

# TITLE; Characteristics on Cyclone and Storm Surge in Beira City, Mozambique

Daiki Tsujio, Pacific Consultants Co., Ltd., [daiki.tsujio@os.pacific.co.jp](mailto:daiki.tsujio@os.pacific.co.jp)

Kenzou Kumagai, Pacific Consultants Co., Ltd., [kenzou.kumagai@os.pacific.co.jp](mailto:kenzou.kumagai@os.pacific.co.jp)

Yusuke Yamasaki, Pacific Consultants Co., Ltd., [yuusuke.yamasaki@tk.pacific.co.jp](mailto:yuusuke.yamasaki@tk.pacific.co.jp)

Atsutoshi Hirabayashi, Japan International Cooperation Agency, [hirabayashi-atsutoshi@jica.go.jp](mailto:hirabayashi-atsutoshi@jica.go.jp)

## INTRODUCTION

There were 2 severe cyclones that attacked the Eastern African area in 2019. Cyclone IDAI attacked Beira city in central Mozambique, causing torrential rains and strong winds that resulted in more than 600 deaths and damage of 240,000 houses. Cyclone KENITH also attacked the northern part of Mozambique in the same year. There is few academic research regarding cyclones and storm surge in the Eastern Africa even if many cyclones attacked there. This study analyzed the characteristics of tropical cyclones that passed through the city of Beira and performed a series of storm surge simulations to understand impact factors based on its characteristics.

## CHARACTERISTICS OF CYCLONE IN BEIRA

In order to understand the characteristics of cyclones in the city of Beira, 59 cyclones are selected from the Best Track database (from 1951 to present) as cyclones that have passed near the city of Beira (See Fig. 1). The center pressure, speed of movement, and direction of movement of the cyclones were analyzed as well as probability evaluation of the center pressure. Cyclone ELINE in 2000 was the lowest center pressure, 930 hPa, followed by Cyclone IDAI (944 hPa). The results clarified that cyclones in the area move very slowly, at speeds of less than 15 km/h, and arrive here in all directions.

## STORM SURGE SIMULATION

Although there was no severe storm surge damage due to low tidal level at the time of Cyclone IDAI attack, damage would be more significant in case of high tide. Therefore, this study conducted storm surge simulations using the shallow-water equation. In Beira, there are relatively large tidal difference between neap tide and spring tide; high tide is about MSL+1.3 m in neap tide and MSL+3.6 m in spring tide. Figure 2 shows the maximum inundation area in the case assuming that Cyclone IDAI would hit at spring high tide. It can be estimated that much severer damage would be caused by Cyclone IDAI 1 week later than the actual date. Furthermore, the worst-case scenario for the city of Beira was examined by performing calculations for the parallel shift cases and the cases where the angle was varied from NW to WSW with respect to Cyclone ELINE (Figure omitted).

## CONCLUSIONS

Cyclones in the area move very slowly, and the effects of storm surge deviation last for more than one day. Therefore, high tides are likely to coincide with cyclones. Especially in Beira, the tidal range of the spring high tide is about 7 m. The simultaneous occurrence of a cyclone and a spring high tide leads to critical damage. Furthermore, the worst cyclone to Beira was identified as the one that passed slightly north of the Beira city in the direction of the WNW as the same as Cyclone ELINE.

Mozambique government has released a hazard map for the case of Cyclone IDAI in spring high tide, to the public in May 2021, based on this study, which is supported by Japan International Cooperation Agency (JICA).

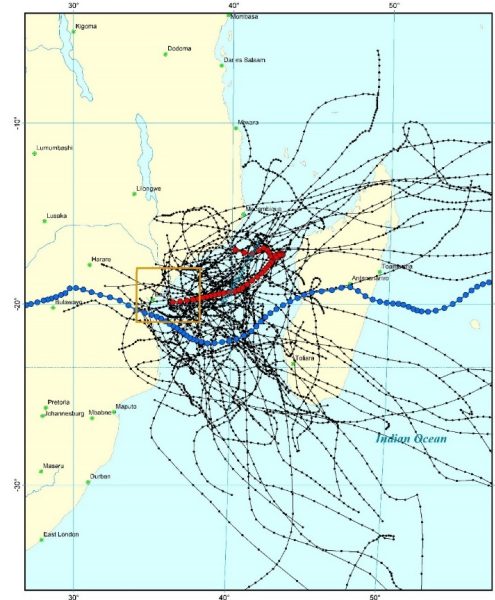


Figure 1 Cyclone tracks that passed through Beira (Red: Cyclone IDAI, Blue: Cyclone ELINE)

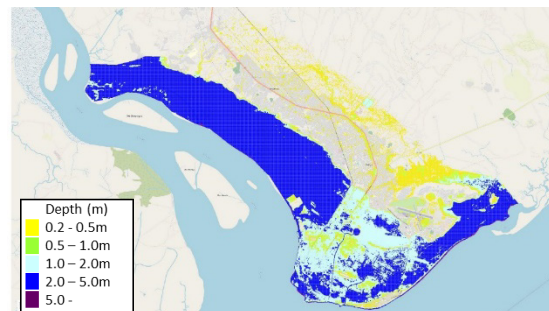


Figure 2 Result of storm surge inundation simulation in the case of Cyclone IDAI with spring high tide

## REFERENCES

- UN OCHA (2019): Cyclones Idai and Kenneth. Southern and Eastern Africa (ROSEA). <https://www.unocha.org/southern-and-eastern-africa-rosea/cyclones-idai-and-kenneth>.
- Mather & Stretch (2012): A Perspective on Sea Level Rise and Coastal Storm Surge from Southern and Eastern Africa: A Case Study Near Durban, South Africa. *Water* 2012, 4, 237-259.