

Long-term suspended sediment transport patterns over the North-Western part of the Persian Gulf, applying a three-dimensional hydrodynamic model

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The North-West part of the Persian Gulf is covered with mud deposits, partly originating from the Arvand River. On the Iranian coastline, Deylam Bay is the western margin of the affected area by the mud. Mud deposits up to 20 meters thickness are observed at the very shallow coast between Shah-Abdollah Port and the Arvand River mouth; it is why very fine sand with oolitic origin is dominant in Deylam port on the south eastern corner of the bay. Near the most northern point of the bay there is a small village with a newly constructed port, called Shah-Abdollah, where repeating sequences of soft mud and fine sand could be observed on the beach, indicating that this location maybe a marginal point of the sandy and muddy sediments. Hence, it is believed that the long-term pattern of suspended mud transport in the North-Western Persian Gulf is the main cause for determination of mud affected margins in this area (Khaleghi et al., 2014). Concurrently with the development of coastal and marine areas in this mentioned body of water, a need for understanding of sediment transport patterns and sediment constituents in the sea-bed increasingly arises in order to clarify the effects of anthropogenic activities and ensure more accurate planning. This research was performed in order to offer a sophisticated response for the arisen needs via providing a better understanding of coastal and gulf-scale processes in the North-Western Persian Gulf, where fine deposits govern the general sediment environment. We applied a quasi-three-dimensional hydrodynamic model to the Persian Gulf and simulated the current field for a 1-year period. The results were compared to a very precious velocity field data which had been collected inside the Persian Gulf in 2012. Using the results, we focused on the north-western part and simulated the sediment transport which is mostly coming from: 1) the Arvand River catchment area and 2) chemical precipitation from the water. The phenomenon was tracked through investigations and a clear border can be distinguished on the sea-bed near the Shah-Abdollah Port where upper-left region is mostly covered by mud and downer-right region is covered by the original sand. The model has a bed module which is capable of simulating the accumulation of sediment constituents including deposition and resuspension considering bed shear stresses induced by bottom currents and wind waves. Wave hindcast is performed using a module based on JONSWAP method.

As it is well established in this field, the proposed hydrodynamic model considers all meteorological driving forces of a general hydrodynamic model including: tide, wind, precipitation, river load, solar radiation, air pressure and air temperature. We note that, even though the Persian Gulf is a semi enclosed water body, tide is the dominant driving force of the water circulation. This was developed in the frame of a quasi-three-dimensional hydrodynamic model. The model is capable of simulation of the velocity field as well as consequent pollutant (dissolved and suspended) transport and oil slick dissemination.

The hydrodynamic model (Sasaki and Isobe, 1999) is based on Navier-Stokes equations with the hydrostatic and Boussinesq approximations. In the water body, the conservation equation for any water quality parameter is given by a three-dimensional transport equation with the source term. A comprehensive water quality model and a multi-layer-material bed module was added to the model.

Through this numerical experience the collected velocity data which clarifies the vertical profile of the velocity in the North-Western Persian Gulf has been reproduced and comparisons show that the model was successfully applied and the model results are in consistency with the observed data. The variation of the horizontal velocity in vertical direction was sophisticatedly reproduced and verifies that the results of this research are of help to understand the gulf-scale processes of the Persian Gulf.

Through applying the boundary condition for several years successively, long-term pattern of suspended mud transport and consequent spatial pattern of formed bed constituent in the study area were extracted and compared with morpho-dynamic evidences in the study area. The main parameters which had to be focused on were the river load and precipitation rate which were comprehensively investigated.

References

- Khaleghi A., M. Soltanpour and S.A. Haghshenas. 2014. A study on the sand-mud mixture at north-west of the Persian Gulf. 34th Coastal Engineering Conference (ICCE 2014), ASCE, Seoul, Korea.
- Sasaki J. and M. Isobe. 1999. Development of a long-term predictive model of water quality in Tokyo Bay. Proceedings of Estuarine and Coastal Modelling, ASCE 6:564-580.