Environmental impacts from dredging operations

Integrated modeling technologies used in Australia’s new harbor project

Nuala Fitzpatrick, Applied Science Associates (Asia-Pacific, APASA), Perth, Australia

Australia has seen an explosion in port and harbor infrastructure projects due to the country’s growth in ore mining, natural gas development and other exports. Dredging operations and sediment displacement are often necessary for port and harbor development, maintenance and creation of shipping channels, and offshore infrastructure projects.

One of the challenges faced during dredging operations is assessing the potential impacts of the suspended sediment and displaced dredge material that result. Such projects can benefit from the predictive capabilities of computer models, to assess the environmental impacts from suspended sediment plumes on water quality and marine biota. Computer models can simulate the marine environment and estimate potential impacts from coastal engineering projects.

Environmental modeling company Applied Science Associates (ASA), provides integrated modeling technologies and studies in support of dredging activities internationally, ASA’s regional Asia-Pacific office (APASA) has been particularly active in supporting dredging operations as Australia’s port development surges.

APASA recently completed a study for Fremantle Ports, in conjunction with Oceanica Consulting Pty. Ltd., of the potential marine environmental impacts of proposed dredging operations associated with the development of a new harbor in Cockburn Sound, Western Australia. The harbor project, known as Kwinana Quay, will include creation of a large area that will support expanding container trade. APASA’s focus was the dredge plume modeling, Oceanica performed extensive environmental work that underpinned the impact analysis, and the Center for Water Research provided the underlying validated hydrodynamic model. The area will be created by dredging more than 10 Mm$^3$ of sand and rock using a large cutter suction dredge.

An integrated modeling study was completed to assess the impact of the expected suspended sediment plumes on the ecology of Cockburn Sound. The project team used ASA’s DREDGEMAP™, an advanced dredge material simulation model, to study the problem. DREDGEMAP predicts the transport, dispersion, settling and re-suspension of sediment released to the water column by dredging operations.

The DREDGEMAP model was calibrated with previous dredging projects in Cockburn Sound, and then used to simulate the Kwinana Quay dredging program. Model inputs included three-dimensional hydrodynamic and wave data from external models, together with detailed dredging, geotechnical and sediment source parameters, to generate a three-dimensional total suspended solids concentration (TSSC) data set. The TSSC data set was subsequently used to estimate light attenuation for assessment of the impact on sea grass health. In addition the...
effects of TSSC on snapper spawn and larvae during the spring and summer periods were assessed, based on results of eco-toxicology tests conducted using replicated dredge-generated sediment samples.

DREDGEMAP is a framework of sediment-related models from ASA’s in-house modeling software suite that includes SSFATE™, SSDOSE™, and CAPModel™ (built by ASA in collaboration with the U.S. Army Corps of Engineers). All models are integrated with advanced GIS and data processing and analysis tools.

Models can be used to determine optimal operational parameters to satisfy regulatory requirements for suspended sediment, and to study the impacts of dredge disposal and capping activities.

ABOUT THE AUTHOR

Nuala Fitzpatrick has seven years professional experience as a coastal engineer. She has been lead coastal engineer for a range of large-scale resource support projects, providing advice and guidance to engineering and environmental teams.

ENQUIRIES

To read the full study, ‘Modelling the Marine Environmental Impacts of Dredge Operations in Cockburn Sound, WA’, visit: www.asascience.com/about/publications