

ALLOWANCE FOR FORMATION OF MEGA SAND WAVES ON THE SEABED IN THE DESIGN OF FAIRWAYS IN ESTUARIES WITH STRONG CURRENTS

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The declared depth in port access channels is often maintained by dredging and monitored by regular bathymetric surveys. However, at remote sites these activities are not cost-effective and the channel depth would need to be defined based on the surveyed depth plus an allowance for sedimentation and variability in bed levels. This allowance can especially be significant in estuaries with strong tidal currents, where mega bedforms, including sand waves, develop on the seabed due to the prevailing strong current flows. The mega sand waves are highly mobile and fluctuate in height as they migrate over the seabed.

Mega sand waves and mega ripples with a height up to approx. 3.2 m were observed in multi-beam bathymetric survey undertaken in the offshore entrance to the Geba River estuary in Guinea Bissau. An example of this is shown in Figure 1. Supramax bulk carriers with a draft of 11-12 m are planned to transit this area on departure from a proposed phosphate export terminal located further upstream in the estuary.

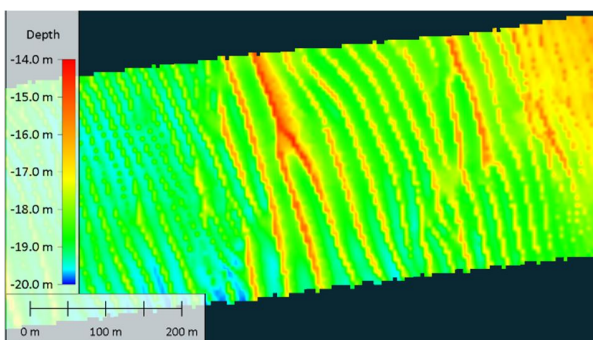


Figure 1 - Mega sand waves observed in the bathymetric survey data

ANALYSIS OF MEGA BEDFORMS

Sediment composition data in conjunction with water depths and tidal currents from a calibrated MIKE HD FM model were analysed to identify the areas potentially suitable for the formation of mega bedforms. Subsequently, a bedform allowance amplitude above the mean depth was determined based on the observed sand waves in the bathymetric survey and the Yalin & Da Silva (2017) formula for mega bedform formation, which best represented the dimensions of the observed features. The allowance was compared to an extensive set of measured dune heights as function of the water depth above the dune crest presented by Schmitt et al. (2007).

UNDERKEEL CLEARANCE CALCULATIONS

The proposed terminal is located 20 km northeast of

Bissau along the Geba River and approx. 140 km upstream from the channel constraining area where mega bedforms may develop. Laden vessel departures will be planned such that the ship leaves the berth against a flood current, transits a shallow section just southwest of Bissau around high tide, anchor in one of the deep and wide sections of the estuary and continue sailing such that it transits the shallow offshore section where mega bedform may develop on the following high tide. A speed profile and associated transit times were determined as such for the entire departure route.

The channel profile was analyzed in 100 m sections using data from the multi-beam survey. The vertical dimensions of the channel were designed accounting for allowances specified in PIANC (2014). A novel approach in the calculation of an allowance for formation of mega bedforms was developed by the authors to consider both a maximum potential bedform height, and also a significant bedform height.

Vessel squat was added based on numerical modelling and the estimated vessel speed profile. Vessel response in waves was determined based on modelled response amplitude operators and simulated wave conditions along the departure route. In this way, a year could be simulated with assumed possible departure windows on every tide. It was found that vessels can depart safely on most tides at a draft of 11 m provided that the ship transits the constraining offshore section around high tide.

CONCLUSIONS

The channel design for the Geba River estuary in Guinea Bissau has adopted a novel method to include data from observed mega sand waves and calculated theoretical upper-bound estimates of dune heights. could be used in this study to define a declared bed level along a planned fairway. Mega bedforms which can develop in areas with sandy sea beds and strong tidal currents can be the governing process in variability in channel bed levels and the approach presented in this paper can be adopted in a channel design in accordance with PIANC (2014).

REFERENCES

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