DHI CASE STORY

CARVING A NEW PATH TO THE SEA

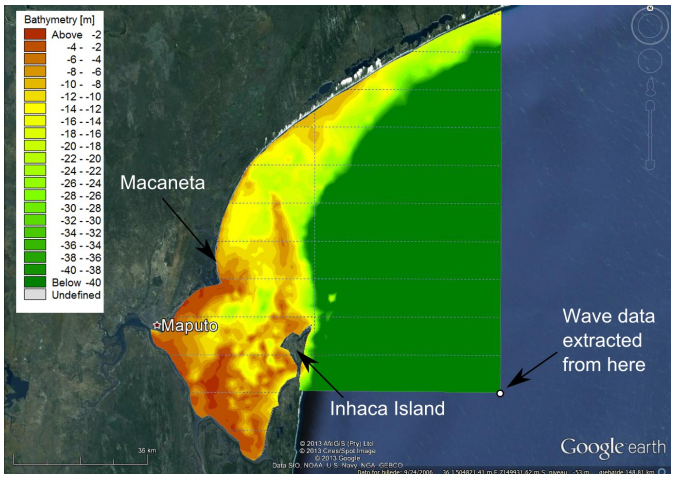
Using detailed coastal analysis to determine riverbank and coastal erosion

Protected from the Indian Ocean by the Macaneta Peninsula, the Lower Incomati Estuary in Mozambique is home to fishing and agriculture industries. Riverbank erosion in recent years has caused concern that the river could break through a narrow isthmus (a narrow strip of land that connects two larger areas of land), threatening these industries. Our detailed coastal analysis provided in-depth information on the state of the erosion. This enabled the Mozambican government to carefully weigh their options and decide whether protection measures were needed.

EROSION THREAT TO LOCAL INDUSTRIES

Separated from the Indian Ocean by the Macaneta Peninsula, the Lower Incomati Estuary in southern Mozambique supports subsistence and commercial fishing and farming industries. Over the years, the local population has observed the rapid erosion of the riverbank in the valley.

This has led to fears that the Incomati River could permanently break through a narrow, 60 m wide isthmus that connects the Macaneta Peninsula to the mainland. If that were to occur, the main outflow of the river would shift upstream by 10 km. This could have severe environmental and socioeconomic consequences for the area. If the river finds a shorter path out to sea, salt intrusion will affect the river further upstream, impacting both the farming and fishing industries.



Bathymetric plot showing the extent of the computational domain used for the local wave model.

SUMMARY

CLIENT

NIRAS, with the support of Danish International Development Agency (DANIDA)

CHALLENGE

- Conflicting information on riverbank and coastal erosion
- Lack of clear, detailed data on river and coastal processes
- Need to provide in-depth information about these processes to help determine whether protection measures were needed

SOLUTION

Detailed coastal erosion study to assess riverbank and coastal erosion and processes

VALUE

- Improved clarity on the state of erosion
- Clearer understanding of the river and coastal processes driving the erosion
- Enabling the Mozambican government to determine the necessity of erosion protection measures

LOCATION / COUNTRY

Lower Incomati Estuary, Macaneta Peninsula, Mozambique

To determine the appropriate course of action, the Government of Mozambique needed to know:

- the extent and rate of the erosion
- the factors causing the observed erosion

SEVERE RIVERBANK EROSION

To help Mozambique obtain more in-depth information, we worked with NIRAS to perform a detailed coastal erosion study of the Macaneta Peninsula. First, we performed a site visit to:

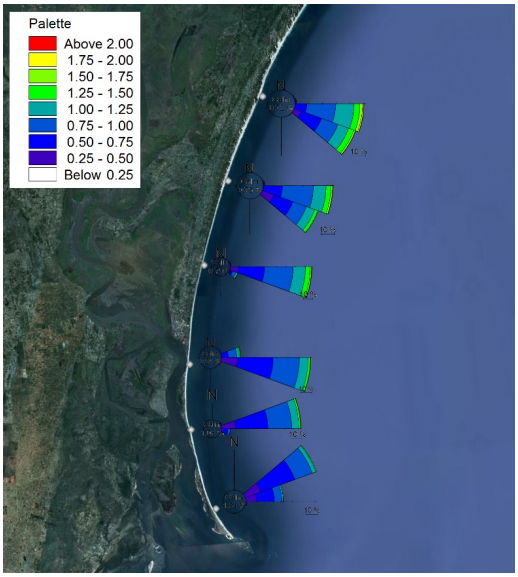
- examine the current state of erosion
- analyse the state of the beach and the local geology
- collect sediment samples

Next, we talked to the local population to gather anecdotal information to obtain a better idea of:

- how the site looked in the past
- the frequency of overwash events – when high sea levels and large waves caused waves to wash over the isthmus and into the river

We then compared current aerial images with aerial images from 1989 to determine historical erosion over the last 25 years. We found that severe erosion has occurred along certain stretches of the riverbank.

The curved portion of the riverbank in the northern part of the isthmus is eroding at a rate of one metre per year. This is typical for meandering (bending) rivers like the Incomati. As water flows through a meandering river, the maximum flow speeds occur close to the outside banks of the curves. The riverbank in the southern part of the isthmus is eroding at a much slower rate.



Wave roses showing the modelled wave conditions along the Macaneta coast.

A STATE OF EQUILIBRIUM

Despite the riverbank erosion, the isthmus has maintained its shape over the last 25 years. We found that overwash events transported sediment from the beach to the riverbank, compensating for the erosion. Although one might expect beach erosion due to this loss of sediment, our analysis of the aerial images indicates that this was not the case.

Using MIKE 21 SW, we assessed nearshore wave conditions along the Macaneta Peninsula. We ran the model for an eight-year period (2005-2013) corresponding to the period for which wave data was available. We found that waves approach the Macaneta Peninsula at a right angle due to the presence of Inhaca Island and a 35 km long shallow area off the coast.

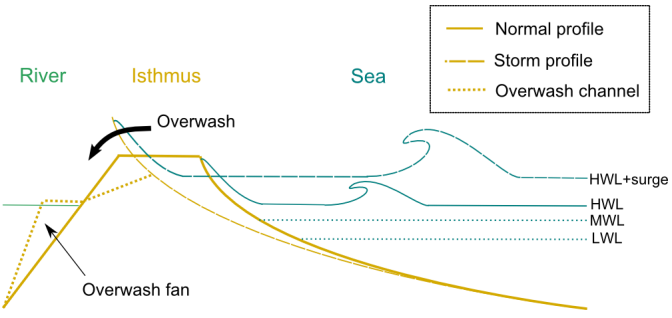
Utilising the LITDRIFT module of LITPACK, we analysed sediment samples and calculated littoral drift (the transportation of sediments along a coast at an angle to the shoreline). We evaluated the direction of the sediment transport. We also determined the equilibrium orientation of the coast – when the beach faces straight towards the mean wave direction, resulting in zero net yearly sediment transport. We found that the Macaneta coast is stable as it is aligned with the equilibrium orientation determined from the wave conditions.

Based on our analysis, the dynamics of the river and the sea seem to have reached a balanced state that maintains the isthmus. This means that the river is unlikely to break through the isthmus. If a breakthrough were to occur, it would likely be due to an extreme wave and water level event, such as a storm with surges and large waves.

With this information, Mozambique now has a better understanding of the:

- general processes acting on the Macaneta coast
- processes that could cause the Incomati River to break through the isthmus
- possible consequences of such a breakthrough

This will enable them to weigh and prioritise protection efforts in the future.



Sketch showing the normal profile of the isthmus compared to a storm profile with overwash channels and fans. Because the isthmus is too low and too narrow for the storm profile to be established, an overwash event occurs.

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