TIDE IN GIRONDÉ ESTUARY
Gwenaëlle Jan, Florent Lyard, Damien Allain, Michel Tchilibou, Jarred Penney

To cite this version:
Gwenaëlle Jan, Florent Lyard, Damien Allain, Michel Tchilibou, Jarred Penney. TIDE IN GIRONDÉ ESTUARY. 9th EuroGOOS International conference, Shom; Ifremer; EuroGOOS AISBL, May 2021, Brest, France. hal-03340111v2

HAL Id: hal-03340111
https://hal.science/hal-03340111v2
Submitted on 24 Sep 2021

HAL is a multi-disciplinary open access archive for the deposit and dissemination of scientific research documents, whether they are published or not. The documents may come from teaching and research institutions in France or abroad, or from public or private research centers.

L’archive ouverte pluridisciplinaire HAL, est destinée au dépôt et à la diffusion de documents scientifiques de niveau recherche, publiés ou non, émanant des établissements d’enseignement et de recherche français ou étrangers, des laboratoires publics ou privés.
TIde IN GIRONDE ESTUARY

Gwenaële Jan (1), Florent Lyard (2), Damien Allain (2), Michel Tchilibou (2) and Jarred Penney (2)

(1) SHOM, 13 rue du châtelier, 29200 Brest, France, gwenaele.jan@SHOM.fr
(2) CNRS/LEGOS, 14 avenue Édouard Belin, Toulouse, France

Abstract

The study investigates the dynamics of the Gironde estuary in order to improve the tidal wave deformation modelling in a constrained environment. The need has been highlighted by statistics over high and low tides and surges, upstream of Fort Medoc (Figure 1) (SHOM & Grand Port Maritime de Bordeaux project, 2013). A numerical model has been configured and supplemented by a multi-sensor in situ measurement campaign. The challenge is to separate the part of the physics explicitly solved by the model from what cannot be solved and must consequently be parameterized with physical resolution ranging, here, from 10 m to 1 km. The results show the improvement in reproducing the deformation of tidal wave, disturbed by river flow and atmospheric stress. From the analysis at tide gauge stations, the mean standard deviation of the amplitude difference between model and observations is now close to 0.03 m, which is an improvement of the score previously obtained (0.10 up to 1.0 m, depending on river flow and atmospheric conditions). Navigation safety along the Gironde River and the risk of flooding camp the motivations of the present study. The expectation of infrastructure for navigation in the estuary is acute.

Keywords: numerical modelling of tidal wave distortion, water level measurement, river dynamics and environmental key points

1. Introduction

The project consists in studying the dynamics of tide in the Gironde Estuary with the aim of understanding the deformation of the tidal wave that occurs as well as establishing choices of parameters likely to control its propagation (e.g. slope of the river bed, bottom friction, river flow, bathymetry and boundary conditions). Standard deviation of tide amplitude and its error have be lower than 0.10 m with a phase lag less than 10 minutes. This is why the study aims to reproduce the observed accentuation of water level asymmetry between rising and falling tides and thus, to predict more realistically the tide shape of high and low tide. Through a numerical development of a river with variable flow, several simulations with variable roughness length led to an automated calibration of the model. The development of a method to characterize the tide in an estuary has allowed to define tidal wave decay coefficients and to classify different
estuarine regimes. The refinement of the methods developed can tend to reduce the phase shift in the prediction of high and low tides.

2. Method

Starting from the statement that the strong non-linearity of estuaries makes the harmonic tidal analysis method fail, barotropic, shallow water tidal model has been identified as a preliminary step necessary to progressively advance in the parameterization of tidal dynamics in this constrained environment. A configuration has been developed and adjusted for this study (T-Ugom, Lyard F. et al., 2020). The friction coefficient (Cd) synthesizes the vertical diffusive effects and the bottom friction effects. The transposition of a 2-dimensional Cd to realistic dynamics remains a complex question. In order to provide some insights to the question of the representativeness of the adjusted Cd, several friction coefficients were tested from spectral simulations. Sequential simulations were run, then, and brought the development of a method to characterize the tide in an estuary and classify different estuarine regimes.

The evaluation of the model is done by comparison with synchronous in situ measurements. In complement, an accurate vertical datum is a key to the project due to the applications related to water level and requirement on tide prediction uncertainty. The realistic tidal modelling is based on a measurement campaign prepared for this study, then carried out in a cooperation with Cnes and partners which greatly enlarged the scope of the deployed instruments, notably, in the framework of the SWOT space mission project (Cnes, Nasa) and its CalVal-related requirements (Ayoub N. et al., 2019, Picot N. et al., 2020). The set of in situ data is made of (a) radar tide gauges from Grand Port Maritime de Bordeaux, from SHOM and from DREAL Aquitaine who provided also river flux; radar gauge onboard (Insu prototype), (b) GNSS floating carpet (La Rochelle University, operated by Insu and Syrte); fixed buoys; (c) GPS-GNSS land network. These data are the validators of the numerical simulation. A Lidar campaign has been carried out, with the sensor and airborne means of the University of Caen. Results from Lidar will lead to a precise information the river surface topography. For this study, the sensitivity of tidal wave propagation to the disturbance from river flow is approached by water elevation time series under different rising and falling tides.

3. Result and Conclusion

From method of bottom friction (Cd) calibration, numerical experiment combined with the analysis of in situ data from campaign 2018, significantly decreases the water height difference between model and observation (e.g. M2 tidal harmonic from 197 mm to 31 mm (Figure 1, Figure 2)). Several terms responsible for the noted damping of waves and the generation of higher harmonics have been calibrated. The results are presented in poster with a first report on numerical simulation validation under weak tidal condition, in particular for Bordeaux where the phasing of tide is improved (Figure 2).
Fig. 1. M2 amplitude (Complex, m) over Gironde and M2 amplitude. Difference model – tide gauge (circle size in cm) (MarEst Project, SHOM, Legos).

Fig. 2. Water height (m) at Bordeaux tide gauge (Grand Port Maritime de Bordeaux), relative to the mean level of the study. Modelled (orange curve) and observed (blue curve) (MarEst Project and partners of CalNaGironde2018 campaign (Cnes, DT Insu, Legos, SHOM, Syrte, et al.,)).
Acknowledgements

DGA for financial support: PROTEVS upstream study, piloted by SHOM in the MarEst project; CNES; DT INSU (C. Brachet, C. Drezen, L. Fichen, A. Guillot, E. Poirier, B. Blanke), Energie de la Lune (C. Giry), Grand Port Maritime de Bordeaux; DREAL Aquitaine; Syrte, Obs. de Paris (P. Bonnefond); University of La Rochelle for GNSS carpet; UniCaen, Circle.

References

