Monitoring, modelling, prediction and control of dredging operations

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The Environment

- Choice of Dredger and Placement Method
- Prediction of Suspended Sediment Source Terms
- Prediction of Suspended Sediment Movement and Intensity
- Prediction of Fate of Suspended Sediment
- Prediction of Impacts on the Environment
Building with nature promotes:

- Characterise the environment
- Develop project to fit the environment
- Fit the physical works to the locality
- Ensure that dredging and reclamation can be carried out with minimum environmental disturbance
What is the environment?
Monitoring

• Currents
• Waves and swell
• Suspended sediments
• Bed materials
• Sensitive receivers (seagrass, coral, mangrove etc, and their ability to withstand stress)
• Natural variability (including storms)
• Replicate in models
The project

- The project
- Choice of dredger and placement method
- Prediction of suspended sediment source terms
- Prediction of fate of suspended sediment
- Prediction of impacts on the environment
- The environment
The project

- Develop works (quays, reclamation, channels etc.) to give minimum impact on sensitive receivers and natural processes
- Use models to assess effects of completed project on current regime, sediment movement, wave regime and local habitats
Choice of dredger

- Identify optimum types of dredging operations
- **Model** to determine outputs and costs
- Assess environmental effects, in principle
- Compare alternatives
- Shortlist of potential methods
Dredger Model

CUTTER SUCTION DREDGER MODEL: OVERVIEW

SITE CONDITIONS
- Material Type
- In Situ Density
- Compressive Strength
- Particle Size Distribution
- Rock Quality Designation
- Disaggregation
- Angularity

CHANNEL DESIGN
- Dredging Depth
- Width of Channel
- Face Height

OPERATION
- Dredging Depth
- Face Height
- Depth of Cut
- Advance Distance
- Stone Trap

DREDGING VESSEL
- Maximum Dredging Depth
- Maximum Swing Speed
- Cutterhead Dimensions
- Power on Cutterhead
- Suction & Discharge Pipe Diameters
- Number of & Power on Pumps
- Fuel Type & Crew Numbers

MODEL

WEEKLY OUTPUT M³

FACE OUTPUT M³/HOUR
WATER FLOW RATE M³/HOUR

LIMITING FACTOR:
- CUTTING / SWING / SUCTION / DISCHARGE

WORKING / STANDING COSTS

FINES LOSSES

PIPELINE
- Length
- Type: Floating / Sinker / Land
- Layout & Static Rise
- Booster Stations

COSTINGS
- Site Surveys
- Working Hours Per Week
- Working Efficiency
- Vessel Rates inc. Crew
- Tugs & Other Vessels
- Fuel, Tooling & Wear
- Overheads, Profits & Risk
Source Terms

The Project

Choice of Dredger and Placement Method

Prediction of Suspended Sediment Source Terms

Prediction of Suspended Sediment Movement and Intensity

Prediction of Fate of Suspended Sediment

Prediction of Impacts on the Environment
• Discharges from dredger (from models)

• Discharges from mode of transport (from models)

• Discharges from reclamation (from models)

• Discharges from placement operations (from monitoring)
Source terms become plumes
Plume modelling

- Use source terms from **dredger models** to input to **plume models**
- Predict maximum turbidity levels and rates of sedimentation
- Assess whether predicted results give rise to constraints to dredging operations
- Access economic effects
Example (3)
Spring tide release - 40 mins before HW

Spring tide - peak concentration

Concentration
mg/l

- 200
- 100
- 50
- 20
- 10
Impacts

THE PROJECT

CHOICE OF DREDGER AND PLACEMENT METHOD

PREDICTION OF SUSPENDED SEDIMENT SOURCE TERMS

PREDICTION OF SUSPENDED SEDIMENT MOVEMENT AND INTENSITY

PREDICTION OF FATE OF SUSPENDED SEDIMENT

PREDICTION OF IMPACTS ON THE ENVIRONMENT
1. Will the sediment impact the environment? Or
2. Will the environment impact the dredging operations? Or
3. Will both be affected?
4. What is the right balance?
5. Specify how the dredging operations are to be monitored and controlled
Monitoring

Key Criteria:

Don’t monitor unless you are going to use the results

Be clear what you are going to do with the results
Monitoring

Use appropriate measuring instruments:

• Some are blind to large size fractions
• Some are highly affected by marine growth
• Need to ensure that results are not spurious

• Be sure how the measurements are to be collected and analysed
Continuity:

The same type of instrument, and preferably manufacturer, should be used for the monitoring:

- before the dredging
- during the dredging
- after the dredging
How to control?

1. Set a level.
2. Measure the effects of dredging in real time
3. Check actual level against set level
4. Modify operations if level exceeded
Control

Or:

1. Identify, from predictive modelling, locations where effects will be clearly seen and the level of effects predicted.
2. Monitor at these locations to demonstrate that the actual effects are no worse than predicted.
3. Only adapt dredging operations if levels exceed predicted figures.
Ask the following questions:

Is it sensible – or practical – to stop the dredging operations?

Does the work allow the dredging activities to be re-programmed for mitigation purposes?

Can real time monitoring really be achieved at an economic cost?
We can have this!
And still have this!