A practical guideline to support best practice in dredge plume modelling

Dredging, an essential activity of coastal infrastructure development, has the potential to impact the marine environment. As part of the Environmental Impact Assessment (EIA) process, dredge plume modelling is routinely undertaken to help predict the intensity and extent of potential impacts to marine benthic habitat. To improve the quality and robustness of impact prediction, CSIRO has led the development of a practical guideline on key aspects of dredge plume modelling which require careful consideration and analysis.

The need for a guideline

Large-scale dredging campaigns can remove millions of tonnes of material from the seabed. Some of the sediments initially suspended into the water by dredging activities are transported away from the dredging location by coastal currents. Dredge-induced suspended sediment plumes (dredge plumes) can reduce the amount of light reaching the seabed and increase sediment deposition in low-energy areas. This generates environmental pressures that could induce potentially widespread ecological impacts in sensitive benthic marine communities (e.g. coral, seagrass and sponge communities).

Dredge plume modelling is designed to predict the dispersion and fate of dredge plumes and can be used throughout the phases of a coastal infrastructure project to assist the planning, design and option selection, impact assessment, and adaptive management during the dredging campaign.

Modelling dredge plumes is challenging as the processes of advection, diffusion, settlement and resuspension of sediment are complex, and there have been debates and inconsistencies in how the modelling is undertaken for environmental impact assessment (EIA). Currently there are no standardised methods for predicting dredge plume dispersion and the potential effects on receiving environments.

Consequently, environmental regulators generally adopt a precautionary approach when evaluating the impacts of proposed developments requiring dredging activities. This approach has led dredge plume modellers to adopt conservative assumptions, which may result in dredge plume model predictions with plume footprints significantly larger than those observed during the actual dredging project. As a result, dredge plume and impact monitoring programs have focussed principally on demonstrating compliance beyond the predicted envelope of impact, and have foregone the opportunity to improve understanding of the relationships between plume-related environmental pressures and ecological impacts by monitoring closer to the dredging activities.

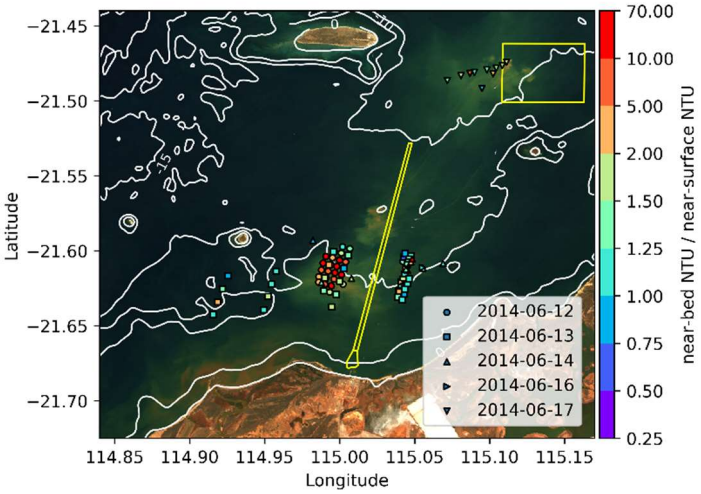

Figure 1: Field observations (coloured geometric shapes on the map) of vertical gradient of suspended sediment (the ratio of near-bed turbidity and near-surface turbidity) 12-17 June 2014, measured during the Chevron Australia Wheatstone dredging project near Onslow, Western Australia. Warm-coloured shapes indicate much higher turbidity near the seabed. White lines show the bathymetry and yellow lines denote the location of the channel and spoil ground.

Who is the Guideline intended for?

The Guideline aims to provide the current best practice for the application and review of dredge plume models in the context of Australian statutory EIA. It is intended as a reference document (instead of a rigid standard) for proponents, consultants, environmental regulators, and the public in preparing and evaluating an EIA. The Guideline focuses on establishing a consistent and sound approach to the modelling of dredge plumes for predicting the pressure fields when applying for EIA approval.

Tackling challenging concepts

The Guideline represents a synthesis of extensive literature review, new research, and key learnings from the Western Australian Marine Science Institution (WAMSI) Dredge Science Node (Themes 2 and 3).

An overarching guiding principle from the Guideline is that dredge plume modellers need to engage ecologists from the very beginning of the EIA process to understand the spatial distribution and ecological thresholds of the sensitive marine habitats and identify relevant cause-effect timescales and pathways.

The Guideline strongly recommends that a public database to support dredge plume modelling be established and all relevant data be made available. The database will greatly improve the availability of reference information at the EIA stage, assisting both those responsible for the EIA preparation, and for interpreting and approving the dredge activity.

Challenging concepts addressed by the guideline include:

- the conceptualisation of complex sediment transport processes to inform a modelling strategy that builds system understanding
- adequate baseline data collection for the success of modelling and interpretation of the model results
- source term estimation and approaches which can be refined as improved knowledge is developed
- field observation requirements for total suspended solids (TSS) and near bottom light levels
- considerations on the choice of a two-dimensional (2D) or three-dimensional (3D) model which considers the vertical gradient in sediment concentration (Fig. 1)
- evaluating uncertainty in plume modelling through consideration of likelihood and confidence in environmental variability, model parameterisations and source terms (Fig. 2)

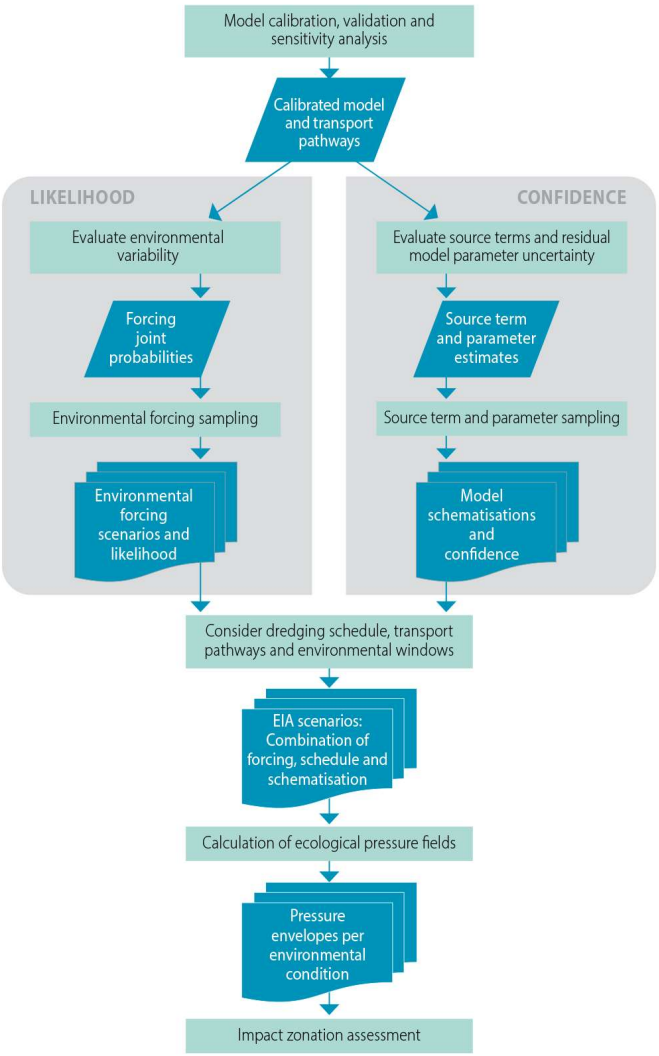

Figure 2: Flow chart of process to evaluate likelihood and confidence in the establishment of EIA modelling scenarios.

Benefits of the guideline

It is hoped that the dredge plume modelling guideline will provide increased confidence in modelling outcomes, leading to a reduction in the monitoring and management burden required by regulators and increased transparency and public confidence in the EIA process.

A **full copy of the guideline** can be found at:

https://publications.csiro.au/publications/publication/PIcsiro:EP207995

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