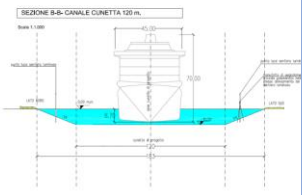
Hydrogeological modelling of dredging the Tresse navigable canal trough the Venice lagoon

Project summary



Client:	CNR - ISMAR
Year:	2016
Service:	Computer Modelling
Sector	Water Resources Engineering
Site:	Venice lagoon (Italy)
Geological setting:	Sedimentary basin
Mathematical model:	Groundwater flow in a saturated porous medium with mass (salt and pollutant) transport
Project in numbers:	150,000 degrees of freedom

Abstract

This study, commissioned by CNR and ISMAR, is aimed at the numerical modelling of the hydrogeological effects of dredging the Tresse navigable canal trough the Venice lagoon.

The hydrogeological analysis is performed with the aid of a state-of-the-art finite-element numerical model with the main objective of predicting the short (minutes), medium (months) and long (decades) term processes of water and pollutant exchange between the shallow aquifer system of the lagoon, enhanced by the canal excavation and ship-wakes.

Project description

A comprehensive investigation has been carried out to quantify the possible effects of dredging a navigable canal on the hydrogeological system underlying a coastal lagoon. The study is focused on the Venice Lagoon, Italy, where the Port Authority is planning to open a new 10-m deep and 3-km long canal to connect the city passenger terminal to the central lagoon inlet thus avoiding the passage of large cruise ships through the historic centre of Venice. A modelling study has been developed to evaluate the short (minutes), medium (months), and long (decades) term processes of flow and contaminant exchange between the subsurface and surface systems, possibly enhanced by the canal excavation, and ship-wakes. The hydrogeological modelling has been supported by an in-depth characterization of the lagoon subsurface along the channel. Geophysical surveys, laboratory analyses

on groundwater and sediment samples (chemical analyses and ecotoxicity testing), in-situ measurements through piezometers and pressure sensors, and the outcome of 3D hydrodynamic and computational fluid dynamic (CFD) models have been used to set-up and calibrate the subsurface multi-model approach. The numerical results, obtained with specific computational models developed by the M3E team, allow to quantify the groundwater volume and estimate the mass of anthropogenic contaminants (As, Cd, Cu, Cr, Hg, Pb, Se) likely leaked from the nearby industrial area over the past decades, and released into the lagoon from the canal bed by the action of depression waves generated by ships. Moreover, the model outcomes help understand the effect of the hydrogeological layering on the propagation of the tidal fluctuation and salt concentration into the shallow brackish aquifers underlying the lagoon bottom.

Project outcome

The services provided to the client are the following:

- Development and calibration of a 2D hydrogeological flow and transport finite-element model.
- Estimate the mass of anthropogenic contaminants (As, Cd, Cu, Cr, Hg, Pb, Se) likely leaked from the nearby industrial area over the past decades, and released into the lagoon from the canal bed by the action of depression waves generated by ships.
- Estimate the effect of the hydrogeological layering on the propagation of the tidal fluctuation and salt concentration into the shallow brackish aquifers underlying the lagoon bottom.

Reference

Nardean, S: Modelling the impact of the Tresse channel dredging on the Venice lagoon aquifers. Banchelor's thesis, 2016.

Teatini, P. et al.: Hydrogeological effects of dredging navigable canals through lagoon shallows. A case study in Venice. Hydrology and Earth System Sciences, 2017.