EQUILIBRIUM MORPHOLOGY MODEL APPLIED THROUGHOUT THE EXTENSIVE NAVIGATION CHANNEL NETWORK OF THE GOLD COAST WATERWAYS, AUSTRALIA

Jesper Nielsen, Seaport OPX, jsen@dhigroup.com
Dan Ware, Gold Coast Waterways Authority, dan.ware@gcwa@qld.gov.au
Helena Karatvuo, Seaport OPX, heka@dhigroup.com
Simon Mortenson, Seaport OPX, sbm@dhigroup.com

INTRODUCTION

The prediction of sedimentation in waterways can preempt navigational hazards and support ongoing maintenance operations. The NCOS online software (Mortensen et al, 2018), used by port operators globally, has recently been upgraded to include the capability to predict sedimentation. This paper introduces the elegant but powerful equilibrium morphology model which would otherwise remain "behind the scenes" in the software.

GOLD COAST CHANNEL NETWORK

The Gold Coast channels are narrower and shallower than those which support commercial shipping for the Port of Brisbane to the north. Nonetheless, the 33 navigable channels totaling 260 km in length facilitate a multitude of recreational, fishing and tourist vessels. The extensive channel network is managed by the Gold Coast Waterways Authority.

The channel network consists of numerous sand bars and spits which can considerably reduce the channel depths in localized areas and restrict safe navigation. Currently these bathymetric features are intermittently dredged and generally reform before re-dredging.

Except for the Gold Coast Seaway entrance channel, the channels are not exposed to waves capable of transporting sand. Whilst freshwater flows following heavy rainfall do temporarily elevate currents, the tidal currents are largely responsible for the formation of the restricting bathymetric features.

THE EQUILIBRIUM MODEL

The bathymetric features in the Gold Coast channel network recover towards their respective pre-dredged / "equilibrium" elevations at a rate dependent on the distance from equilibrium. That is, the recovery post dredging is fastest immediately following the cessation of dredging. Whilst these features reform due to sand transport associated with tidal currents, the spring-neap tidal cycle is a subscale process. The recovery of the features is effectively described by Equation 1, which has previously been used in the description of other coastal morphological responses (Nielsen, 2019).

$$\frac{dz}{dt} = \frac{z_{eq} - z}{\tau_{morph}} \qquad (1)$$

The equation indicates that the rate at which the bed elevation (z) will return to the equilibrium elevation (z_{eq}) is dependent on the difference between the instantaneous and equilibrium elevation and a morphological time constant (τ_{morph}). The time constant is derived from a calibration exercise. Figure 1 demonstrates how reliably the bathymetric features return to an equilibrium value post dredging and how effectively the equilibrium equation represents the data.

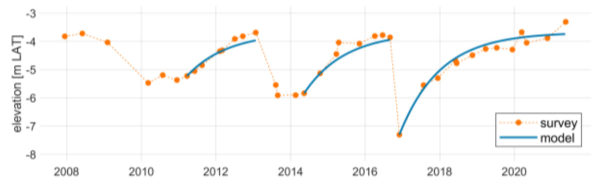

Figure 1 - Elevation timeseries plot of the sand bar which restricts the South Channel of the Gold Coast Network. The sand bar has been dredged and recovered 3 times since 2008.

It is not only the accuracy of the model that makes it so useful, but how readily it can be deployed throughout an entire channel network. The above figure demonstrated how the model could be applied at a discrete point, however in application, Equation 1 is solved on every grid point for which there exists historical survey data. This means that reliable forecasts of the entire network can be generated in a matter of seconds for years into the future - this is remarkable for a morphological model.

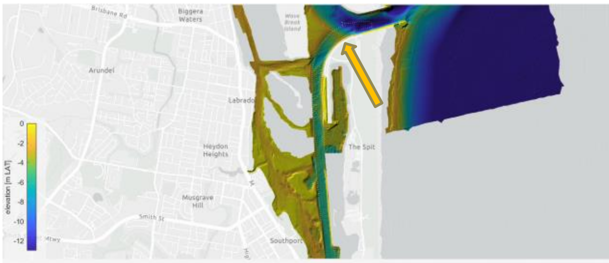

Figure 2 - Plan view plot of forecast bathymetry. An arrow indicates the location of the sand bar featured in Figure 1.

The equilibrium model is also well suited to scenario testing and hence the planning of future maintenance operations.

REFERENCES

Mortensen S. et al. (2018): Web-Based Operational System for Optimising Ship Traffic in Depth Constrained Ports, 34th PIANC World Congress, Panama City, Panama.

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