. Results reveal substantial shoreline changes, with notable erosion in central and northern Mangaluru, Tannirbavi, and Hosabettu. Accretion is observed in south Someshwara and north Sashihitlu. Rainfall patterns are analyzed using Persian CCS gridded data, depicting the dynamic nature of precipitation during the cyclonic event. This research contributes valuable insights into the short-term effects of cyclonic storms on shorelines, emphasizing the importance of geospatial techniques for coastal management. The findings serve as a foundation for mitigating cyclonic impacts and enhancing resilience in the Mangalore coast, aiding future coastal management strategies.

Keywords: Cyclone Tauktae, Shoreline, Erosion, Transect, DSAS.

Introduction

Humans have had valuable coastal locations since the beginning of time. A third of the world's population lives within 100 km of the coast. The population of coastal zones is quickly increasing due to plentiful natural resources and urbanization. Various development projects have been established in the coastal zone, putting significant strain on it and resulting in a variety of coastal dangers such as sea erosion, seawater intrusion, coral bleaching, shoreline alteration, and so on. Waves, tides, winds, current storms, sea-level rise, geomorphic processes of erosion and accretion, and human activities are all factors that influence shoreline transformation. The shoreline also shows the recent formations and destruction that have occurred along the coast. A shoreline is a boundary between water bodies and land, generally in sea estuaries and lakes. Shoreline change is the fluctuation in the boundary between land and water due to sea level rise, tides, wave action, cyclones, wind, and other natural and anthropogenic factors. The change in shoreline can be expressed both in spatial and temporal terms. There are two major kinds of change that can occur in shoreline: Erosion and accretion. Waves alter the shape of the shoreline and create various coastal landforms. The loose granular sediments react to the ever-changing waves and currents on a constant basis. The beach profile is significant because it can be considered as an excellent natural mechanism for breaking waves and dissipating their energy.

The coastal region of India are vulnerable to intense weather brought on by tropical cyclones (Rajeevan *et al*., 2013; Murakami *et al*., 2017; Poulose *et al*., 2020; Chakravarty *et al*., 2021; Mishra *et al*., 2021). The cyclone seasons in India

Department of Geography, Mangalore University, Mangalagangothri, Karnataka, India

***Corresponding Author:** Poojith K. D. P., Department of Geography, Mangalore University, Mangalagangothri, Karnataka, India, E-Mail: poojith125@gmail.com

How to cite this article: Poojith, K. D. P., Somashekhara, Angadi, D. P. (2024). Assessing the impact of cyclonic storm Tauktae on shoreline change in Mangaluru coast using geospatial technology. The Scientific Temper, **15**(1):1685-1688.

Doi: 10.58414/SCIENTIFICTEMPER.2024.15.1.16

Source of support: Nil

Conflict of interest: None.

Received: 05/01/2024 **Accepted:** 06/02/2024 **Published** : 15/03/2024

are traditionally separated into pre-monsoon (April–May) and post-monsoon (October–December). During the post-monsoon months, cyclones are common and have negative consequences. The cyclones cause large-scale coastal drift, resulting in coastal erosion, mangrove deforestation, and the loss of huge trees (Deshpande *et al*., 2021). Cyclones occur more frequently on India's eastern coast than on its western coast. Nevertheless, in recent years, cyclones across the Arabian Sea have begun to increase in frequency (Baburaj *et al*., 2021; Kar and Banerjee, 2021). Tropical cyclones over the Arabian Sea are garnering scientific attention as their frequency has grown as a result of increased sulfur dioxide (SO2) emissions and anthropogenic black carbon over the Arabian Sea (Evan *et al*., 2011; Murakami and Vecchi, 2015). During cyclonic events, the sea surface's dynamic nature is noticeable, which leads to severe wave action, increased wave height, storm surge and, increased frequency of waves. These factors result in damage to the shoreline and cause erosional activities. From May 14–15, cyclone Tauktae formed on the west coast during pre-monsoon season. Cyclone Tauktae was the most powerful storm to hit Karnataka state and is was also the most affected cyclone to hit the Mangalore coast. Around 121 villages were affected during the cyclone and 4 were deceased in coastal Karnataka.

The motive of the study is to assess the impact of cyclone storm Tauktae on shoreline change in the Mangalore coast. The study has been conducted based on the objectives of collecting sentinel-210 m resolution satellite images of pre and post-cyclonic periods, extracting pre and post-cyclonic shorelines, and mapping the impact caused by Tauktae cyclonic storm in terms of accretion and erosion. The study also focuses on mapping rainfall conditions using gridded data during cyclone Tauktae from 12/05/2021 to 17/05/2021.

Study Area

Study area lies between 12° 45′ 0″ N to 13° 50′ 0″ N latitude and 74° 45′ 0″ E to 75° 5′ 0″ E longitude. It consists of ten coastal villages. The study area extends from Someshwara in the south to Sasihithlu in the north, about 35.14 Km (without considering river mouths, ports and artificial structures along the coast). The study area is bounded by the Arabian sea in the left, Kerala state in the south and Udupi district of Karnataka in the north. The study area consists of one of India's major ports, New Mangalore Port Trust (NMPT) (Figure 1).

Methodology

A simple GIS technique is used to assess cyclonic storm Tauktae's impact on shoreline change on the Mangaluru coast. The pre-and post-cyclonic (Table 1) cloud-free satellite images of sentinel -2 with 10-meter resolution have been collected from the USGS Web portal, bands 2, 3, 4 & 8 were selected and layer stacking was done (Figure 2).

The color infrared band combination has been set to differentiate land and water easily. The manual digitization

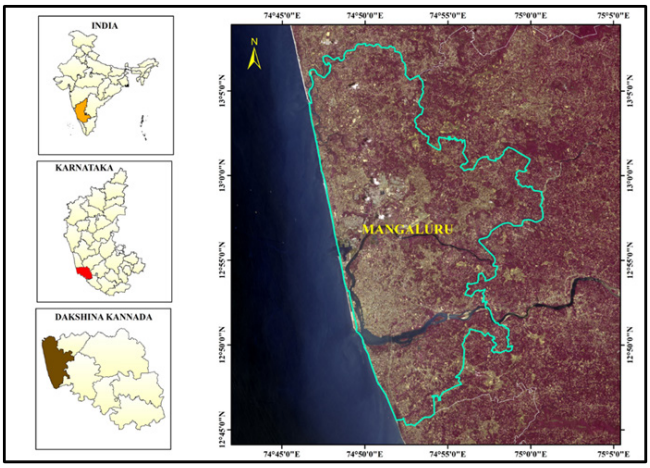

Figure 1: Study area

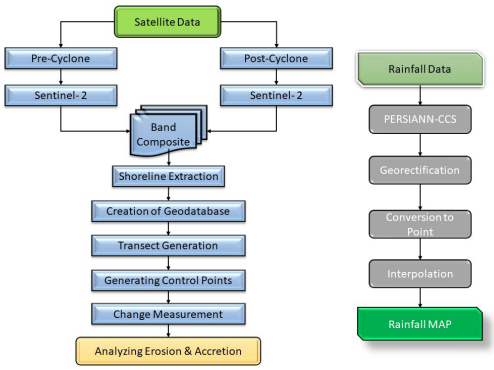

Figure 2: Methodology flow chart

Table 1: Datasets used in the study

Data	*Time Period*	*Source*	*Resolution*
Sentinel-2	01-04-2021	USGS	10 m
Sentinel-2	26-05-2021	USGS	10 m
Rainfall Data	12-05-2021 17-05-2021	CHRS	4 km

technique was adopted to extract the shoreline along the coast, and the natural and man-made structures like river mouths and ports were ignored during the extraction. The baseline has been drawn by buffering 300 meters from the shoreline off the coast. A geodatabase has been created to store the extracted shoreline along with the baseline. Transect lines with 50-meter intervals connecting pre and post-cyclonic shorelines have been generated with the help of DSAS in ArcMap 10.8 (Figure 3).

The generated transects has been intersected with the pre and post-cyclonic shoreline to get the point locations (Figure 4). Further, these points are connected with line features to measure the length of shoreline movement. The length of shoreline movement is calculated with the help of geometric calculation in ArcMap 10.8. The foreword movement of the shoreline towards the sea is considered accretion, and the backward movement is considered erosion.

Figure 3: Generated transects along the coast

Figure 4: Generated point locations

To map the rainfall condition during the course of cyclone from 12/05/2021 to 17/05/2021, the rainfall data have been collected from the CHRS data portal and PERSIAN CCS gridded rainfall with 4 km resolution have been selected. The collected data sets are geometrically corrected and projected to UTM zone 43. The projected data sets are converted to points, Interpolation kriging has applied, and maps are generated (Figure 4).

Result and Discussion

The study is focused on bringing out the changes in shoreline caused by the Tauktae cyclone in the Mangalore coast. The result of the study is generated by studying the movement of shorelines during past and post-cyclonic periods.

A notable number of changes in shoreline is found along the coast. A major part of the study area is affected by erosion and in some parts accretion is noted (Figure 5). A high erosion rate of more than -24.8 meters has been found in the areas of central and northern Mangaluru, Tannirbavi, Hosabettu, north of Idya nd South of Surathkal. Moderate erosion rate with -12.60 to -24.85 meters as noted in Mangaluru, major parts of Tannirbavi, Panamburu, Kulai, Hosabettu, Idya, Surathkal and Sashihitlu. There is a low erosion rate of less than 12.6 meters in Someshwara, south of Ullal, Suratkal and Sashihitlu.

A high accretion rate of more than 26.23 meters has been found in the south of Someshwara and north of Sashihitlu. A

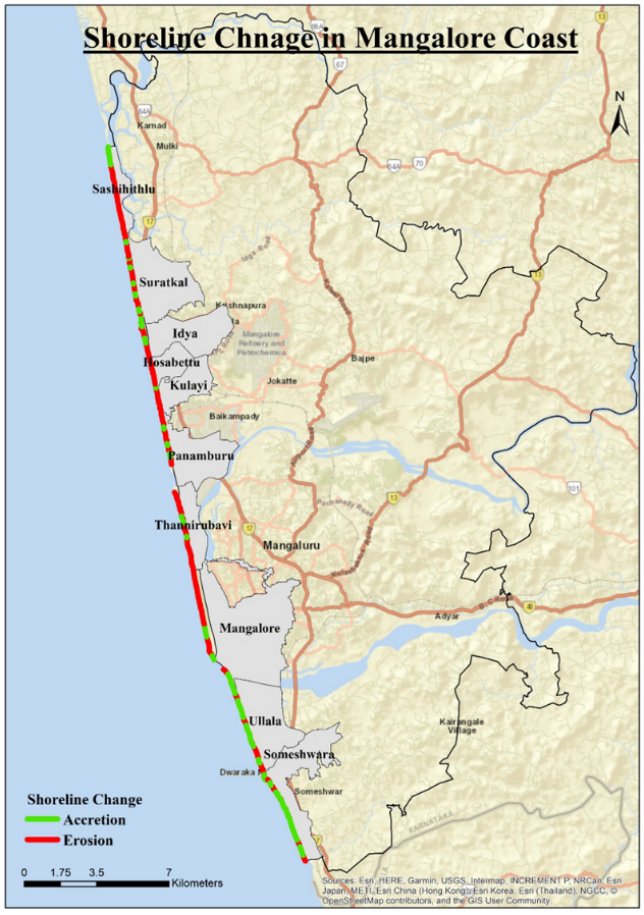

Figure 5: Shoreline change

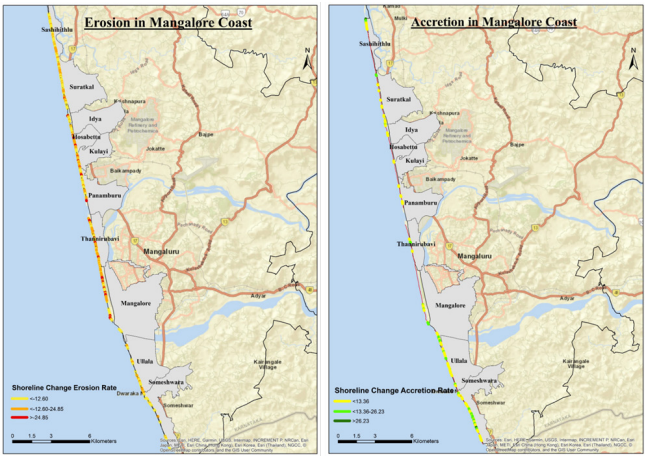

Figure 6: Erosion and accretion along the coast

moderate accretion rate of 13.36 to 26.23 meters has been found in central Someshwara, Ullal, south of Mangaluru, a central part of Tannirbavi and north of Surathkal. A less than 13.36 meters accretion rate has been found in parts of Someshwara, Ullal, Mangaluru, Panamburu, Idya, Suratkal, and north of Sashihitlu (Figure 6).

Rainfall conation in and around Mangaluru coast during cyclonic storm Tauktae is analyzed using Persian cloud

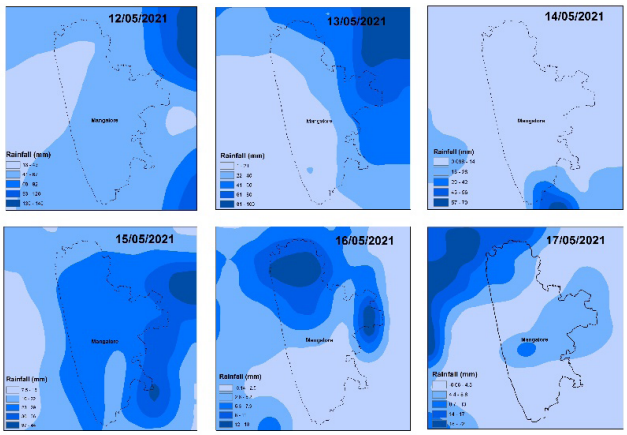

Figure 7: Rainfall pattern

classification system (CCS) gridding predicted rainfall data. The generated maps clearly show the rainfall pattern in and around Mangaluru coast from 12/5/2021 to 17/5/2021 (Figure 7).

Conclusion

Through this study its evident that cyclonic storms can imbalance and affect the shoreline of a particular region where it passes through. Studies has proven that geospatial techniques can be well adopted in analyzing the very short-term change in the shoreline. Mangaluru coast has witnessed a high.

Erosion rate of more than -24.85 meters and accretion rate of more than 26.23 meters during pre and post cyclonic period of Tauktae. The result acquired from the study can be beneficial for mitigating cyclonic impact on the shoreline and for coastal management in the Mangaluru coast.

Acknowledgment

We would like to express our heartfelt gratitude to Prof. Dasharatha P. Angadi from the Department of Geography, Mangalore University, for his invaluable guidance throughout the research process. Additionally, we sincerely thank the USGS for generously providing Sentinel-2 datasets at no cost and for making the DSAS ArcGIS extension accessible. Special appreciation is also extended to the CHRS data portal for providing free access to gridded rainfall data, significantly enhancing the quality of this study.

References

Baburaj, P., Abhilash, S., Nirmal, C. S. A., Sreenath, A., Mohankumar, K., & Sahai, A. K. (2022). Increasing incidence of Arabian Sea cyclones during the monsoon onset phase: Its impact on the robustness and advancement of Indian summer monsoon. Atmospheric Research, 267, 105915. https://doi.org/10.1016/j.atmosres.2021.105915

Deshpande, M., Singh, V. K., Ganadhi, M. K., Roxy, M. K., Emmanuel, R., & Kumar, U. (2021). Changing status of tropical cyclones over the north Indian Ocean. *Climate Dynamics*, 57(11–12), 3545–3567. https://doi.org/10.1007/s00382-021-05880-z

Evan, A. T., Kossin, J. P., Chung, C., & Ramanathan, V. (2011). Arabian Sea tropical cyclones intensified by emissions of black carbon and other aerosols. Nature, 479(7371), 94–97. https://doi.org/10.1038/nature10552

Kar, C., & Banerjee, S. (2021). Tropical cyclone intensity classification from infrared images of clouds over Bay of Bengal and Arabian Sea using machine learning classifiers. Arabian Journal of Geosciences, 14(8). https://doi.org/10.1007/s12517-021-06997-5

Mishra, M., Acharyya, T., Chand, P., Santos, C. a. G., Kar, D., Das, P. P., Pattnaik, N., Da Silva, R. M., & Nascimento, T. V. M. D. (2021). Analyzing shoreline dynamicity and the associated socioecological risk along the Southern Odisha Coast of India using remote sensing-based and statistical approaches. Geocarto International, 37(14), 3991–4027. https://doi.org/10.1080/10106049.2021.1882005

Murakami, H., Vecchi, G. A., & Underwood, S. (2017). Increasing frequency of extremely severe cyclonic storms over the Arabian Sea. Nature Climate Change, 7(12), 885–889. https://doi.org/10.1038/s41558-017-0008-6

Poulose, J., Rao, A. D., & Dube, S. K. (2020). Mapping of cyclone induced extreme water levels along Gujarat and Maharashtra coasts: a climate change perspective. Climate Dynamics, 55(11–12), 3565–3581. https://doi.org/10.1007/s00382-020-05463-4