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Numerical study of tides and tidal currents in the Nacala Bay, Western Indian Ocean

Evaristo António Simbine[1] (evaristoantoniosimbine@gmail.com), Teófilo FP João[1,2](Ferraz-r@hotmail.com), Fialho PJ Nehama[1,3] (fialho.nehama@gmail.com)

[1] Escola Superior de Ciências Marinhas e Costeiras, UEM, 1o de Julho ave., Quelimane, Mozambique
[2] Ministry of Science and Technology, Praça da Independência, Quelimane, Mozambique.
[3] Corresponding author

Background

Most of what is known about the oceans was derived from field observations of water properties that vary from one site to another. Ocean observations are taken from oceanographic or hydrographic measurements employing direct or indirect approaches. On the other hand there in an increasing use of numeric models to adequately quantify ocean properties and their changes in space or time, as well as devise information from the pre-instrumentation period and make predictions for the future. Therefore, a great number of hydrodynamic models can be found in the literature, and we chose the Estuarine and Lake Computer Model (ELCOM) to investigate the tides in Nacala Bay. Understanding the tides and tidal currents is of particular importance for many coastal areas where living and non-living marine resources are driven by the tide dynamics. Located in northern Mozambique, Nacala is a natural harbour of great socio-economic importance for the country, and yet, the oceanographic conditions of the bay did not receive much attention from researchers. The present study aims to contribute with information on tides and currents for the bay in general, and it will seek to describe the propagation of tidal wave throughout the bay in particular.

Methods

ELCOM is a tri-dimensional sigma layer model developed by the Australian centre for Water Research, that solves the Navier-Stokes equations using high-order differentiation schemes. The geometry and bathymetry was discretized from a nautical chart, and initial fields for temperature and salinity were taken from historical records. Tides were extracted from the global TMD model, and the model results were validated against tide gauge data.

Results

The tidal oscillation in the bay undergoes two high waters and two low waters every day, reaching a maximum of 1.91 and 0.34 metres of amplitude during spring and neap tides, respectively. For all control stations the tidal currents at the surface level were much stronger during flooding than ebbing, in agreement with earlier observations. The bay can be

dynamically divided in two halves, provided that the currents are considerably stronger in the left side of the bay than in the other half, a clear indication of the predominance of the Bernoulli effect inside the bay.

Conclusion

The Nacala Bay exhibits semi-diurnal tides with the principal lunar and principal solar constituents being the two major contributors. Shallow water constituents are not significant although tidal distortion is considerably high at the margins. During spring tides the currents flow mainly in the direction to and from the bay, and across-mouth flow is important during neap tides. This is particularly important for sailors that need to pay special attention to the tidal cycle as they make their way into or out of the bay.