Assessment of harbor oscillations and ship waves for mariners' safety – Collaboration (June 19 – July 28, 2016)

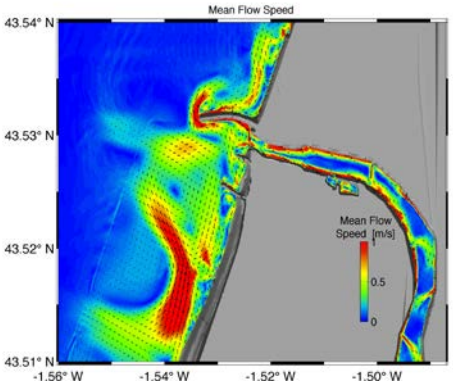
Theme：Mariners' safety, harbor oscillations, ship waves, numerical modeling.
Location: Université de Pau et des Pays de l'Adour, Anglet, France
Leibniz Universität Hannover, Hannover, Germany

The effects of sea-level rise and storm intensification pose a combined engineering and social-economic problem to coastal communities around the world. Especially, ports and harbors are challenged by long-period oscillations triggered by swell waves and basin resonance. At the same time, an increasing global market forces these facilities to ensure safe and timely operations.

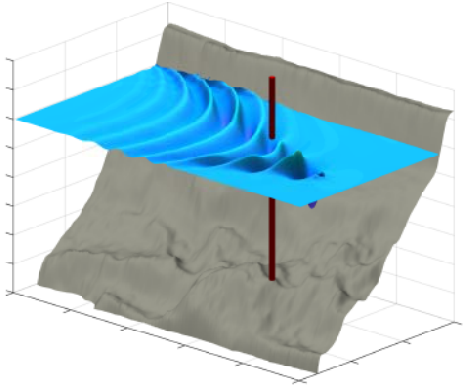
Assistant Prof. Volker Roeber (International Research Institute of Disaster Science (IRIDeS), Tohoku University) and Associate Prof. Denis Morichon (Université de Pau et des Pays de l'Adour) have been investigating harbor oscillations in the Port of Bayonne (SW France). The Port of Bayonne is a natural harbor at the mouth of the Adour River. It is mainly being used by bulk cargo vessels to support a local steel refining factory as well as by fishing and recreational boats. The harbor entrance faces the open Atlantic Ocean and is partially sheltered by two breakwaters. However, large winter swells are known to cause substantial oscillations in combinations with strong flow velocities in the entire harbor and upstream in the Adour river. Snapped mooring lines, drifting vessels, and shutdown of operations are common problems during these events. In addition, the discharge of the Adour River is transporting large amounts of sediments downstream. The longshore drift, interrupted by the breakwaters, contributes to the sediment accretion near the harbor entrance that requires regular dredging operations.

The collaborative study has been focusing on the numerical computation of the local wave conditions and subsequent harbor oscillations. We found that during large winter swell events long-period infragravity waves are released from breaking swell waves right in front of the harbor entrance where a sill of dumped dredging material acts as a focal point for the local waves. Part of the IG spectrum experiences resonance due to the harbor's geometry. The mean flow velocity in the area where vessels are moored can quickly exceed 1 m/s and provides an explanation for the mooring problems reported by the port authority (lamanage).

In addition, a collaborative study with the hydraulics and coastal engineering laboratory of Prof. Torsten Schlurmann (Leibniz Universität, Hannover, Germany) has shown that ship waves can be accurately computed with depth-averaged equations such as used for storm waves or tsunamis. Especially the propagation and interaction with waterway embankments and harbors can be accurately computed with simple geometries of moving pressure disturbances does and does not require the detailed computation of fluid-body (ship hull) interaction. A manuscript, submitted to Coastal Engineering, is currently under revision.



Flow speed generated by storm waves around Port of Bayonne.



Ship waves near a waterway embankment

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